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Psychological Perspectives on Financial Decision Making

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Editors

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Foreword by Hersh Shefrin

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Foreword

During the 1970s and 1980s, much of my research focused on the way self-control issues impact the way people make financial decisions. I think it is fair to say that the planner-doer framework which my co-author Richard Thaler and I developed together represents the first neuroeconomic model to appear in the literature.

Viewed from the vantage point of today, the neuroeconomic structure we employed might seem a bit primitive, as our model of the human brain has just two components, the prefrontal cortex and the limbic system. With the passage of time, great strides have been made in identifying the roles played by a host of neurological structures, such as the nucleus accumbens, dorsolateral prefrontal cortex, and anterior insula.

Despite its relative simplicity, the planner-doer model provided a useful framework for identifying weaknesses in the neoclassical approach, both from a positive and normative perspective. Evidence that many people voluntarily choose to operate within their budget sets instead of on the boundary certainly tells us that financial decisions often fail the test of neoclassical rationality. This evidence led us to ask whether people were behaving irrationally or whether the neoclassical notion of rationality is ill suited to a world in which human brains are structured as multisystems, or both.

The planner-doer model is the core of the behavioral life cycle approach, meaning the psychological approach to the way people consume and save over the course of their life cycles. Retirement saving is an important application of the model, but not the only one, as we also applied the model to explaining decisions about the consumption of addictive goods such as nicotine, overeating and dieting, procrastination in receiving dental treatment, gift giving, and the purchase of durable goods such as air conditioners.

This book, edited by Tomasz Zaleskiewicz and Jakub Traczyk, is very much in the spirit of the historical line of inquiry I have described above. The book is divided into three parts, the first pertaining to decision technology within the brain, the second pertaining to decision making at the level of the individual, and the third being what I would call real-world applications and which the book's editors call the level of society. Readers of this book will come away with an appreciation of financial decisions are impacted by the way we are wired, and how that wiring is impacted by a variety of contextual and demographic factors.

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Preface

Making financial decisions is a substantial part of our daily lives. We choose what to buy, where to buy, how much to pay, and how to pay. We make choices concerning taxes: to pay what we ought to or try to evade? If we possess enough money, we decide whether and what amount to save or invest. Alternatively, we may spend our financial surplus for shopping or gambling. In less favorable circumstances in which we lack resources, we potentially must decide on whether and how to borrow. Sometimes, we are asked to donate to different charitable causes, a potential decision that also demands us to decide on how much to donate and whether to donate anything at all. These are just a few illustrations, and many others, more or less specific, can be listed here. However, what makes all these examples similar is that they involve money and require making decisions under risky or uncertain conditions.

The commonness of financial decision making in the contemporary world has made this area one of the core topics of theorizing and research in various scientific disciplines, including economics, psychology, and, more recently, brain sciences. Given that financial decisions are *ex definitione* related to money, it is not surprising that their analysis has been dominated for decades by classical economics, which represents a normative approach to the analysis of human behavior. At the heart of the normative economic reasoning lies the concept of rationality. Rational choice theory tells us what is logically consistent and optimal. Classical economics portrays a financial decision maker who analyzes all important information, is hardly susceptible to biases and emotions, and has stable preferences—the so-called *homo economicus*. For example, it is assumed that financial markets are rational because investors who make their decisions there are also rational. In this context, "rational" means that the investors' choices result in an optimal level of utility (i.e., individuals are able to act in accordance with the most preferred balance between risk and expected return).

Another example of how conventional economic models interpret financial decision making might refer to saving. Here, the economic theory (named *the life-cycle hypothesis*) posits that rational consumers have the cognitive capacity to plan their consumption and savings over their life-cycle. As Richard Thaler—one of the founders of behavioral economics who was awarded the Nobel Prize in Economics in 2017—suggests in his book *Misbehaving*, such an assumption requires decision makers to have rational expectations about the future and be able to make all necessary calculations that concern future earnings, expenditures, life expectancy, etc. What is more, the normative theory of financial choice implicitly says that people will have enough will-power and self-control to realize their optimal saving plans.

Even if the normative model of decision making developed in classical economics is very elegant and fascinating in different ways, it appears to not adequately describe people's real behaviors. In the context of decisions made on financial markets, extensive empirical evidence has documented that investors are overly confident, too optimistic in forming expectations, strongly averse to losses, overreactive to information, etc. The investors' reliance on different rules of thumb, their susceptibility to cognitive errors, and strong feelings (both negative, such as fear or regret, and positive, such as joy or excitement), may make the market highly unstable and lead to such phenomena as price bubbles or sudden crashes. Decisions related to saving that real people make in real circumstances are also far from what rational, normative models predict. For example, consumers were found to face tremendous difficulties with delaying gratification, assign an unproportionally high value to immediate rewards, or have unstable time preferences. All these behavioral peculiarities cause people to save less than predicted by the rational economic theory, which may be observed especially in the context of retirement saving (statistics show that a substantial portion of US citizens will not have enough savings to maintain their standard of living). Societies also grapple with the increasing level of (over)indebtedness. Consumers want to have more and spend more, but, at the same time, they do not possess enough financial resources, which make them less willing to restrain whims and more eager to use quick loans.

The normative-descriptive gap in the analysis of financial decision making has motivated researchers to search for and create models that more realistically reflect people's behaviors in different areas of the market. The 1970s brought vast progress in the development of descriptive, evidence-based theories of financial choice. It is enough to refer to Daniel Kahneman's and Amos Tversky's research on heuristics, biases and framing, and their development of prospect theory—one of the dominant theories of choice under risk—as well as Herbert Simon's bounded rationality theory that models how people with their cognitive limitations deal with decision dilemmas in a highly complex environment. The developments in behavioral decision research showed that the classical utility theory is not a sufficient approximation of decisions made in the real world. This fact initiated some economists' interest in descriptive models of choice and eventually resulted in the emergence of a new subdiscipline of economics—behavioral economics. This field combines insights from psychology, economics, decision theory, and even biology to reveal anomalies in human behaviors that cannot be explained by standard economic theory and to propose new models of decision making that can more accurately predict people's financial activities.

One prominent example of combining economics and psychology to develop a descriptive model of financial decision making is the behavioral life-cycle hypothesis proposed by Hersh Shefrin and Richard Thaler in 1988. These authors assumed that people's consumption and saving depend *inter alia* on how they interpret their income. Using the terminology of this behavioral model, we would say that people hold their wealth in different mental accounts, which means that they mentally frame their assets as current income, current wealth, or future income. For instance, $1,000 won in a lottery is likely to be added to the current income mental account, but the same amount of money received as an inheritance might be framed as future income. Consequently, one would be more willing to consume in the former case and save in the latter. Mental accounting was not the only novel concept introduced by the behavioral life-cycle hypothesis. The model also offered original theorizing related to the functions of self-control in intertemporal decision making. Drawing from the famous psychological research by Walter Mischel on gratification delay in young children, Shefrin and Thaler introduced the conceptual framework that saving may be a result of the interplay of two selves: The Planner and The Doer. The former is responsible for strategic thinking in terms of long-term goals, while the latter is oriented toward consuming immediate rewards. Thinking about the human mind as a structure of multiple selves has a long tradition in psychology, but it was exceptionally original in economics. Subsequently, the idea was developed by Daniel Kahneman in his two-system model of information processing (fast and automatic, System 1, and slow and analytical, System 2).

Behavioral economics has vigorously developed since the 1980s and has become mainstream rather than an extravagance. It has also become an umbrella for other behavioral subdisciplines of economics: behavioral finance, experimental economics, or behavioral game theory. As Richard Thaler writes in his work, one day behavioral economics will disappear because all economics will be behavioral.

Most of the recent advancements that arose from the linkage of economics, cognitive, affective, and social psychology, and neurobiology and developed our understanding of financial decision making are represented by such fields as neuroeconomics and decision neuroscience. These two interdisciplinary areas use neuroimaging and psychophysiological methods, animal models, and neuropsychological approaches to discover the underlying mechanisms behind financial choices. The most popular method for performing neuroeconomics research is probably to study which brain areas are involved in making decisions and to interpret these observations in terms of behavioral phenomena. The neuroscientific research has enormously helped to better understand: (a) decision making processes under risk and uncertainty, (b) intertemporal choice, and (c) economic decision making in a social context. For example, the results collected by Alan Sanfey and his colleagues in the area of social neuroscience showed why people are ready to prefer lower earnings over higher earnings while interacting with unfair partners. They used an ultimatum game in which the first player decided how to divide money between themselves and the second player, and then the second player decides whether to accept this offer. In the case of acceptance, the money is divided as proposed by player 1. In the case of rejection, both players receive nothing. A rational player 2 will accept all offers higher than 0 (even if they are very unfair) because it is better to earn something than to end the game with no money at all. However, evidence shows that a player 2 will tend to reject very unfair offers; this finding indicates that they prefer no money to some money. This decision is not rational from the normative perspective. Sanfey and his team investigated the differences in neural reactions between the unfair and fair offer conditions and found that rejecting unfair offers was associated with heightened activity in anterior insula—a brain region related to emotions. This finding suggests that irrational decisions from a normative perspective may be explained when their affective basis is considered. As we will show later in this book, emotions may be responsible for choices that violate the axioms of rationality (but they do not have to). In many cases, they serve as an adaptive tool to support smart decision making.

Both behavioral economics and neuroeconomics represent a descriptive approach to financial decision making. To paraphrase the metaphor proposed by Meir Statman—a behavioral finance researcher—these two disciplines tell a story about "normal decision makers" rather than "rational decision makers." They show how real people undertake their economic activities in real environments filled with complexity, uncertainty, a lack of reliable information, and under social pressure. The present handbook is also part of such an approach. Its content does not deal with the question of what is the right way to make financial decisions; rather, it aims to answer the question of how people actually figure out such difficult dilemmas. Therefore, it highlights three different levels—the brain, the individual decision maker, and the society—on which financial choices may be analyzed. We hope that bridging these various horizons will be helpful to better comprehend making decisions in the field of personal finance. Social science typically distinguishes three levels of analysis: the micro-level (an individual), the meso-level (a group or a tribe), and the macro-level (a nation or a society). Here, we suggest a slightly different understanding of this differentiation; specifically, we begin our investigation on the neural level, namely single neurons and neural networks. The meso-level refers in our plan to an individual decision maker endowed with specific personality features, cognitive abilities, and emotional reactions. Finally, we introduce the macro-level. Similar to the classification offered by social science, we construe it as the level of the society. However, instead of tracing global phenomena that are the effect of interactions between hundreds or thousands of people, we attempt to show how the specificity of individual economic actions translate into large groups (e.g., the society to which an individual belongs).

The first level can be named the micro-level because it represents the biological, neuroscientific investigation of financial decisions (Part I). The human brain receives and integrates different types of information that are necessary to make very complex financial decisions. Understanding how information is processed in the brain is very useful for interpreting phenomena that are observed on the behavioral level, including: making choices under risk and uncertainty, susceptibility to biases, using different rules of choice, following emotions, etc. A more insightful knowledge of the biological mechanisms behind judgment and decision making would also be valuable for creating tools that support more beneficial consumer choices.

The second level is the level of an individual (Part II). It covers psychological functions of both cognitive and emotional processes involved in making financial decisions. Individual differences in cognitive abilities (e.g., numeracy and financial literacy) may influence smart decision making in the field of finance. However, good decisions result from analysis and statistical reasoning, as well as emotions that can be as informative as quantitative expertise when different economic dilemmas are contemplated. People's judgments, choices, and actions depend on what they know, how they feel, how they regulate their moods, how much they are able to control their reactions, how much they are open to new information, etc. Personality—another construct investigated in this part of the book—is understood as a set of specific cognitive, emotional, and behavioral patterns, together with some demographic factors (e.g., age) and in interaction with various environmental characteristics determines decision making processes in all spheres of life, including finance.

Finally, the third level refers to the place of an individual decision maker in a society (Part III). Although psychology is typically focused on individual decision making, it does not ignore broader, societal consequences of single choices. People individually decide how much they want to save, whether they intend to take out a loan, how much risk they will accept in the financial market, how much money they agree to spend on gambling, or whether they will be honest in paying their taxes. However, the accumulation of individual decisions creates the dynamics of the societal system. For example, if many citizens do not honestly pay taxes, the society as a whole will have worse chances to fund public investments. To explain large-scale economic phenomena such as poor contribution to retirement plans, it would be helpful to first figure out their determinants on more basic levels (e.g., the level of individual behaviors). This approach also holds for designing and implementing various intervention programs.

The first part of this book comprises three chapters. The first two chapters focus on neural mechanisms behind financial decision making and the third one analyzes the role of hormones in regulating our physiology and behavior in the area of finance. The authors of Chap. 1, Peter Kraemer, Regina Weilbächer, Laura Fontanesi, and Sebastian Gluth, show different possibilities of how neural activity relates to observed financial behaviors. However, instead of focusing only on the relationship between single-cell activity and choices, they focus on the joint activity of entire neuronal populations within a brain region, as well as the interaction of different brain regions in decision making. In particular, the authors discuss the pivotal role of the brain reward system in financial decision making. As neuroeconomic research has documented, this system is crucial for the motivation and modulation of goal-directed behaviors. Additionally, the authors discuss the advantages of evidence accumulation models in predicting financial decision making. This chapter may also be useful for readers who are unfamiliar with the neuroscientific literature because the authors outline the basic principles of neural information processing and explain the methods applied in neuroeconomics.

Chapter 2, by Vinod Venkatraman and Elizabeth Beard, continues with presenting models and research from decision neuroscience. The authors begin by providing an overview of this research area and show how it has progressed to its current mature form. The key part of the chapter elaborates on the neural bases of valuation, especially in the context of financial decision making under risk and uncertainty. The valuation of potential gains and losses is an essential part of the economic decision process. Both normative and descriptive models of choice refer to such concepts as value maximization or subjective utility, therefore irrespective of whether or not we postulate that people maximize expected utility, it is important to understand the biological mechanisms behind valuation itself. The second part of this chapter reviews neuroscientific approaches to strategic decision making. It deals with the questions of how individuals arrive at a decision and how they simplify complex representations of decision variables. The results presented by the authors indicate that activation in different brain regions can predict people's behavior in various phases of the decision process.

The final chapter in Part I by Joe Herbert (Chap. 3) presents another way of using biology to analyze financial decision making. The key topic of this chapter is the role of hormones, such as testosterone, cortisol, and oxytocin. As the author documents, hormones participate in physiological regulation and exert effects on different behaviors. Testosterone enhances competitiveness, aggression, risk-appetite, and optimism, all of which are of great significance in the context of financial decisions that people make as entrepreneurs, managers, investors, or consumers. Oxytocin plays an important role in social bonding, and a vast amount of research has found that the level of this hormone influences how much people trust each other being involved in an interaction. This phenomenon is of special importance because trust is an essential ingredient of financial transactions. Finally, Chap. 3 reviews research related to the effects of cortisol on financial decision making. It shows that the release of this hormone is increased in response to stress. The literature review presented by the author suggests that stress, and the associated levels of cortisol, can impair attention and risk assessment, and that more prolonged increases may have different effects on risk appetite and impulsivity.

Chapters from 4 to 9 build Part II of the book and provide evidence on how financial decision making may be investigated at the level of an individual. In Chap. 4, Agata Sobkow, Dunia Garrido, and Rocio Garcia-Retamero review research concerning the role of cognitive abilities in financial behavior and discuss potential applications of knowledge about individual differences in cognition for designing methods that might help people make better decisions. This approach especially concerns the issue of supporting decision makers with lower levels of cognitive abilities. The two authors show that financial decisions are predicted by different cognitive abilities, including intelligence, cognitive reflection, and multiple numeric competencies: statistical numeracy, approximate numeracy, and subjective numeracy. Importantly, these abilities operate on the basis of different cognitive mechanisms and predict distinct decision outcomes, which means that they should not be reduced to a single cognitive ability.

The authors of Chap. 5—Eyal Carmel, David Leiser and Avia Spivak—discuss research related to financial literacy, which is defined as the combination of knowledge, ability, skills, and confidence that supports good financial decisions. For example, more literate people are better in money management activities and make more effective economic decisions (e.g., have better retirement plans) compared to those who are less literate. The concept of financial literacy has gained increasing interest in recent years, both among researchers and practitioners, because it appears that the majority of people around the world have problems with solving even relatively uncomplicated economic tasks that may be responsible for their ineffective behaviors in the area of personal finance. The straightforward solution in this context would be to increase consumers' financial literacy. However, as the two authors propose, people's aptitude to deploy their financial literacy relies on different factors: some endogenous (i.e., personality) and some external (i.e., economic circumstances). The authors also introduce their original theoretical model that summarizes evidence concerning the effects of financial literacy on economic behavior and offer its practical implications.

Chapter 6, by Tomasz Zaleskiewicz and Jakub Traczyk, contributes to understanding how individuals make their financial decisions, with an elaboration on the valid role of emotions. Normative models of choice have largely ignored the importance of feelings in the decision process. On the contrary, descriptive theories suggest several paths through which emotions regulate decision making. The chapter makes a distinction between integral and incidental emotions. The former are caused by the decision itself (e.g., one experiences fear because she or he is aware of a high probability of loss), while the latter are not directly related to the decision problem and are driven by external causes (e.g., one is angry because a car broke down, but the anger impacts the risk-taking motivation). For example, the authors show how stock market decisions made by investors may be distorted by mood caused by weather. Contrary to popular views, the authors propose that emotions may fulfill an adaptive role in financial decision making and be supportive in making beneficial choices. They also introduce their own view on the association between emotions and risk that draws from psychological science on mental imagery.

The authors of Chap. 7—Katarzyna Sekścińska and Łukasz Markiewicz—review research outlining the relations between financial decisions and different personality dimensions. Personality traits represent a relatively stable system of one's thinking, feeling, and behaving. Individual differences in personality were found to be related to a wide representation of decision making factors. For example, anxiety increases financial risk aversion, but the need for excitement motivates an individual to engage in risky and uncertain situations. The authors of this chapter review studies that show how psychological knowledge about personality might be used to better understand such financial activities, including saving, borrowing, or investing. For example, they provide evidence that people may differ in their willingness to save because they also differ in the amount of self-control—the ability to subdue one's impulses to achieve long-term goals. This chapter also informs about how economic behaviors may be interpreted in the context of personal characteristics related to the five factors of personality (extraversion, neuroticism, agreeableness, conscientiousness, and openness), subjective time perspective, and motivation.

The two chapters that conclude Part II present the perspective of an individual decision maker from a more dynamic view. In Chap. 8, JoNell Strough, Jenna Wilson, and Wändi Bruine de Bruin investigate how financial decision making is the subject to change with age-related differences in cognitive abilities, experience-based knowledge, emotional processes, and motivation. The topic explored by these authors is of special importance because we live in an aging society; this factor also impacts processes that regulate financial behaviors. Strough and colleagues discuss how age-related declines in cognitive abilities may yield suboptimal decisions, especially when decisions are complex or decision makers lack motivation to deploy cognitive resources. However, they also note that changes in emotional processes that appear with age may have a positive effect on decision making. Finally, this chapter reviews research that shows how using different interventions (e.g., nudging) may support older individuals in making smarter financial choices.

The final chapter in this part of the book—Chap. 9 by X.T. Wang—explores the issue of uncertainty that is one of the central concepts in economics. Many if not most financial decisions are made in uncertain circumstances. For example, investors can hardly predict future price changes; entrepreneurs have no access to the knowledge of strategic goals of other market agents; and consumers do not possess information about expected changes in interest rates. As the author of this chapter suggests, traditional, normative models of financial choice often fail in the face of uncertainty because probability estimates are not precise or are simply unknown. He also argues that even if information about probability may be obtained, the probability estimates of the model can be inaccurate and dangerously misleading. Another claim proposed in this chapter is that the “less is more” rule might be especially useful under uncertainty. The author discusses preliminary evidence for reducing uncertainty by using frequency counts, single reason, simple heuristics, and decision reference points.

The chapters that comprise Part III of the book show different peculiarities of making individual financial decisions in a broader societal context. They cover the psychological analysis of such common financial behaviors as investing, saving, borrowing, gambling, and charitable giving. In Chap. 10, Sandra Andraszewicz investigates the psychological mechanisms behind two extensive phenomena observed in financial markets: crashes and price bubbles. Assuming people are rational in the sense of the assumptions held in normative decision models, such mispricing tendencies should not happen. However, all those who are either active on the market or only systematically observe it are aware that mispricing is omnipresent and reoccurring. Therefore, this research requires analyses rooted in descriptive models of financial behavior. The chapter begins with a review of concepts and research on crashes and bubbles. Next, it provides evidence on how mispricing tendencies may be driven by biases such as group-think, the disposition effect, overconfidence, or home bias. Finally, and importantly, the author introduces the concept and methods of experimental asset markets—a strain of experimental studies that aim to examine coordination on stock markets. The chapter concludes with a short note on econophysics—a field that deals with simulation and prediction of stock market players’ behavior.

The authors of Chap. 11—Damien Brevers, Claus Vögele, and Joël Billieux—explore one of the most controversial and mysterious type of financial behavior, namely gambling. People’s engagement in gambling has increased in recent years, mainly due to easier access to online casinos. However, this phenomenon means that that the scale of problems that arise from the popularity of gambling (addiction, indebtedness, etc.) has also grown. Therefore, a deeper insight into the nature of problem gambling is important from theoretical and practical points of view. The authors of this chapter show why and in which sense decisions related to gambling are biased and produce unbeneficial consequences. They explain why some gamblers perseverate in gambling despite repetitively encountering severe negative consequences. The chapter reviews the behavioral evidence highlighting that gambling disorder is characterized by a preference for alternatives featuring high-risk, high-reward, and short-term gains—even though these options are less adaptive with regard to their long-term value (large monetary losses). Brevers and colleagues also discuss how gambling may be better understood when neuroscientific approaches are applied.

In Chap. 12, Tommy Gärling and Rob Ranyard offer a psychological perspective on consumer borrowing. They explore both antecedents and consequences of this financial activity, referring to popular dual-process theories of judgment and decision making. Such theories typically distinguish between two categories of psychological processes: affective, intuitive, and automatic on the one hand, and analytical, deliberate, and controlled on the other. In this context, the authors pay special attention to one major determinant of borrowing, namely present-biased temporal discounting, and show that people judge the value of immediate consumption as exceeding the value of deferred consumption. They explore the role of the self-control factor and review research that shows how borrowers evaluate credit options and decide which to accept. Gärling and Ranyard not only investigate psychological mechanisms of consumer indebtedness, they also propose intervention techniques that might be applied to reduce overspending and overborrowing. Maladaptive gambling and overindebtedness are not the only examples of detrimental decision making in the field of finance.

Another illustration is tax evasion, which is the core topic of Chap. 13 by Andre Hartmann, Martin Mueller, and Erich Kirchler. Two major questions asked in behavioral research on taxes are: (a) Why and under which conditions are people noncompliant? (b) Which interventions might be implemented to reduce tax evasion? Hartmann and colleagues review different methodological approaches to the study of tax compliance and review evidence showing the validity of both economic and psychological models of tax evasion. However, the core theme of this chapter is the authors' original "slippery slope framework," which integrates empirical findings from economics (e.g., audits and fine rates) and social psychology (e.g., social norms and fairness considerations) into a coherent frame that explains individual tax compliance behavior. The authors propose that two factors determine the level of tax compliance: the power of the authorities and the taxpayers' trust in the authorities. They show that while the former factor is more responsible for enforced tax compliance, the latter more strongly determines voluntary tax compliance. The chapter concludes with practical implications for policymakers and researchers in the field.

The final chapter in this book—Chap. 14 by Daniel Västfjäll and Paul Slovic—deals with the psychological aspects of financial decisions related to charitable giving. The authors argue that affect plays a central role in driving charitable decisions; in this context, they explore two psychological phenomena: compassion fade and pseudoinefficacy. The first phenomenon is a kind of a cognitive bias that predisposes individual decision makers to behave more compassionately toward a small number of identifiable victims compared to a large number of anonymous ones. In other words, people are willing to spend more money to save one concrete victim (potentially known by a name and picture) than to save many victims that are presented only in the form of statistics. This approach is not rational form a normative perspective, but it may be explained when people's emotional reactions are considered. The second phenomenon (pseudoinefficacy) means that people are less willing to help one person when they are made aware of the broader number of people in need that they are not helping. In other words, the effect of compassion fade is weakened or completely disappears when decision makers also receive statistical information about the millions of others who are also at risk of starvation but cannot be supported. Västfjäll and Slovic conclude their chapter by showing that nudges and decision-aiding techniques may be employed to mitigate biases in charitable giving.

As we have already highlighted, the present book offers a descriptive view on financial decision making. It shows how real people—with their cognitive limitations, their susceptibility to passions and emotions, and driven by various motivations—cope with real financial dilemmas and arrive at choices that produce beneficial outcomes, but sometimes also severe, negative consequences. The perspective we offer does not aspire to compete with more traditional, normative approaches toward financial decisions; rather, it aims to complement them. We hope that the book will be supportive for those who are fascinated with decision making theories and conduct research in this area. Our intention was to create a volume that might also be useful from an applied, more practical point of view. Many of the chapters provide direct suggestions on how to intervene to assist people in making better financial decisions.

Preparing this handbook was a very rewarding experience for both of us. We had the chance to cooperate with outstanding researchers and wonderful authors whose contributions to the field of financial decision making cannot be overestimated. While they represent different areas of expertise (neuroscience, cognitive psychology, affective psychology, behavioral economics, etc.), what connects them is their passion for investigating human choices and behaviors. We thank all of them for making this book a successful project and greatly appreciate all their effort. We also would like to thank our editors at Springer—Sharon Panulla and Morgan Ryan—who invited us to this project and were always exceptionally helpful and supportive.

Wroclaw, Poland

Tomasz Zaleskiewicz
Jakub Traczyk

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Part I
The Level of the Brain

Chapter 1
Neural Bases of Financial Decision Making: From Spikes to Large-Scale Brain Connectivity

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Spiking Neurons

The Anatomy of the Neuron

The human brain consists of a complex network of approximately 86 billion nerve cells, called *neurons* (Azevedo et al., 2009). Neurons are considered to be the smallest information processing unit in the brain. The cellular architecture of a neuron comprises three main compartments: the *soma*, the *dendrites*, and the *axon* (see Fig. 1.1). The soma is the body of the cell. It contains the nucleus and other organelles which keep the cellular mechanisms running. The dendrites are ramifications branching out of the soma: They receive inputs from other cells via connection nodes called *synapses*. The axon originates at the cell body and ends at the synapse, which connects to the dendrites or somata of other (post-synaptic) neurons.

The Neuron at Rest: The Membrane Potential

To understand how neurons can process information, it is essential to know what happens in the local environment of the cell. The border of a neuron is its *cell membrane*. It separates the *intracellular space* from the *extracellular space*. Both spaces contain lots of floating particles with electrical charges, called *ions*. The extracellular space contains more calcium (Ca^{++}), sodium (Na^{+}), as well as chloride (Cl^{-}) ions. In contrast, the intracellular space has a higher concentration of potassium (K^{+}). As indicated by the plus and minus signs, the ions also carry a positive or

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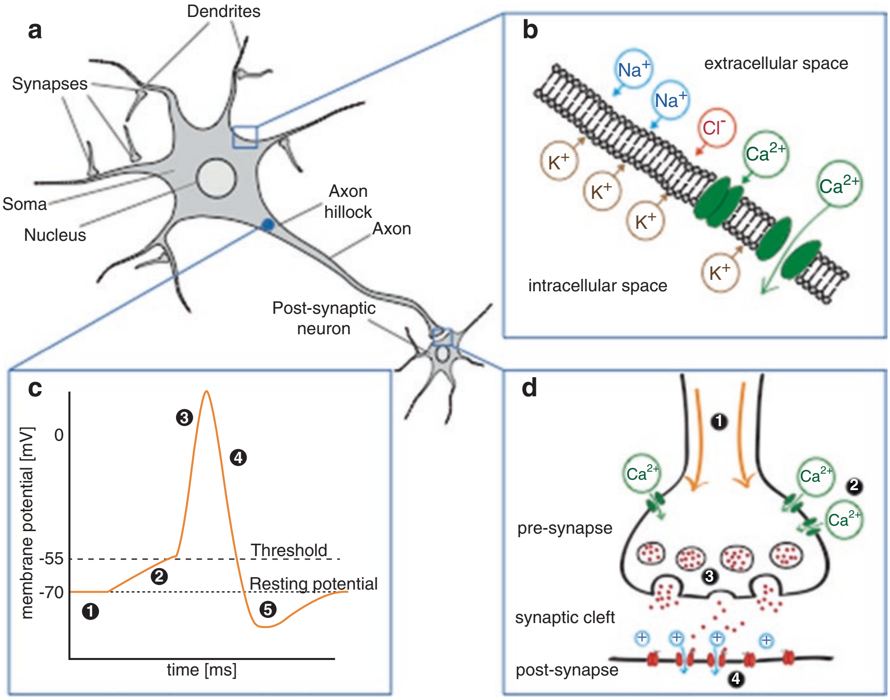

Fig. 1.1 Anatomy and function of a neuron. (**a**) Coarse anatomy of a neuron. (**b**) Neural membrane with different ions as colored circles. Green structures within the membrane are ion channels in closed (left) or open (right) state. (**c**) Time course of an action potential. At (1), the membrane is in the resting state. (2) The membrane potential depolarizes slowly until it hits a threshold. (3) Rapid increase in the membrane potential, followed by a decrease (4) including an overshoot. (5) Depicts the refractory period. (**d**) Shows the processes at the synapse. (1) Action potential arrives and (2) causes an opening of calcium channels. This causes the bubble-like vesicles to fuse with the membrane and to release the neurotransmitters (red dots) into the synaptic cleft. The neurotransmitters can move in the cleft and connect with post-synaptic receptors (4) which allows positive ions to move into the cell. Drawings adapted from Scidraw.io under Creative Commons 4.0 license

negative charge. They cause the intracellular space to be overall negatively charged and the extracellular space to be positive. The difference in electrical charge between intracellular and extracellular space gives rise to an electrical potential, the *membrane potential*. When the neuron is at rest, the membrane potential is typically around −70 millivolt (mV), which is referred to as the *resting potential*.

The ions underlie physical driving forces, which is why they have a natural tendency to move into, or out of the cell. In Fig. 1.1 (panel B), the arrows indicate that potassium (K^+) ions tend to move out of the cell, while Ca^{++}, Na^+, and Cl^- ions tend to diffuse into the cell. However, the cell membrane usually hinders them from doing so. A common way for ions to diffuse between intra- and extracellular spaces are *ion channels*. These channels are proteins embedded in the membrane (green structures in panel B). They comprise a pore with one opening to the intra- and one to the extracellular space. When they are closed (left channel in Fig. 1.1, panel B), ions cannot pass through, but when they are open (right channel), they allow ions to diffuse between intra- and extracellular space. Each channel has its physical structure, which only permits specific ion types to pass through, while others cannot. Thus, there are special channels for Ca^{++}, Na^{+}, and Cl^{-}, etc. Importantly, while the ions are diffusing from one space to the other, they alter the net charge of intra- and extracellular spaces and thereby the membrane potential. Say, for example, that Ca^{++} ions diffuse into the cell. As a consequence, there are more positively charged ions inside the cell, causing the membrane potential to be less negative than usual. This phenomenon is called *depolarization*.

The Neuron in Action: The Action Potential

The depolarization of the membrane potential can trigger a critical mechanism of information processing, the *action potential*. An action potential is a brief change in the polarization of a neuron where the membrane potential depolarizes to reach a positive peak and repolarizes again. The prototypical sequence of events is shown in Fig. 1.1 (panel C). At first (1), the membrane potential equals the resting potential, meaning that the neuron is not active. When some ion channels open to allow the influx of positively charged ions, the membrane potential depolarizes (2). As the depolarization reaches a threshold (often around −55 mV), specialized ion channels open, which grant Na^{+} ions to access the cell (3). In the vicinity of these channels, the membrane potential becomes positive. The event is very brief (0.5–2 ms) and is followed by a longer period of *repolarization* (4) during which other channels open to allow the outflux of K^{+} ions. That outflux effectively repolarizes the cell, and it even overshoots so that the membrane potential is more negative than at rest for some time (5). This time interval is called the *refractory period*. Since the membrane potential is more negative than usual, the neuron is unlikely to fire an action potential within this period. The refractory period sets an upper limit for the firing rate of action potentials, for instance, to 100 action potentials per second (100 Hz).

The action potential is most likely generated at the axon hillock, the part of the neuron where the axon branches out from the soma (Fig. 1.1, panel A). The depolarization of the membrane potential at the axon hillock causes adjacent Na^{+} channels to open as well, which triggers a propagating cascade of membrane depolarizations along the axon. The action potential thus travels down the axon until it arrives at the synapse. Noteworthy, the propagation of the signal was described by Hodgkin and Huxley (Hodgkin & Huxley, 1952). Their approach was a key contribution to the establishment of computational neuroscience as a scientific discipline and brought them the Nobel Prize for Physiology or Medicine in 1963.

Communication from One Neuron to the Next

When the action potential arrives at the synapse (Fig. 1.1, panel D), it enables the neuron to communicate with other neurons via *synaptic transmission*. The sequence of events begins with the arrival of the action potential (1), which traveled all along the axon to the *pre-synapse*. The membrane of the pre-synapse contains Ca^{++} channels that open due to the incoming action potential (2). The influx of Ca^{++} ions serves as a trigger for bubble-like structures called *vesicles* to fuse with the membrane (3) and thereby releasing their cargo, chemicals called *neurotransmitters*. The neurotransmitters are released into the *synaptic cleft*. This cleft is a space between the pre-synapse and the dendrite or soma of another neuron, the *post-synapse*. When the neurotransmitters are in the cleft, they can reach the post-synapse and form a connection with a *receptor* protein (4).

Different types of receptors can have individually different effects on the post-synaptic neuron. A relatively simple form of receptors are *ionotropic receptors*. They are essentially ion channels that open as soon as a neurotransmitter connects with them. This can lead to an influx of positive ions (as in Fig. 1.1, panel D, (4)) which depolarizes the post-synaptic cell and makes the occurrence of an action potential more likely. Such a small contribution is called an excitatory post-synaptic potential (EPSP). Importantly, every type of receptor is activated by its own set of neurotransmitters. While neurotransmitters such as *glutamate* activate receptors that allow positive ions to enter and cause an EPSP, other neurotransmitters such as *GABA* might activate receptors that allow the influx of negatively charged ions. This leads to a suppression of action potentials because it polarizes the cell even more. Notably, these inhibitory post-synaptic potentials (IPSP) are exploited in the use of psychoactive drugs such as benzodiazepines or anesthetics. Since neurotransmitters specifically activate certain receptors, they are often important for particular processes. For instance, dopamine plays a crucial role in the reward system and thus for financial decisions, on which we will elaborate in this chapter.

From Neurons to Networks

The sheer complexity of neural information processing may leave many readers puzzled. The key message here is that neurons communicate with each other through synaptic transmission. This transmission can cause activation or deactivation of other neurons, or it can cause the production of new proteins or trigger other cellular processes. Apart from the different qualities of these processes, one should also consider the quantitative aspect. A neuron in the neocortex receives inputs from on average 7000 synapses (Pakkenberg et al., 2003). While some of these inputs can come from other neurons nearby, others may come from neurons in entirely different brain regions. Those neurons have long axons that project through the brain to their respective target neurons. Through these long-range connections, it becomes possible for the brain to have cortical modules, specialized to process certain tasks (such as visual perception or memory retrieval)—and to pass their processed information on to the next brain region in the processing line.

The brain can be sub-divided into several compartments. Most cognitive neuroscientists focus on the cerebral cortex, the heavily folded structure of the forebrain which is larger than any other part of the human brain. The cerebral cortex includes neuronal populations, specialized for the processing of sensory information such as vision, taste, feelings of touch but also for high-level representations such as values and volatility. However, the cortex is not the only part of the brain involved in financial decision making. Subcortical regions such as the basal ganglia are crucial for different forms of goal-directed behavior and reward-based learning.

Methodological Tools Used in Neuroscience

In this part, we will briefly introduce three very different approaches to how brain activity is being measured. Notably, each of these methods has its advantages and disadvantages, which puts an emphasis on studying the neural basis of financial decision making with a multi-modal approach instead of focusing on a single method.

Single-Unit Recording

To measure the activity of neurons and neural populations directly, some researchers use *single-unit recording*. For this method, very fine wires, called *electrodes*, are implanted into specific brain regions, and neural action potentials are recorded. The main advantages of this method are the high temporal and spatial resolution as well as the high signal quality. Thus, neural activity can be observed in real-time and be measured precisely in the brain regions of interest. The disadvantage, on the other hand, is its invasiveness. Although the electrode itself is not causing much damage to the neural tissue, the necessary surgery that requires the skull to be opened is a risky intervention. Therefore, single-unit recording is usually applied to animals such as rodents or non-human primates. In humans, it is used only in rare cases, for example, when electrodes are implanted for the treatment of severe epilepsy. Moreover, the surgery is usually only applied to a few individuals, because it is not only invasive but also time-consuming and expensive. The animal colony needs to be maintained, and data collection takes months to years. Furthermore, animal research comes with a high ethical cost. Therefore, researchers try to limit the number of research animals to a necessary minimum (e.g., two or three monkeys). A researcher who is interested in human behavior during financial decision making may wonder why animal research should be of any relevance. Given the ethical limitations to studying fundamental neural mechanisms in humans, the investigation of neural processes in a close human relative, such as monkeys, offers insights into general mechanisms of how the brain implements decisions. From these insights, researchers can often draw inferences about the functioning of the human brain. As we will see later, this approach has let to at least two scientific breakthroughs that are relevant to financial decision making: the identification of the dopamine system as the brain's reward system, and the concept of (neural) evidence accumulation during decision making.

Functional Magnetic Resonance Imaging (fMRI)

fMRI is a non-invasive measurement tool that can safely be used to study the brain activation of healthy human participants. It requires the participant to lie in an MR scanner, which is a fairly large tube-like system of magnetic coils. These coils allow measuring the different magnetic properties of *oxygenated* and *deoxygenated* blood, the so-called blood-oxygen-level-dependent (BOLD) signal (Huettel, Song, & McCarthy, 2014). Importantly, more oxygen is needed in a region in which the neurons have a higher firing rate due to ongoing information processing (Attwell & Iadecola, 2002; Iadecola, Yang, Ebner, & Chen, 1997; Logothetis, Auguth, Oeltermann, Pauls, & Trinath, 2001). Therefore, fMRI does not measure single neurons and their spiking activity directly, but we can infer this activity indirectly via the associated changes in the cerebral blood flow. Notably, the fMRI BOLD signal is more strongly associated with post-synaptic potentials than with action potentials (Attwell & Iadecola, 2002; Logothetis et al., 2001). An advantage of fMRI is its relatively high spatial resolution (in the order of millimeters), which is not as good as the resolution of single-unit recording but much better than other non-invasive methods (see below). Additionally, the technique allows measuring activity from the whole brain at once. In contrast, single-unit recording is confined to small areas. On the downside, fMRI features a rather low temporal resolution for at least two reasons. First, the *hemodynamic response* (i.e., the change in blood flow as a response to neural activation) takes about 5 seconds until it reaches its peak and about 25 seconds to get back to baseline. Second, there is a technical limitation of the sampling rate by which MR images are recorded.

Electroencephalography (EEG) and Magnetoencephalography (MEG)

Another critical non-invasive approach to studying the human brain in action is EEG. With EEG, changes of membrane potentials of the dendrites of neurons are recorded at the scalp. Thereto, a fairly large number of electrodes (e.g., 64 or 128) are positioned on the scalp, usually with the help of an elastic cap. Importantly, to effectively measure a signal at the scalp, a large number of adjacent neurons is required to change their membrane potential simultaneously and to share the same spatial orientation. Because of this and due to a strong loss of signal with distance, EEG allows recording mainly cortical activity, whereas subcortical regions such as the midbrain are less suited to be investigated with EEG (but activity in these regions might affect the EEG signal at the scalp nonetheless). All these limitations result in the fact that EEG has much lower spatial resolution than fMRI. On the other hand, it has an excellent temporal resolution (in the order of milliseconds), given that EEG is sensitive to the electrical properties of neural activation. Thus, we can use EEG to track brain activity even during the fastest decisions as they emerge. Similar to fMRI, EEG does not measure action potentials, but rather post-synaptic potentials.

There are two typical ways of analyzing EEG data. The first approach is to measure *event-related potentials (ERPs)*. Here, the time course of the voltage difference is averaged over many repetitions (e.g., trials in which specific decisions were made). This allows separating the "signal", the EEG activity that is consistently linked to a particular psychological process, from the "noise", which is assumed to be random across the repetitions. One well-studied ERP is the readiness potential (Kornhuber & Deecke, 1965/2016), a motor component appearing before an individual performs an action (e.g., pressing a button to indicate a decision). It is measured at electrodes positioned at the center of the scalp. The second approach to analyze EEG data is the *time-frequency analysis (TFA)*. TFA exploits the fact that the EEG signal can be decomposed into different frequencies (i.e., different time constants of oscillating up- and down-states of the EEG signal). Importantly, different frequencies are associated with different psychological mechanisms. For instance, closing the eyes increases oscillations in the so-called alpha-band between 8 and 12 Hz (Berger, 1929). Preparing a decision decreases the power in the so-called beta-band between 13 and 30 Hz (Gluth, Rieskamp, & Büchel, 2013b; Polanía, Krajbich, Grueschow, & Ruff, 2014). While EEG itself and the existence of different frequency bands was discovered almost 100 years ago by the German neurologist Hans Berger (Berger, 1929), TFA is a comparatively novel approach (~ 25 years), which allows measuring the change of oscillations on the range of tens of milliseconds but requires relatively high computing power to do so.

A method that shares many similarities with EEG is magnetoencephalography (MEG). With MEG, we do not record the electrical but the magnetic consequences of neuronal activity. Electric currents generate changes in the magnetic field, which can be measured by a MEG scanner with so-called SQUIDS (superconductive quantum interference devices). Compared to EEG, MEG has a somewhat higher spatial resolution and a similarly high temporal resolution (for an introduction to EEG and MEG as well as its data analysis see Cohen, 2014; Luck, 2014). Nonetheless, both EEG and MEG suffer from the *inverse problem.* The inverse problem refers to the fact that an infinite number of electrical current distributions could be responsible for the measured electrical or magnetic potentials. Thus, in principle, it is impossible to say where exactly and from how many sources in the brain exactly an EEG or MEG signal at the scalp is coming from. Nevertheless, source reconstruction methods have been developed that employ mathematical approximation methods to identify the most likely areas where the signal originates from (Grech et al., 2008).

Measuring the Communication Between Brain Regions

An important advantage of fMRI, EEG, and MEG, compared to single-unit recording, is the possibility to measure the activity of the entire brain. Therefore, it is possible to identify the many brain regions that are involved in complex cognitive functions such as financial decisions. Even more importantly, it allows assessing the cross-talk between different brain regions via the analyses of functional connectivity (Friston et al., 1997; Friston, Harrison, & Penny, 2003). As discussed above, many regions in the brain can be associated with specific functions, such as visual perception or attention. However, the brain needs to combine these different processing steps to realize such complex cognitive functions as making a financial decision. Therefore, connectivity analyses are fundamental to study the neural basis of the human mind, and they will become even more important in future research, as we try to achieve a deeper understanding of our complex cognitive abilities.

Manipulating Brain Activity

All of the methods introduced above (i.e., single-unit recording, fMRI, EEG, MEG) measure neural activity (directly or indirectly). However, there exists a set of other neuroscientific methods, including brain lesion studies, brain stimulation (e.g., transcranial magnetic stimulation; TMS) and optogenetics, that do not measure but allow to alter brain activity. This manipulation can either be on purpose (e.g., stimulating a particular brain area with TMS), or not (e.g., lesions of the brain after an accident). Importantly, these manipulation methods allow making causal inferences on the necessity of a brain area to implement a specific psychological function and are thus complementary to the previously presented measurement methods. The interested reader can find a more extensive description of the different neuroscientific measurement and manipulation methods in the relevant textbooks (e.g., Chap. 6: Experimental Methods in Cognitive Neuroscience (Ruff & Huettel, 2014) of the second edition of *Neuroeconomics*: *Decision Making and the Brain*).

The Reward Circuit

The brain's reward circuit lies at the heart of our ability to make financial and economic decisions. This is because the reward circuit enables us to evaluate different options with respect to central economic metrics, such as expected value, risk, or volatility. Furthermore, it allows us to improve such evaluations based on experience, an ability referred to as *reward-based learning*. Reward-based learning comes into play whenever we do not have access to the exact reward information of the options from which we can choose but have to acquire this information from experience. It is also important when rewards change over time, that is, when the environment is volatile. This is the case in many decisions we make on a daily bases, from deciding which medicine to take to cure a headache to deciding which brand of pasta to buy or which stock to invest in.

A Network of Cortical and Subcortical Structures

The reward circuit is embedded in the so-called *cortico-basal ganglia circuit* (Fig. 1.2). This circuit connects the dopamine system, which is responsible for reward-based learning, with a set of cortical and subcortical brain regions (including the prefrontal cortex, thalamus, and striatum), which are essential for actions and motor planning (Haber & Behrens, 2014; Haber & Knutson, 2009). The areas that contain dopamine neurons are the substantia nigra pars compacta (SNc) and the

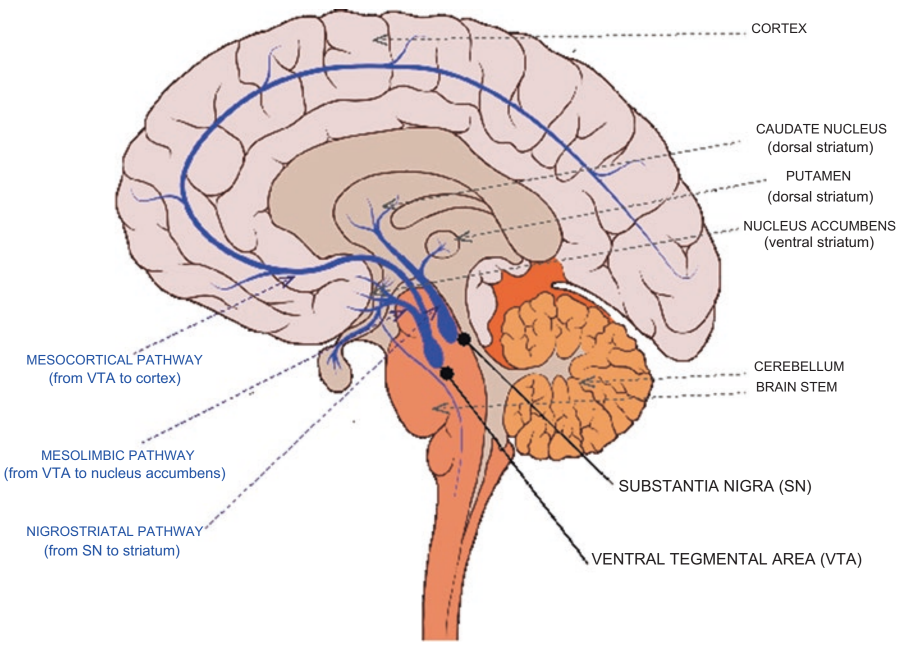

Fig. 1.2 The three main dopaminergic pathways in the central nervous system, i.e., the main output of the dopamine neurons of the substantia nigra (SN) and the ventral tegmental area (VTA). (Drawings adapted from: https://commons.wikimedia.org/wiki/File:Dopaminergic_pathways.svg#filelinks)

ventral tegmental area (VTA). These two rather small nuclei are located in the midbrain, an evolutionary older part of the vertebrate nervous system. The midbrain is part of the brainstem, which connects the forebrain with the spinal cord. Since its anatomical location is far from the skull, it is hard to measure its activity without making use of invasive methods such as single-unit recordings. This is why most dopamine studies to this date typically employ non-human primates and mice as subjects (Smith, Wichmann, & Delong, 2014). On the other hand, evaluative and motor areas, situated more closely to the skull, have been explored largely in humans using fMRI and EEG. In what follows, we will concentrate on the subcortical areas that are responsible for reward-based learning.

The output of the dopamine neurons is organized in three major pathways (see Fig. 1.2) and one minor pathway (i.e., the tuberoinfundibular pathway, which will not be further discussed here). The SNc mainly projects to the dorsal striatum (i.e., to the caudate nucleus and to the putamen), forming what is called the *nigrostriatal pathway*. The VTA projects to both the ventral striatum (i.e., to the nucleus accumbens) and to the cortex, forming the *mesolimbic* and *mesocortical pathways*, respectively. The mesolimbic and mesocortical VTA neurons substantially overlap (Wise, 2004), and for this reason the two systems are often referred to as the *mesocorticolimbic* pathways. The mesocorticolimbic pathways play a role in reward, motivation, and maternal behavior (Klein et al., 2019). In particular, they are responsible for increases in behavioral activity (both toward appetitive stimuli and away from aversive stimuli), and lesions to this system can suppress exploratory and approaching behaviors. The nigrostriatal system, on the other hand, is involved in more habitual and procedural aspects of behavior (Klein et al., 2019).

Dopamine Neurons Encode a Reward Prediction Error (and More)

The most important function of the brain's dopamine system is to enable reward-based learning by encoding a teaching signal, the *reward prediction error (RPE)*. The RPE is a theoretical construct derived from artificial intelligence (Sutton & Barto, 1998). It is the difference between the experienced reward and its previous expectation. When the RPE is positive, negative, or zero, it means that the experienced reward is higher than, lower than, or equal to the previous expectation, respectively. Thus, the RPE is critical for updating expectations based on experience, because new expectations can be adjusted according to the RPE's sign and magnitude. For example, when the RPE is highly positive, the new expectation should increase more than when the RPE is also positive but lower in magnitude.

In the late 1980s and in the 1990s of the twentieth century, Wolfram Schultz and colleagues (Schultz, Dayan, & Montague, 1997) provided the first evidence that dopamine neurons encode a full RPE signal. In the original study, electrodes were implanted in the midbrain of two alive and behaving monkeys to precisely measure the spiking activity of the dopamine neurons. The monkeys learned to associate a stimulus (e.g., a red box) to a reward (e.g., a piece of apple) over many trials. At the outset of this learning experiment, dopamine neurons did not respond to the presentation of the red box, but their firing rate increased at the delivery of the reward (i.e., a positive RPE). After learning, the neurons already fired when the box was shown (corresponding to positive expectations), and the firing rate did not differ from baseline when the monkey received the reward (which was now fully predicted, corresponding to no RPE). Moreover, the firing rate decreased when the monkeys received no reward (i.e., a negative RPE). These properties of dopamine neurons have been replicated in numerous follow-up studies (e.g., Bayer & Glimcher, 2005), and generalized to the human brain via fMRI studies of the midbrain (e.g., D'Ardenne, McClure, Nystrom, & Cohen, 2008) and of dopaminergic projection areas such as the ventral striatum (e.g., O'Doherty, Dayan, Friston, Critchley, & Dolan, 2003). One important finding of these studies is that dopamine neurons do not only respond to rewards themselves but also to reward-predicting cues (like the red box in the study by Schultz and colleagues). Thus, the dopamine system is also central to decision making, as it specifies the expected value or utility of available choice options.

Traditionally, studies focused on value-aspects of rewards, while more recent studies have shown how uncertainty is incorporated in the representation of rewards, too (Gershman & Uchida, 2019, Berke, 2018). In particular, Fiorillo and colleagues (Fiorillo, Tobler, & Schultz, 2003) showed that the activity of dopamine neurons increases with the risk associated with a specific option and with the distance of the reward from the reward-cue (Fiorillo, Newsome, & Schultz, 2008).

Decision Making as Evidence Accumulation

In the previous part of this chapter, we discussed the reward circuit as the brain's key system for implementing reward-based processes and highlighted its importance for decision making. However, what is yet missing is an understanding of how the emergence of decisions over time can be described, and how these emerging decisions are implemented in neural structures. This part of the chapter is devoted to such a mechanistic description of decisions. In particular, we will introduce a framework of decision making that has been proven to be extremely fruitful for decision neuroscience, as it spans the various levels of description (i.e., from spiking neurons to large-scale brain connectivity) and applies to different types of goal-directed behavior: from economic and financial decisions to perceptual decisions and probabilistic inferences. This framework is referred to as *evidence accumulation*.

The Principle of Evidence Accumulation

Evidence accumulation models describe decisions as a time-consuming process of sequential sampling and storing of noisy information (which is why these models are also known as sequential sampling models; e.g., Bogacz, Brown, Moehlis, Holmes, & Cohen, 2006; Busemeyer, Gluth, Rieskamp, & Turner, 2019). This information represents the accumulated evidence in favor of choosing one among several choice options. As soon as sufficient evidence for one of the options has been collected, the sampling process ends, and a decision is implemented. With respect to predicting behavior, evidence accumulation models have one crucial advantage over other prominent theories of decision making, including expected utility theory (Von Neumann & Morgenstern, 1947) and prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992): They predict not only choices themselves but also the speed of decisions as well as the interplay between choice probability and speed. Thus, they can account for the phenomena that more difficult decisions take longer (because the evidence is accumulated more noisily) and that time pressure reduces the quality of decisions (because the accumulation process is often terminated prematurely). What makes evidence accumulation models so attractive from a neuroscientific perspective is that they specify the process of decision making in much detail so that the framework lends itself naturally to be tested with respect to its implications for the brain.

Evidence Accumulation in Single Neurons and Population of Neurons

Roughly at the same time when the reward prediction error signal was found in the dopamine system, the concept of evidence accumulation received first neuroscientific support from a series of single-unit recording studies in monkeys, performed by William Newsome, Michael Shadlen, and colleagues (Shadlen & Newsome, 1996; reviewed in Gold & Shadlen, 2007). The monkeys performed a perceptual decision making task, in which they were presented with brief videos of randomly moving dots. Some of these dots exhibited a coherent motion in one direction, and the monkey's task was to judge this motion correction by making a saccade (i.e., an eye movement) to the respective side. Importantly, the task gave the experimenters excellent control over its difficulty, because the percentage of coherently moving dots could be decreased or increased at will. Newsome, Shadlen, and their colleagues recorded the activity of neurons in the lateral intraparietal cortex (LIP), an area known to be important for the generation of saccades. Strikingly, they found that the firing rates of LIP neurons exhibited many properties that are consistent with the notion of evidence accumulation: Their activity ramped up gradually, this ramping was faster in trials with higher coherence (i.e., lower difficulty), and it terminated at a fixed and difficulty-independent threshold, at which point the saccade was elicited.

Even though a more recent study questioned whether the firing rates of single neurons really exhibit gradual accumulation-like increases (Latimer, Yates, Meister, Huk, & Pillow, 2015), there is robust evidence that these patterns occur at least at the level of neuronal populations (e.g., the summed activity of LIP neurons). Notably, these findings have inspired neural network models that implement evidence accumulation at the level of neuronal populations (Wang, 2002), and that are not restricted to perceptual decisions but can be applied to value-based, economic, and financial decisions as well (Hunt et al., 2012).

Evidence Accumulation in Large-Scale Brain Activation and Connectivity

Similar to the single-unit recording studies in monkeys, the first fMRI study on evidence accumulation used a perceptual decision making paradigm (Heekeren, Marrett, Bandettini, & Ungerleider, 2004). Here, the authors asked participants to choose whether an ambiguous stimulus was either a house or a face, thus leveraging the fact that different visual cortical areas encode faces (i.e., the fusiform face area) vs. places and scenes (i.e., the parahippocampal place area). Arguably more directly relevant for financial decision making is an fMRI study from our own research team, in which participants could either buy or reject an offered stock in every trial (Gluth, Rieskamp, & Büchel, 2012). Participants received information in the form of multiple ratings from stock-rating companies that indicated whether the stock was more likely to have a positive or negative value. To be able to track evidence accumulation signals in the brain with the slow and sluggish fMRI-BOLD signal (see the section on tools in neuroscience above), we presented these stock ratings sequentially—one at a time—over an extended period of up to 18 seconds. We found that an evidence accumulation model provided very accurate predictions of the behavior in this task (i.e., whether the stock was bought or not, and how many ratings were sampled before deciding). On the brain level, we saw that regions associated with the dopamine system (see the previous section), including the ventral striatum and the ventromedial prefrontal cortex (vmPFC), encoded the accumulated value signal of the stock. In addition, activity in regions that are linked to the preparation and initiation of motor responses, including the pre-supplementary motor area (pre-SMA) and the primary motor cortex, scaled with the propensity to make a decision according to the fitted evidence-accumulation model. In a follow-up EEG study, we again showed that the emergence of financial decisions could be tracked by the gradual build-up of the EEG signal at electrodes positioned over cortical motor areas (Gluth, Rieskamp, & Büchel, 2013a).

While our study identified the "players" in the brain that are important for implementing evidence accumulation when making economically relevant decisions, a more recent study completed the picture by connecting these “players” via functional connectivity analyses (Pisauro, Fouragnan, Retzler, & Philiastides, 2017). Notably, EEG and fMRI were recorded simultaneously to combine the excellent temporal resolution of EEG with the superior spatial resolution of fMRI. As choice options, the authors did not use stocks but food snacks. Food choices and associated response times could be accounted for by an evidence-accumulation model. With respect to the neuroscientific results, the authors first identified a gradually ramping EEG signal related to evidence accumulation. This EEG signal was then implemented in the fMRI analysis to locate it in the brain. In line with our work, the pre-SMA could thus be identified as the source of the EEG-based evidence accumulation signal. Finally, the authors tested which regions were functionally connected to the pre-SMA as a function of the strength of evidence. This analysis revealed a connection between pre-SMA and the above-mentioned dopamine projection areas ventral striatum and vmPFC.

Altogether, the large-scale neuroimaging studies in humans and the single-unit recording work in monkeys (but also in other animals such as rodents; e.g., Brunton, Botvinick, & Brody, 2013) indicate that the principle of evidence accumulation provides a powerful framework to describe decisions on behavioral as well as neurobiological grounds. The attentive reader will have recognized that many of the discussed studies on evidence accumulation do not employ financial decision making tasks directly. This reflects the flexibility and breadth of the evidence accumulation framework and should be regarded as an asset, since it demonstrates the framework’s potential to unify research on and models of decision making across domains.

Concluding Remarks

In this chapter, we have addressed the neurobiological and cognitive foundations of financial decisions. We started by introducing basic principles of neural processing and important neuroscientific tools to study the brain on different scales, ranging from the activity of single neurons to the connectivity profiles of distant cortical and subcortical brain regions. We then discussed the reward circuit, whose role is pivotal for the motivation and modulation of goal-directed behavior. Finally, we outlined the principle of evidence accumulation as a neurobiologically plausible framework for financial (and many other types of) decision making.

Despite the remarkable progress in understanding the neural bases of decision making over the last decades, many open questions remain to be addressed for the comparatively young research areas of decision neuroscience and neuroeconomics. For instance, more research is needed to further bridge the gap between processes of reward-based learning and principles of decision making (see, for instance, Fontanesi, Gluth, Spektor, & Rieskamp, 2019) to achieve a comprehensive, mathematically precise, and neurobiologically plausible theory of how the brain implements decisions and how it improves them based on experiences.

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Chapter 2
Neural Correlates of Decision Variables and Strategic Preferences

Vinod Venkatraman and Elizabeth C. Beard

Introduction

Human beings are tasked daily with making numerous complex decisions that involve the acquisition and integration of information across a variety of sources under varying levels of risk and uncertainty. These complex decisions have both short-term and long-term impact on people's lives – from investment and financial planning to preventative health care and medical decisions. Since the early 1950s, researchers have sought to understand the cognitive processes that result in differing judgments and decision preferences. In more recent decades, scientists have incorporated neuroscience techniques across a variety of species to better understand the biological basis of decision processes and individual differences in decision making, a field of research commonly referred to as "decision neuroscience" or "neuroeconomics" (we will use decision neuroscience for the remainder of the chapter, though the two terms are virtually synonymous).

A central goal of decision neuroscience research has been to improve our understanding of decision preferences and strategies, taking into account our biological constraints and limitations. Decision neuroscience studies, for example, typically target a particular decision variable (e.g., risk sensitivity) and incorporate that variable into a model function (e.g., prospect theory). Then, studies manipulate the level of that variable across a range of stimuli (e.g., monetary gambles) and subsequently identify aspects of brain function that track changes in that variable. These decision variables are often derived in part from classic economic or behavioral economic models. However, choice and preferences often go beyond simple interactions between decision variables. While a decision generally involves implicit weighting of key decision variables resulting in the selection of one of several potential

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outcomes, a decision *strategy* describes how individuals evaluate relevant information that results in a decision (Venkatraman, 2013). Conversely, decision neuroscience studies have also sought to identify mechanisms underlying the adaptive use of decision strategies. These differences in decision strategies can also explain variability in preferences across individuals as well as within individuals across decision contexts.

In this chapter, we will first provide a brief overview of the field of decision neuroscience and the criticisms and progress made over the past two decades. Next, we will outline key regions and systems of the brain that map onto distinct decision variables and inform our understanding of financial decision making processes. Lastly, we will identify and review key findings surrounding the neuroscience of how people employ different decision making strategies.

Decision Neuroscience: An Overview

Over the past two decades, there has been an exponential increase in the use of neuroscience methodologies and techniques to better understand the psychological mechanisms associated with decision making. Early decision neuroscience research sought to bridge existing research on judgment and decision making that focused on the mathematical modeling of judgments and decision preferences. Researchers would often identify an economic phenomenon of interest and the key variables (or parameters) that were shown to impact choice behavior and then identify aspects of brain function and neural regions that tracked changes in those decision variables. As such, a large portion of the decision neuroscience literature has aimed to identify the neural mechanisms that result in individual choice behavior and reflect decision preferences (Camerer, Loewenstein, & Prelec, 2004; Glimcher, 2003; Loewenstein, Rick, & Cohen, 2008; Ochsner & Lieberman, 2001; Platt & Huettel, 2008; Sanfey, Loewenstein, McClure, & Cohen, 2006).

Early decision neuroscience studies examined the potential neural correlates of many of the fundamental variables present in traditional economic models. Some key variables include the value of monetary rewards (Rangel, Camerer, & Montague, 2008; Yacubian et al., 2007) and other rewards (Berns, McClure, Pagnoni, & Montague, 2001; Smith et al., 2010), risk (Huettel, Stowe, Gordon, Warner, & Platt, 2006; Preuschoff, Bossaerts, & Quartz, 2006), ambiguity (Hsu, Bhatt, Adolphs, Tranel, & Camerer, 2005), probability weighting (Hsu, Krajbich, Zhao, & Camerer, 2009), intertemporal choice (Kable & Glimcher, 2007; McClure, Laibson, Loewenstein, & Cohen, 2004; Prévost, Pessiglione, Météreau, Cléry-Melin, & Dreher, 2010), and loss aversion (Tom, Fox, Trepel, & Poldrack, 2007). Other studies focused on complex variables from alternative decision making models, such as framing strength (De Martino, Kumaran, Seymour, & Dolan, 2006) and social cooperation (Rilling et al., 2002). Some of the key brain regions involved in the representation of these variables are summarized in Fig. 2.1.

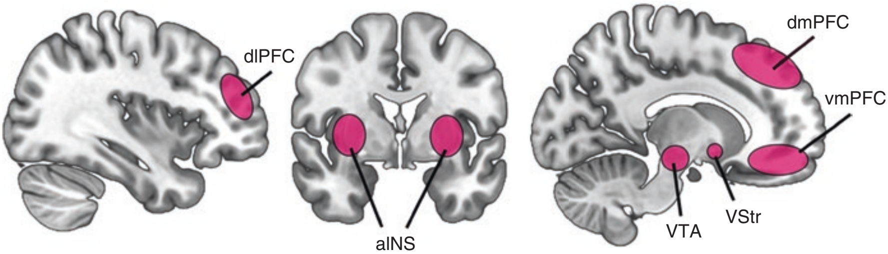

Fig. 2.1 Brain regions associated with key decision variables and strategies. From left to right: dorsolateral prefrontal cortex (dlPFC), anterior insula (aINS), ventral tegmental area (VTA), ventral striatum (VStr), ventromedial prefrontal cortex (vmPFC), dorsomedial prefrontal cortex (dmPFC)

Beyond providing evidence that specific neurological activity reflects key decision components, early decision neuroscience work revealed specific networks of brain regions associated with decision making processes.

Nevertheless, the field of decision neuroscience has had its share of critics over the years, with terms such as "fad" and "pop science" used as frequent references to the work of the field. Early critics often claimed that neuroscience methods were fundamentally conflicting to the traditional methodologies employed by economists (Bernheim, 2009). While it is common practice for many economists to draw inspiration from the fields of psychology and cognitive science, opponents of decision neuroscience felt that developing a deeper understanding of the underlying brain mechanisms of economic decision making processes had little relevance toward the broader goals of understanding large-scale economic behavior (Bernheim, 2009; Gul & Pesendorfer, 2008; Harrison, 2008). Two core principles of decision neuroscience, identified by Clithero, Tankersley, and Huettel (2008), seek to address these concerns by focusing on the additive benefits of decision neuroscience. The first principle – *mechanistic convergence* – asserts that neuroscience techniques and subsequent data will not replace extant data sources in economics and the social sciences. Decision neuroscience can help identify novel opportunities for behavioral experiments. A second principle – *biological plausibility* – posits that while measures of choice behavior are crucial for assessing economic models, neuroscientific methods can help to identify broad classes of robust or even predictive models (Clithero et al., 2008). Bibliographic and social network analyses of decision neuroscience publications and researches have revealed the interconnected and interdisciplinary nature of decision neuroscience and neuroeconomics, with research being published across diverse and otherwise areas of science previously considered unrelated (Levallois, Clithero, Wouters, Smidts, & Huettel, 2012).

More recently, a review by Krajbich and Dean (2015) further exemplified the utility current work in decision neuroscience could provide to understanding variables that are already of interest to traditional economists. The authors summarize insights from three areas of decision neuroscience: identifying biological causes of stochastic choice, attentional costs, and the relationship between environment and economic choice. In each of these three domains, new findings linking environmental factors to brain function and choice behavior have extended decision models and informed subsequent lines of research (Krajbich & Dean, 2015). In addition to elucidating individual choice behavior, translational approaches to decision neuroscience have exemplified the predictive validity of fundamental decision neuroscience techniques (Genevsky, Yoon, & Knutson, 2017). Since 2012, researchers have shown how specific neural regions involved with reward and valuation have predicted population-level behavior across a variety of domains such as song downloads (Berns & Moore, 2012), loan rate success (Genevsky & Knutson, 2015), information dissemination (Scholz et al., 2017), funding campaign success (Genevsky et al., 2017), and several advertising outcomes (Falk, Berkman, & Lieberman, 2012; Kühn, Strelow, & Gallinat, 2016; Venkatraman et al., 2015). These findings not only provide significant insights toward understanding the biological basis of decision making behaviors at both individual and aggregate levels but also provide substantial evidence that understanding decision making at a neurobiological level can inform market-level decision research more broadly.

Neuroscience and Financial Decision Making

Valuation and uncertainty play a crucial role in our understanding of long- and short-term financial decision making. One might consider, for example, the factors that play into investing in a stock. Invest too early, and you risk the company underperforming. Too late, and you've missed your shot at a decent gain. From early economics and decision models to current neuroscientific research, determining how individuals perceive risk and reward and how these perceptions ultimately guide decision making at the individual and population levels are vital in knowing what guides financial decision making. Some of the most fundamental variables (or parameters) of decision models involve subjective value, uncertainty or risk, and the computation and anticipation of a reward – all of which play integral roles in financial risk-taking.

Valuation

One of the main factors of decision making involves the assessment and consideration of potential outcomes and determining their respective *values*. A plethora of decision making and economic models contain some components of value maximization or subjective utility (Kahneman & Tversky, 1979; Samuelson, 1937). Early work in systems neuroscience with animal and rodent models identified dopamine as a key neurotransmitter that functions to assign value based on environmental stimuli (Schultz, 2006, 2007; Wise & Rompre, 1989). Dopaminergic neurons produced in the ventral tegmental area (VTA) project to the nucleus accumbens (nACC) in the ventral striatum (vSTR) and play an essential role in motivated behavior and reward-based learning (Berridge, 1996, 2007; Berridge & Robinson, 1998; Schultz, Dayan, & Montague, 1997). In studies using fMRI in human subjects, the tracking of value (or subsequent reward) modulates activation in the vSTR and the VTA (Berns et al., 2001; D'Ardenne, McClure, Nystrom, & Cohen, 2008; McClure, Berns, & Montague, 2003).

While these dopaminergic systems focus on updating predictions about reward and subsequent learning and motivation, another early area of research examined differences in reward anticipation and receipt. Knutson, Westdorp, Kaiser, and Hommer (2000) developed a task called the monetary incentive delay (MID) task to help disentangle these two important components of decision making. The MID task involved cueing participants to potential monetary consequences of a given trial. Then, in response to a target, the subject had to respond (via a button press) to either receive the said monetary reward or avoid punishment (a monetary loss) (Knutson et al., 2000). During the anticipatory phase of the trials, the researchers observed increased activation in striatal and medial prefrontal regions (Knutson & Greer, 2008). Other early fMRI studies using gambling or card-guessing games also suggested that receipt of reward evoked unique vSTR activation (Breiter, Aharon, Kahneman, Dale, & Shizgal, 2001; Delgado, Nystrom, Fissell, Noll, & Fiez, 2000; Elliott, Friston, & Dolan, 2000). Additionally, studies of reward anticipation that de-couple reward anticipation from choice found that vSTR activation was associated with the relative motivational value of the rewards as determined by reaction times, suggesting that even without choice, vSTR serves as a common currency mechanism that may influence motivated behavior (Sescousse, Li, & Dreher, 2015).

In addition to tracking changes in reward or value signals, one must determine the subjective value of each available outcome in order to make a choice. Subjective value is thought to serve as a common underlying currency, allowing potentially complex or different outcomes to be compared along a common scale (Bartra, McGuire, & Kable, 2013). Early research of subjective value established that a key set of brain regions – specifically the ventral striatum (vSTR), the ventromedial prefrontal cortex (vmPFC), and the posterior cingulate cortex (PCC) – scale with the subjective value of potential outcomes during choice (Bartra et al., 2013; Rangel & Clithero, 2014). Additionally, these regions generally respond to the valuation of outcomes across multiple domains and contexts such as food, money, and social support (Berns et al., 2001; Delgado et al., 2000; Fehr & Camerer, 2007; Vartanian & Goel, 2004).

Risk and Uncertainty

Another critical component of decision making models involves the level of uncertainty for any given outcome. Broadly, uncertainty involves a lack of information regarding rewards or outcomes (Garner, 1962; Knight, 1921). Uncertainty occurs in the majority of real-world financial decisions; we often do not know the exact likelihood of a specific outcome at any given time. Economic models involve risk when known probabilities reflect uncertainty. In decision neuroscience and behavioral economic paradigms, studies of risky decision making typically ask subjects to choose between outcomes with varying reward amounts and modalities.

Preliminary fMRI studies of risky decision making (where the probability of different reward outcomes is known) have identified the lateral and orbital prefrontal cortices, anterior cingulate cortex (ACC), posterior parietal cortex, and insular cortex as key regions involved with risk processing (Behrens, Woolrich, Walton, & Rushworth, 2007; Huettel, 2006; Huettel, Song, & McCarthy, 2005; McCoy & Platt, 2005; Preuschoff, Quartz, & Bossaerts, 2008). More specifically, researchers have posited that the anterior insula may track changes in risk information (Preuschoff et al., 2008). Prefrontal and parietal regions (typically associated with executive control processes) are often associated with risky decisions (i.e., selecting the risky option as compared to a sure outcome), the evaluation of risk, and judgments about probability as well as value (Barraclough, Conroy, & Lee, 2004; Huettel et al., 2005; Paulus, Rogalsky, Simmons, Feinstein, & Stein, 2003; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003).

In many traditional decision neuroscience paradigms, subjects are often asked to choose between a safer, lower-value option and a riskier, high-value option (De Martino et al., 2006; Huettel, 2006; Tom et al., 2007). Research exploring these trade-offs has shown that specific regions reliably predict choice behavior in individuals with anterior insula activation reflecting safer (often sure) choices (Paulus et al., 2003). Conversely, activation in the vmPFC and vSTR often predicts risk-seeking choices (Kuhnen & Knutson, 2005; Tobler, O'Doherty, Dolan, & Schultz, 2007). In these studies, it has become apparent that trade-offs between decision variables such as risk and reward reflect similar trade-offs in the resulting neural activation of specific brain regions (Kuhnen & Knutson, 2005; Sanfey et al., 2003).

Cases of uncertainty where the probabilities are unknown are commonly referred to as ambiguous decisions. Early imaging studies presented subjects with decision problems where they were asked to choose between a known probability of reward or an unknown, ambiguous option. To compare differences between risk-taking when probabilities are known to when probabilities are unknown, researchers generally provide subjects with a visual representation of a given probability (such as a pie chart) and related outcome. In ambiguous trials, the visual information is restricted (where the pie chart is covered). In one study, the lateral orbitofrontal cortex (OFC) and amygdala showed increased activation in decisions related to ambiguity compared to those involved with risk (Hsu et al., 2005). Other related studies found that the posterior parietal cortex, the insula, and the lateral prefrontal cortex (PFC) were all associated with ambiguity-related processing, with the lateral PFC in particular tracking ambiguity attitudes (Huettel et al., 2006). These distinct regions are now thought to reflect differential components of ambiguous decision making, with lateral OFC reflecting loss aversion tendencies (Kringelbach & Rolls, 2004; O'Doherty, Kringelbach, Rolls, Hornak, & Andrews, 2001) and parietal cortex reflecting representations of outcome anticipation specifically when probabilities are ambiguous (Bach, Seymour, & Dolan, 2009).

Neuroscience and Strategic Decision Making

Beyond decision variables, understanding decision strategies is critical for a more complete understanding of financial decision making. The study of decision strategies involves understanding the processes involved with how individuals arrive at a decision, not just how parameter values influence what they choose. Decisions rarely occur in binary, fully informative outcomes, and following a completely compensatory approach to decisions would require extensive neurocomputational resources. For example, with the number of car models available to a given individual, reviewing every single car on the market with the same weighted additive decision strategy would take much more time than could ever be useful. Adaptive decision making in the real world, outside of a lab, typically involves a variety of strategies that individuals adopt based on the context and demands of the choice at hand (Gigerenzer & Goldstein, 1996; Payne, Payne, Bettman, & Johnson, 1993). It is well established that people employ strategies to simplify these complex representations of decision variables to reduce computational demands (Camerer, 2003; Gigerenzer & Goldstein, 1996; Kahneman & Frederick, 2002; Payne, Bettman, Coupey, & Johnson, 1992; Tversky & Kahneman, 1974). Instead of reviewing every single attribute of every single car available, one might choose to prioritize only price and safety ratings or exclude cars above a certain price threshold. While the bulk of decision neuroscience has focused on understanding the compensatory interactions between decision variables (such as how risk or reward outcomes impact people's decision making), others have sought to model how individuals represent and process decision problems (Venkatraman, 2013).

In a 2011 study, Venkatraman and colleagues used a multi-outcome decision making task to investigate the mechanisms underlying individual differences in decision making strategies. Subjects viewed a five-outcome gamble consisting of two outcomes with strict gains, two outcomes with strict losses, and a middle outcome that was either "$0" or slightly negative. To investigate the decision processes involved in complex risky choice, subjects then chose between different ways of improving the gamble by adding money to one of the five outcomes. Adding money to different outcomes reflected differing decision strategies: gain-maximizing added money to the extreme positive outcome, as compared to loss-minimizing where money is added to the extreme negative outcome. Both of these potential choices represent a compensatory framework of risky choice, particularly when these alternatives are also associated with a higher expected value. Alternatively, adding money to the middle outcome reflected probability-maximizing choices in that they increased the overall probability of winning (or decreased the overall probability of losing). The problems presented in the task were designed such that subjects could use one of two strategies for approaching these complex choices: a compensatory strategy that utilized all available information or a simplifying (gist-based) heuristic strategy that emphasized the overall probability of winning while overlooking aspects of the complex gamble (Venkatraman, Payne, Bettman, Luce, & Huettel, 2009b; Venkatraman, Payne, & Huettel, 2011).

These and other studies using a similar gambling task with mixed gambles have found that subjects often made choices that systematically violated predictions of traditional economics models such as expected utility theory and cumulative prospect theory with subjects choosing the probability-maximizing strategy (Payne, 2005; Venkatraman, Payne, et al., 2009b; Venkatraman, Payne, & Huettel, 2014). In a series of subsequent behavioral studies aimed at identifying the boundary conditions of the probability-maximizing strategy, we found that there was substantial individual variability in preferences across subjects (Venkatraman, Huettel, Chuah, Payne, & Chee, 2011a). In the first study, subjects ($n = 128$) chose the probability-maximizing option in about 69% of trials. In trials where this choice was associated with lower expected value, subjects still chose this option the majority of the time (59%). In the second study ($n = 71$), the middle option was slightly modified in some problems in order to make it so that the subject's choice could not change the problem's valence or overall probability of winning. In these problems, subjects were significantly less likely to choose the probability-maximizing option. While in both studies the majority of subjects showed a strong preference for the probability-maximizing heuristic, there were still several subjects whose choices reflected more traditional decision models (such as the gain-maximizing or loss-minimizing strategies).

Corresponding imaging work found that different brain regions predicted model-specific choices. In one study, we found that an increase in activation in regions commonly associated with emotion predicted whether subjects made choices in line with traditional decision models (Venkatraman, Payne, et al., 2009b). Increased activation in the anterior insula (aINS) predicted loss-minimizing choices, and increased activation in the ventromedial prefrontal cortex (vmPFC) predicted gain-maximizing strategies. Activation in regions associated more with cognition was associated with probability-maximizing choices. Specifically, activation in the dorsolateral prefrontal cortex (dlPFC) and posterior parietal cortex predicted preference for the probability-maximizing alternatives.

In addition to regions associated with specific choice behavior, Venkatraman and colleagues (2009b) also looked for regions that were associated with the average preference for the probability-maximizing heuristic across individuals. One would expect regions associated with strategy selection to show greater activation when a subject switches from one strategy to another and control activation in brain regions associated with implementing the selected strategy. As such, activation in the dorsomedial prefrontal cortex (dmPFC) increased when subjects switched away from their preferred strategy on a particular trial. For example, if a subject had a stronger preference for the probability-maximizing strategy, they showed increased dmPFC activity when they made a gain-maximizing choice. These early behavioral and fMRI studies suggest that people adopt different decision strategies and subsequent computational mechanisms in different contexts.

Activation of these brain regions associated with decision strategy (such as the dlPFC and dmPFC) represents interactions among brain systems and can lead to different choice behaviors that are sometimes consistent with economic theories of rationality and sometimes consistent with simplifying or heuristic choices. In selecting a given option, we not only have to choose between a number of different outcomes, but we often have to determine a guiding strategy to reduce the computational burden of our decision processes. Broadly, this ability to shape one's behavior in an adaptable manner has been referred to in other domains outside of decision making as "cognitive control." This flexible behavior is also studied considerably in the context of adaptive decision making with the substantial overlap of these two "systems" reflected in their underlying neural architecture.

Bridging these two distinct bodies of research, we developed a framework identifying three distinct properties that are fundamental to strategic control across both the cognitive control and decision making domains (Venkatraman & Huettel, 2012): selection, optimization, and hierarchy. Selection involves choosing actions that are consistent with the goals and context of a given task and can occur at several levels of cognition – from response selection to complex strategy selection and task switching. Optimization involves the ability to assess and compare performance feedback with internalized goals in order to optimally organize behavior. Furthermore, this optimization system should also be able to detect errors and incorporate them into subsequent performance. Lastly, efficient control systems operate within hierarchical levels, with each level influencing subsequent representations at higher levels. These three components of cognitive control and decision making strategy are reflected in two distinct neural regions: the medial and lateral prefrontal cortex (Venkatraman & Huettel, 2012).

Neurons in the dorsolateral prefrontal cortex (dlPFC) have been shown to assimilate and process contextual information and influence the subsequent selection of appropriate pathways in other brain regions (Miller & Cohen, 2001). This assimilation and allocation is particularly important when uncertainty is involved, or one is required to choose flexibly between multiple responses. Several lines of early work suggest that the dorsolateral prefrontal cortex features a hierarchical organization. Anterior regions of the lateral PFC are associated with contextual control (determining when stimuli in an environment become relevant), and posterior regions are associated with sensory control (Badre, 2008; Koechlin, Ody, & Kouneiher, 2003). This posterior-to-anterior gradient is thought to reflect an increasing level of abstractness and, when there is a need to detect changes in the environment, relies on feedback from the dorsomedial prefrontal cortex (dmPFC; Venkatraman & Huettel, 2012).

Many studies of cognitive control use paradigms involving components such as executive function, response selection, and task difficulty, yet they rarely incorporate findings from complex decision making. Earlier work has demonstrated the role of the dmPFC in flexible control of behavior, showing that dmPFC activation is related to contexts that often involve conflict between competing response tendencies or choosing between options that are evenly matched (Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999; Carter et al., 1998; Kerns et al., 2004; Pochon, Riis, Sanfey, Nystrom, & Cohen, 2008; Rushworth, Kennerley, & Walton, 2005). Additionally, the dmPFC has been shown to reflect the degree to which the current task context is static or variable over time (Behrens et al., 2007). Given the role cognitive control plays across various levels of decision making, it is crucial to understand whether the dmPFC is specific to the domain of choice and decision making or whether it extends into other types of cognition and decision processes.

To test whether anterior-to-posterior hierarchy exists within the dorsomedial prefrontal cortex (similar to the dorsolateral prefrontal cortex), we had subjects complete two different tasks that evoked three distinct forms of cognitive control demands: response, decision, and strategy (Venkatraman, Rosati, Taren, & Huettel, 2009a). Using a classic counting Stroop task, where subjects were tasked with counting the number of times a neutral word (e.g., "cat") or an incongruent number (e.g., "one") appeared on the screen, we identified regions associated specifically with response-related control. To understand decision- and strategy-related control demands, subjects completed an attribute-balancing task where they had to choose between two different stocks that were rated on two independent attributes. In this task, subjects could choose adaptively between two strategies: select the stock with the highest expected value or select the stock that was more balanced across the two attributes. The magnitude of strategy control was manipulated by systematically changing the relative values of the attributes for the two stocks. In this task, the easiest congruent trials featured a balanced stock with a higher expected value (and were chosen in 89% of trials). Incongruent trials occurred when the balanced choice had a lower expected value than the high variability stock. In these trials, subjects chose the balanced option only 23% of the time and took longer to select an option. In this task, there was a third condition, equal trials, where both options had equal expected value and were the most difficult. Subjects took the longest to select an option and still chose the balanced option 65% of the time (Venkatraman, Rosati, et al., 2009a).

Across both tasks, we replicated previous findings that a region in the anterior dorsomedial prefrontal cortex (dmPFC) predicted strategic variability across subjects – with greater activation when subjected made choices that ran counter to their preferred strategy (Venkatraman, Rosati, et al., 2009a). More importantly, we discovered evidence for an anterior-to-posterior topography of the dmPFC based on variable control demands. In the Stroop task, more posterior regions of the dmPFC were significantly associated with response-related control. Middle regions of the dorsomedial prefrontal cortex were associated with decision-related control in the stock task, with an increase in dmPFC activation reflecting increasing difficulty in making decisions. More anterior regions of the dorsomedial prefrontal cortex were associated with strategy-related control demands (when subjects had to choose an option that was incongruent with their preferred strategy) in the stock task. These findings reflect a functional organization of the dorsomedial prefrontal cortex similar to that of the dorsolateral prefrontal cortex – suggesting that both cognitive control and strategic decision making function in a hierarchical fashion (Taren, Venkatraman, & Huettel, 2011).

Future Directions

In this chapter, we outlined how neuroscience techniques can inform our understanding of financial decision making. Specifically, decision neuroscience provides essential additive benefits to our understanding of people's decision making processes – largely within the financial realm. By furthering our understanding of the biological underpinnings of various decision processes, neuroimaging techniques provide a unique window toward understanding what drives decision processes at the most basic levels. As such, combining our understanding of choice preferences and financial decision making with neuroscience techniques allows researchers to identify and perhaps even develop robust and predictive models of decision making and behavior (Clithero et al., 2008).

More recently, researchers have begun to examine how distinct regions and subsequently identified networks within the brain interact to gain a better understanding of the processes associated with these variables (beyond identifying the associations generally). Connectivity approaches generally measure the relationship between multiple regions that are engaged during resting or task-based activity. For example, Smith, Clithero, Boltuck, and Huettel (2014) recently examined whether interactions between the posterior ventromedial prefrontal cortex (pvmPFC) and co-activated regions could predict subjective value. During the study, they had participants rate the attractiveness of unfamiliar faces and later provide their willingness to pay to review the images as a metric of a participant's subjective value of the various images. They identified activation in several regions that were associated with increases in attractiveness such as the dorsal anterior cingulate cortex, the anterior ventromedial prefrontal cortex, and the caudate. Additionally, the researchers examined which neural regions showed distinct co-activation with the posterior ventromedial prefrontal cortex in response to stimuli attractiveness and subjective value. They found a network of regions commonly associated with social reward value showed increased functional connectivity to the pvmPFC. Regions such as the temporoparietal junction (TPJ), medial prefrontal cortex, posterior cingulate cortex, and middle temporal gyrus (MTG) showed increased functional connectivity to pvmPFC with increasing subjective value. Perhaps most interestingly, using trial-to-trial hierarchical regression and model comparison, the researchers found that a model including the activation estimates related to the four functional connectivity regions and social valuation in addition to the activation estimates related to attractiveness ratings best predicted and explained additional variance in subjective valuations (Smith et al., 2014). In another example, Domenech et al. (2018) combined drift-diffusion models (another decision making model) with fMRI to better understand the computations associated with value-based decisions. Their models showed that value-based choices were implemented in a two-stage process: a valuation process associated with activity in the vmPFC and a selection process focused toward the most desirable outcome which was associated with activation in the prefronto-parietal network (PPN) (Domenech, Redouté, Koechlin, & Dreher, 2018). Importantly, these findings emphasize how, while individual regions can contribute to key decision variables, network connectivity analyses can help flesh out how key regions interact to provide a better understanding of the entire decision making process.

Decision neuroscience researchers have also looked at how the network of these key neurological regions associated with strategy selection and adaptive decision making unfold to impact choice behavior. In one study, Wan et al. (2015) scanned a sample of amateur players of a Japanese game called shogi (similar to chess) to understand the neurological basis of decision making in a strategic choice context. While the authors found distinct neural regions associated with selection of an offensive choice or a defensive choice, they also found that connectivity between the dorsolateral prefrontal cortex (DLPFC) and these regions reflected which strategy the player would ultimately choose. Wan and colleagues' findings extend previous research on strategy in decision making as well as emphasize that decisions are rarely reflected by a single region in the brain or specific decision variable by utilizing network and connectivity approaches (Kolling & Hunt, 2015).

Beyond network approaches, recent work has also sought to consolidate understanding of various brain regions (much like the lateral prefrontal cortex) associated with multiple decision processes and tasks. For example, Shenhav and colleagues recently elaborated on the debate surrounding the computational function of the dorsal anterior cingulate cortex (dACC) – another critical region in executive function (Shenhav, Cohen, & Botvinick, 2016). Generally, the dACC supports the flexible adjustment behavior toward goals that may be distracted by other automatic processes as well as motivation and reward associated with decision making. Drawing on works from multiple research disciplines in neuroscience, Shenhav et al. (2016) posit that the role of the dACC is to identify the ideal level of cognitive control to exert toward a given process. The authors outline how, at a computational level, the dACC shifts decisions surrounding how to exert effortful control based on the weighted contributions of reward outcome and the cost of effort. Summarizing decades of neuroimaging studies involved with the dACC, the authors elaborate on how the dACC plays a role in monitoring the need for cognitive control, which ultimately accounts for the region's role in motivating effortful behavior. Similar to past work consolidating the varied findings surrounding the lateral prefrontal cortex, Shenhav et al. call for future work to further develop and refine our understanding of the computations conducted by the dACC and other neural systems that surround reward-based decision making and cognitive control (Shenhav et al., 2016).

In addition, current research has started to focus on computational and clinical applications to further our understanding of decision processes. Clark and Dagher (2014), for example, looked at the role of dopamine and risk-taking in research focused on patients with Parkinson's disease and gambling addictions. In their review, Clark and Dagher identify how those with gambling addiction (sometimes a disorder associated with Parkinson's disease) often demonstrate increased impulsivity and delayed discounting in experimental measures of reward behavior. The authors take a computational clinical approach to suggest that the association between reward-related dopaminergic activity in the ventral striatum and insula related to impulse control in patients with Parkinson's may provide clues into the biological underpinnings of addiction more generally (Clark & Dagher, 2014). In another example, Kumar et al. (2018) recently examined neural activity during a monetary learning task in healthy individuals and a sample of participants with unmedicated major depressive disorder (MDD, a disorder commonly associated with blunted reward processing). They found that relative to healthy control participants, MDD participants showed a blunted reward learning and decreased reward signal in ventral striatum (vSTR) as well as decreased connectivity between the ventral tegmental area (VTA) and striatum during feedback (Kumar et al., 2018). By combining computational modeling approaches with clinical insights, researchers can better elucidate critical mechanisms associated with specific decision processes.

Complex decision making is required in almost every facet of our daily lives – particularly when it comes to financial decisions. From the impulsive choice to buy a pricey latté at the coffee shop down the street to selecting the best retirement savings plan, understanding what leads people to make certain choices over others is crucial to improving their well-being. For decades, the complementary fields of cognitive neuroscience, economics, and psychology have worked to better understand why we see differences in people's choice behavior and what internal and external processes influence the choices people make. More recently, the burgeoning field of decision neuroscience has uncovered key insights into the neurological processes involved in complex decision making. While considerable progress has been made toward our understanding of how key decision variables are represented in the brain and how people process and engage in complex choices, there are still questions with regard to topics such as how contextual factors such as age, mental state, or social setting impact decision making. Future work utilizing computational and network approaches in healthy and clinical samples will help move decision neuroscience beyond simple decision making paradigms toward a more comprehensive understanding of how we make decisions.

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Chapter 3
Hormones, Stress and Financial Decision Making

Joe Herbert

The Significance of Making Decisions and the Variety of Finance

Making decisions, and getting crucial ones correct, is the basis of successful survival in any species. A small rodent has to decide whether to hunt for food, balancing need for energy with the risk of being predated. A stag has to decide whether to engage another in a contest for access to a female, balancing reproductive success against possible damage or death from the rival's antlers. A human trader has to decide whether to buy or sell a stock or commodity, balancing possible gain against loss. In each case, the individual concerned has a stock of information, both previous (experience) and current on which to base his decision. This information is used to assess the risks and benefits of the incipient action. The decision to act or not will therefore depend on the amount and accuracy of this information, the way this is processed by the brain and the precision with which the chances and consequences of success (expectation) against the risk of failure are assessed. In the world of economics, this has led to the conclusion that individuals assess the 'utility' of the reward (Camerer, 2003; Genest, Stauffer, & Schultz, 2016). This does not necessarily correspond to the nature of the reward – for example, the absolute amount of money – but to the significance or importance it has for the individual. Mathematical economics explores these issues extensively and how well they predict courses of action or the results of individual behaviour. Models of economic behaviour can be developed at different levels: for markets, populations, countries, etc. All, however, depend ultimately on the behaviour of individuals. These individuals have varying levels of financial expertise or access to relevant information, and the impact of their decisions may differ substantially. For example, the decision making process of a

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professional trader who deals in millions of pounds each day will be different from a householder buying a car, or shopping in a supermarket, and different again from the CEO of a major company determining longer-term policy. One of the problems facing those trying to develop coherent theories of economic decision making is how far such theories should be all-embracing or restricted to particular contexts. Similar problems complicate attempts to understand the neural bases of economic decisions and how these are influenced by hormones.

This chapter is mainly concerned with the effect of hormones on financial decisions in males. This is not because similar processes in females are not interesting, or that they may show significant differences from those in males. It is a fact that the professional world of finance has been, and to a degree still is, dominated by males, though this situation is slowly changing. Therefore nearly all the available studies have been made on males, whether in real-life or in laboratory replicas of real-life financial decision making. Females dominate domestic financial decision making, but although there is a mountain of data on market research investigating the reasons and biases that influence these decisions, there has been little effort to study any of the physiological factors that might contribute to them. It is incontestable that studies that compared neural and endocrine underpinnings of situations in which males and females make similar financial decisions would be highly interesting and informative. There is, however, a literature on gender differences in decision making in general, and risk-taking in particular, which is considered further below.

Cognition Versus Emotion

The idea that financial decisions are made solely on a rational cognitive basis of utility is long gone (Kahneman, 2011; Kahneman & Tversky, 1979). Traders may be over-confident (optimistic) about outcome (i.e. wrongly assess risk) or too risk-averse to take the chances necessary for maximal gain. They may be unduly influenced by inaccurate or incomplete information or by the action of others (herding; Devenow & Welch, 1996). The way that a financial situation is presented, which has no relevance to its actual value, may influence decisions (framing effects; De Martino, Kumaran, Seymour, & Dolan, 2006; Sonnemann, Camerer, Fox, & Langer, 2013). Social factors, such as social status, or temporal discounting, or unrelated financial demands, may influence estimates of success or failure (Frydman & Camerer, 2016). Risk appetite or aversion may alter because of intervening factors from day to day or even hour to hour. There has been a move to class at least some of these influences as 'emotional' rather than 'cognitive' or 'intuitive' versus 'rational', but this assumes a clear distinction between them. There was a time when emotions were seen as degrading an otherwise purely cognitive process. There is now increasing evidence that emotions have a cognitive element; for example, situations that generate fear or anxiety also recruit cognitive assessments of that situation and its significance. The upshot is the realisation that cognitive and emotional processes are so tightly integrated that it is impossible to separate them (Davidson, Schere, & Goldsmith, 2003; Fox, 2018). Furthermore, attempts to define what an emotion is are still unsatisfactory, and definitions of a list of 'basic' emotions have varied widely (Darwin, 1872; Ekman, 2004; Plutchik, 1997). Nevertheless, there is evidence that biased (e.g. framing-related) financial decisions were associated with activation of the amygdala, part of the brain known to be concerned with emotion, whereas cortical activation (anterior cingulate) was triggered by those not influenced by framing, suggesting neural separation of the two decision making processes (De Martino et al., 2006).

The Role of Reward in Financial Decisions

The concept of reward underlies most decisions, including financial ones (Juechems & Summerfield, 2019). These may differ in important ways. The food-seeking rodent is responding to internal signals indicating the need for energy. If he finds food, the reward will be the appetitive process of eating and reduction in hunger and a consequent improvement in his physical state. The stag's reward is the act of mating but there is no gain for him, only his biological fitness. The trader may make money. Money has no intrinsic value but is a key to improved access to many more primary rewards. Current events, such as changes in hormones, or coincident stress, may alter the value of these rewards or the processes by which they are evaluated (e.g. risk assessment, optimism about outcome). They may also alter the learning process by which decisions that are perceived to result in a successful outcome are reinforced.

Reward signals in a biological context are generated in response to needs. Fundamentally, these are current or anticipated homeostatic states such as energy depletion, salt or water deficit or alterations in body temperature. Reproductive demands are not homeostatic, but the neural machinery underlying them is markedly similar (Herbert, 2007). Secondary rewards, such as financial gain, are learned associations that have many of the properties of primary ones. In humans, both sets can have properties that go beyond their primary purpose, such as influencing social or professional status, and are thus no longer strictly homeostatic.

Although the literature on the neural basis of reward has focussed largely on the striatum and associated areas of the brain, particularly dopamine, in fact it is the hypothalamus that registers need states. In order to be biologically relevant, the current state of motivation and hence anticipated reward has to relate to physiological conditions. Thus, dehydration induces thirst, and water is rewarding. Food may not be. The reverse is true for a state of food deprivation. During a period of intense sexual motivation, both food and water may be ignored. The hypothalamus detects deficit states and initiates both the requisite motivational state and the appropriate endocrine and autonomic response. The mechanism by which it does this can be described in both anatomical and biochemical terms. The latter is represented principally by a range of neuropeptides. Whilst it would be an exaggeration to say that there are specific biochemical codes for each category of hypothalamic activity, there are some striking correlations between the identity of these peptides and a given pattern of physiological and behavioural response. Dehydration activates the hypothalamic peptide angiotensin, which, along with vasopressin, initiates thirst, drinking and the cardiovascular response required both to cope lack of water and salt. A variety of peptides control eating, including neuropeptide Y and agouti-related peptide (AGRP) that initiate hunger and pro-opiomelanocortin (POMC) and α-MSH that terminate eating. Sexual behaviour and pituitary-gonadal activation are controlled by kisspeptin and GnRH, but many others as well. Many of these peptides have a range of actions, which complicates interpreting them as specific codes.

There is also some evidence for an anatomical distribution of function within the hypothalamus. For example, male copulatory behaviour is located in the pre-optic area and anterior hypothalamus, but so, too, is maternal behaviour. Control of eating lies within the paraventricular and arcuate nuclei, but these are also concerned with regulation of the pituitary. The ventromedial nucleus has a role in female patterns of sexual behaviour, but also in aggression. It seems likely that there are distinct patterns of activation in each of these areas that represent a particular motivational state.

The Brain and Financial Rewards

Is there a hypothalamic source for initiating and regulating financial motivation and reward? This seems unlikely. The essential difference between wanting money on the one hand and food, water or sex on the other is that the latter responses are not learned, though the associations and conditions that accompany them may be (e.g. cultural influences on food preference). The nature and value of money is learned and will vary with culture: a dinar would not be considered valuable in the UK, etc. Associative learning of rewards, however, occurs in the amygdala (Cardinal, Parkinson, Hall, & Everitt, 2002; Janak & Tye, 2015). Objects or situations that initially have no incentive value can acquire such value through learned associations with reward, and the amygdala is part of this neural mechanism (Mahler & Berridge, 2012). The amygdala (unlike the hypothalamus) has extensive inputs from the cerebral cortex, so it can access complex information, such as that relating to finance (Murray, 2007). This will include the concept of money as an asset, the recognition of coins and their worth and the social and personal consequences of wealth or poverty, all of which can be ascribed to the cortex. The amygdala can also register both positive and negative events and thus both profit and loss (Paton, Belova, Morrison, & Salzman, 2006). It is therefore highly likely that this is the site at which the value of money is learned. Damage to the amygdala or the orbitofrontal cortex (the two are highly interconnected) reduces aversion to loss (i.e. punishment; De Martino, Camerer, & Adolphs, 2010). There are extensive two-way connections between the amygdala and the hypothalamus, so there is no reason why a secondary state representing money should not be set up in the hypothalamus. Whether it uses one of the existing primary reward systems is speculative. It is important to note that both the amygdala and the hypothalamus express high concentrations of steroid hormone receptors.

The ‘reward system’ in the brain has been much studied. It is usually considered to include the ventral striatum (e.g. nucleus accumbens), its dopaminergic innervation from the midbrain and the orbital frontal cortex and anterior cingulate gyrus (Schultz, 2006, 2016; Shenhav, Straccia, Botvinick, & Cohen, 2016). The ventral striatum has been shown (using fMRI) to respond to the expected value of a reward signal, but also to the probability of that reward being obtained. If a financial choice was associated with risk, then activation of the orbitofrontal cortex (OFC) and insula occurred proportionately to the degree of risk, though there is interaction between these sites and the ventral striatum. For example, activation of the striatum and cingulate increase the probability of a risky choice, whereas OFC responses predict a safer one (Brand, Grabenhorst, Starcke, Vanderkerckhove, & Markowitsch, 2007; Christopoulos, Tobler, Bossaerts, Dolan, & Schultz, 2009). Damage to the amygdala or OFC results in individuals making very poor financial decisions (Bechara, Damasio, & Damasio, 2000). All these areas also respond to social aspects of financial decisions, for example, fairness or cooperation (Knutson & Bossaerts, 2007). Since much of the evidence about the function of different areas of the brain in humans comes from fMRI, it is important to note the limitations of fMRI as an investigatory tool: it is an indirect indicator of brain activation, and the exact link between the signal it gives and the activity of the local brain area is still uncertain. Furthermore, the nature of that activation is not revealed by fMRI. Experimental studies on the dopaminergic system, which innervates both the ventral striatum and OFC, have suggested that it acts as an error detection signal: that is, it responds to differences between actual and anticipated rewards. This will guide decision making and influence choice (Schultz, 2006; Schultz, Stauffer, & Lak, 2017).

It is evident that there must be some connection between those parts of the brain concerned with motivation and attraction to particular stimuli according to either current physiological need (e.g. in the hypothalamus) or learned associations between arbitrary stimuli and reward (e.g. money, in the amygdala) and the generalised reward system, which includes the dopaminergic system, ventral striatum and orbitofrontal cortex (OFC). The latter seems not to be specific for any category of reward, whereas the former matches reward to actual or anticipated need and thus biases the more generalised reward system. Although there are known connections between the two systems, for example, between the amygdala and the OFC and the nucleus accumbens (Janak & Tye, 2015), the mechanism that encodes or transmits the required bias from the system recognising specific rewards to that regulating reward in general is not understood.

Risk Appetite and Financial Decisions

Many real-life financial decisions involve some element of risk. Risk implies that there is more than one possible outcome from a given choice and that one or more of those outcomes may result in loss, danger or other undesirable consequences. Perceived risk therefore contributes to the subjective value of a financial option.

Individuals differ in the amount of perceived risk they are willing to take, and this can vary within an individual with time or occasion. One way of assessing risk appetite is to present a subject with a range of decisions, increasing in value but decreasing in probability of success. The point at which the subject balances the value of the reward with the probability of loss is a marker of risk appetite. It is the perceived, not the actual, value of the reward and the perceived, not the actual, probability of success that determines risk-taking. Each component requires its own assessment, and this, in turn, depends on several factors (D'Acremont & Bossaerts, 2008). The first is accuracy or completeness of the information on both parameters. This will be influenced both by current data and by experience of similar events in the past. The consequences of failure, and thus the amount of risk that is tolerated, are influenced both by personal factors (e.g. immediate loss of money) and by secondary ones such as loss of job, esteem or social status. Risk appetite is therefore the amount of risk that is acceptable on a particular occasion or circumstance. Estimating risk accurately is an essential part of financial decision making. As we will see, hormones can have major influences on these assessments and on risk appetite itself. Although these are discussed on the context of financial decisions, it is obvious that other decisions, particularly those made under duress (e.g. in combat or competition), have properties that are essentially similar to financial ones, though objectives may be different (Kusev et al., 2017). There are important differences in value judgments and risk assessments, and this is reflected in activation of distinct areas of the brain. Reward activates the striatum (which includes the nucleus accumbens), whereas risk results in responses in the prefrontal cortex (Tobler, Christopoulos, O'Doherty, Dolan, & Schultz, 2009). There are also important differences, as already pointed out, between, for example, professional traders operating within a timescale of minutes or even seconds, those in situations of more deliberate decision making (e.g. finance managers) and everyday decisions taken occasionally by those not well-trained in finance. These differences limit the credibility of generalised theories of economic decision making that claim to be universal.

Hormones and Financial Decisions

Assessing the role of hormones in financial decisions is not easy. There are several methods, none of them entirely satisfactory. The most convincing are those that study individuals under real-life conditions. In these studies, levels of hormones are related to performance under various, real-life, circumstances. This has considerable face validity, in that it enables the nature of the event to be categorised, it has real significance for the subjects, and the outcome can be classified. It also enables a focus on one set of subjects (say, financial traders) and one type of person (say, profession male traders), which simplifies conclusions but may limit their generality. A huge deficit is that such studies are always correlational, so that deductions of causality are never possible. Nevertheless, such studies may point the way to more analytical approaches. A more direct method would be to administer the hormone of interest to subjects who then engage (together with appropriate controls) in real-life financial transactions. This has obvious ethical barriers, equivalent to giving steroids to athletes entering real-life competitions, and is therefore seemingly impossible. One way forward is to study subjects in laboratory settings. These allow replication of some aspects, at least, of real-life decision making with the possibility of manipulating hormones and other variables, thus giving direct insight into causal relationships. The drawbacks are that laboratory settings often reproduce only partially the complex and demanding conditions of real-life transactions, the rewards (and losses) are usually very minor compared to real-life so they lack true significance, and the subjects (often students) are not trained in, or accustomed to, financial matters. Neither of these circumstances allows manipulation of the brain. Experimental studies on animals do allow more intrusive procedures. Although animals (e.g., chimpanzees) can learn to exchange tokens for rewards, it is doubtful that they comprehend the concept of money. However, situations in which the animal has to take risks to gain a reward (e.g. a possible electric shock, varied with a given or changing probability) replicate some aspects of human decision making. This has allowed assessment of the contribution of areas of the brain and neurochemical or endocrine factors to risk-taking for reward. The recent development of scanning techniques has offered one entry to studying the activity of the brain during financial transactions in humans, though interpreting such scans requires caution (see above).

There are many hormones that might influence financial decision making. For example, a chronic lack or excess of thyroid hormone will influence both mood and cognitive ability; so, too would reduction or overproduction (or administration) of insulin in diabetics. This may be true for many other hormones. However, these hormones are not particularly sensitive to the conditions that occur during financial dealings, but rather represent disorders which affect many activities. Cortisol and testosterone are two hormones that both have a pre-emptive action on financial events and also react to them without departing from normal ranges (Herbert, 2018). They are thus the focus of this chapter. Further research in the future may uncover other hormones with similar properties.

Stress and Its Influence on Financial Decisions

Risk implies stress. Outcomes that carry a risk of loss or danger, or whose endpoint is not entirely predictable, generate stress. Stress is the generic term given to the psychological and physiological response to an unusual demand that requires an adaptive or coping response and which may exceed the perceived capacity of the individual. Stress is accentuated in situations that are perceived as either unpredictable or uncontrollable (Dickerson & Kemeny, 2004). Engineers recognise two components: the stressor, the event or circumstance that gives rise to the demand, and stress, the response to that demand. In the context of biology, both elements are subsumed under the ‘stress’ rubric. However, this should not disguise the fact that variations in both the external event and the individual’s response to it are distinct elements of the overall stress response. Stress itself has many forms: one is the distinction between an acute stress, lasting only a few minutes or hours; a short-term one, lasting a few days; and a chronic one, lasting days, weeks or months. The behavioural and endocrine response to each category, whose boundaries are not distinct, varies.

Many financial transactions have an uncertain outcome. They may also have considerable significance for the person concerned, risking security, a job, asset ownership and more general consequences such as social status, relationships and self-esteem. These are the external sources of stress. They are not absolute, but depend on perceived qualities of the situation; the social and other sources of support available; the degree of uncertainty, information and control that the situation holds; and the personality of the individual concerned (e.g. trait anxiety, sometimes referred to as 'neuroticism'). What is stressful to one person may be unremarkable to another. The response to stress has two major components: psychological and physiological (Lucassen et al., 2014). The two are linked, but that link is also individually variable. It should not be assumed that stress is inevitably deleterious. A state of arousal, increased attention and recruitment of personal and social sources of support and help are often required for a successful outcome, that is, are adaptive. There are instances when moderate stress improves performance on financial decisions made under uncertainty (gambling; Preston, Buchanan, Stansfield, & Bechara, 2007).

The Endocrine Stress Response

The physiological response to stress is both endocrine and neural. The adrenal gland is an intrinsic part of the response to stress, though it is not the only one. It has two major divisions: the cortex and the medulla. Both are components of the stress response. The innermost part of the adrenal, the medulla, is developmentally similar to the nervous system, and its cells secrete noradrenaline (norepinephrine) and adrenaline (epinephrine). The medulla is innervated by autonomic fibres from the spinal cord, and so is under direct control of the brain. Autonomic fibres innervate most of the body and are activated under many conditions, acute stress being one. Secretion of adrenaline and noradrenaline from the adrenal medulla is part of that generalised response. Heart rate increases, as does blood pressure and respiration rate and blood flow to the muscles, a response often termed the 'fight or flight' reaction. Activation of the adrenal medulla (and autonomic system) is characteristically a short-term phenomenon, though a more persistent one can occur. Basal levels of activity are essential for adequate control of heart rate, blood pressure, etc., so this system is not only a stress-related one.

The brain also has a noradrenergic system, which is separate from the peripheral one, but often operates in concert with it. Specialised cells in the brain stem produce noradrenaline, and these cells project to wide areas of the other parts of the brain, including both the limbic system and cortex. The innervation pattern is not uniform:

some areas of the brain receive more noradrenergic input than others. This means that activation of the system will influence the function of extensive but not universal areas of the forebrain. The circumstances under which the central noradrenergic system is activated are often very similar to those of the peripheral, adrenal (autonomic) one (Berridge & Waterhouse, 2003), so the two systems are, to considerable degree, coordinated. However, peripheral adrenaline and noradrenaline (together referred to as catecholamines) do not enter the brain from the blood (they are excluded by the blood-brain barrier), so any effect they have on neural function is an indirect one.

An acute stress might be a short-term financial transaction, carrying with it the risk of a loss, but whose outcome is quickly known and (usually) not of lasting significance. A bet is one example. The endocrine response is largely a surge of noradrenaline (norepinephrine) and adrenaline (epinephrine) from the adrenal medulla. This is part of a generalised autonomic response and is associated with increased heart rate, blood pressure and respiration. In the brain, there is activation of the corresponding central noradrenergic system, which increases the state of arousal and, if the potential loss is a serious one, a coincident state of anxiety (Ulrich-Lai & Herman, 2009). If this psychological and physiological state occurs in anticipation of the event, then working memory, executive function and decision making may well be impaired (Malhotra, Ku, & Murnighan, 2008; Zhou & Ni, 2017) (Fig. 3.1).

Cortisol and Decision Making

It is the outer layer, the cortex of the adrenal gland, that has the most relevance to the influence of stress on financial decision making. It has three concentric divisions. The outermost one (zona glomerulosa) secretes the steroid aldosterone, which plays a major role in salt and water balance. The innermost one (zona reticularis) produces the steroid dehydroepiandrosterone (DHEA), which has multiple roles, including providing the foetus and placenta with precursors for making other steroids. In the adult it influences the immune system and declines with age. It also has a moderating effect on the actions of cortisol. Cortisol, the most relevant adrenal steroid for the stress response, is secreted from the intervening layer (zona fasciculata). Unlike the other two layers, the secretion of cortisol is regulated by the pituitary peptide adrenocorticotrophic hormone (ACTH) and hence by signals from the hypothalamus (e.g. the peptide corticotrophin-releasing factor, CRF). The hypothalamus, in turn, is a major player in the control of motivation and, through its connections with the amygdala and other areas of the limbic system, emotional reactions, stress responses and coping adaptations. Behavioural and physiological stress responses are coordinated by the hypothalamus and amygdala. Exposure to a stress-inductive stimulus activates corticotrophin-releasing factor (CRF). As well as initiating release of ACTH and hence cortisol, it also induces a state of emotional anxiety. Both are part of the overall response to stress (Kalin et al., 2016).

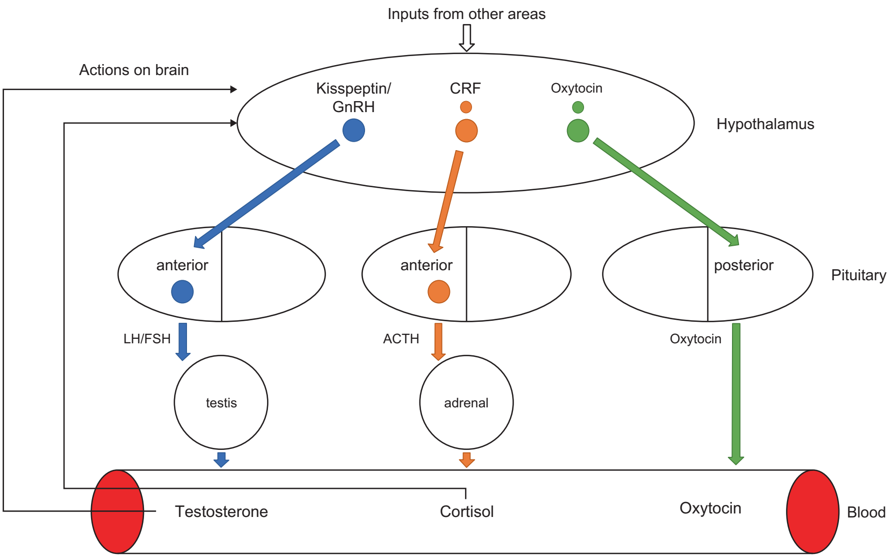

Fig. 3.1 The neuroendocrine mechanisms controlling the release of testosterone, cortisol and oxytocin. The latter have two neural systems: one for peripheral action and the other for a central one. Whereas the hypothalamus controls testosterone and cortisol by a chain of command signals, peripheral oxytocin is produced directly from the brain

Cortisol is secreted from the adrenal as a series of pulses, separated by about 90 min (circhoral). These pulses are large in the morning, but diminish as the day progresses, so that by the late evening they may be almost absent (Russell, Kalafatakis, & Lightman, 2015). This gives rise to the marked daily rhythm in cortisol: average levels are 5–10 times higher at around 0800 h than at 2000 h. This rhythm is driven by activity, so travelling across time zones (or night shifts) causes a corresponding shift in the zenith and nadir of the daily cortisol rhythm. The perception of a stressful situation (or a physical demand such as an infection) results in a surge in cortisol. This is secondary to preceding activity in the hypothalamus and pituitary and forms the endocrine component of the classical stress response (Selye, 1950). Stress-related elevation of cortisol can last for hours, days or months. Both elevated levels and the loss of the daily rhythm have consequences for neural function (George et al., 2017).

Cortisol is a steroid, and so crosses membranes easily. This includes the blood-brain barrier. However, entry to the brain is limited by cortisol binding to a carrier protein in the blood. This protein, corticoid-binding globulin (CBG), binds around 90–95% of blood cortisol; only the 'free' 5–10% can enter the brain. There is an equilibrium between 'bound' and 'free' cortisol; since there is spare capacity in CBG, extra cortisol from the adrenal will bind to CBG, but the free fraction will also increase. At some point, the binding capacity of CBG will be exceeded: then any secreted cortisol will remain in the 'free' form and enter the brain as a surge. Since the amount and binding affinity of CBG varies, this point will also be an individual variable.

Once cortisol enters the brain, it binds to a large protein, the glucocorticoid receptor (GR). This complex molecule lies inside the cell and moves into the nucleus when cortisol is attached to it. It then binds to a special sequence in DNA and in this way either increases or represses the expression of a large number of genes. The capacity of GR is also limited, and there are many genetic variations in its structure that alter both its binding capacity and its ability to regulate gene expression (Wust et al., 2004). This, therefore, is another source of individual variation in the stress response. Cortisol also acts on a second membrane-bound receptor that lies on the surface of brain cells. This has a more rapid action than the classical intracellular one, but is less well understood (Vernocchi et al., 2013).

GRs are expressed in most of the brain, but are particularly dense in the limbic system, and the orbital part of the frontal lobes, areas, as we have seen, closely involved in emotional states (Bustamante et al., 2016; Butts & Phillips, 2013). Within the brain, cortisol can be metabolised to inactive forms (e.g. cortisone), which limits its action. The enzymes responsible (e.g. 11-β hydroxysteroid dehydrogenase) are also genetically variable and will contribute to individual responses to stressful conditions (MacLullich et al., 2012). In addition to genetic contributions, the experience of adversity during early life can have long-standing and profound consequences for the sensitivity and amplitude of stress reactions in later life (Meaney, Szyf, & Seckl, 2007).

Stress affects decision making, but there are significant qualifications. Most laboratory studies have focussed on the effects of short-term stress. The nature of the stress is important. Physical stressors, such as immersing one hand in cold water, and psychological ones, such as requiring the subject to deliver a public speech, both elevate blood adrenaline and cortisol. But they result in different patterns of neural activity (in the hippocampus) (Liu et al., 2018).

Stress can impair executive functions, including attention and behavioural inhibition (impulsivity), task management and forward planning (Starcke & Brand, 2016). Individual cortisol levels were raised in response to uncertainties and volatility in the market in financial traders under both real-life and laboratory conditions (Coates & Herbert, 2008, and Cueva et al., 2015) and giving short-term cortisol increased preference for risky choices (i.e. risk appetite) (Cueva et al., 2015; Putman, Antypa, Crysovergi, & van der Does, 2010). It also impairs detection of errors, a crucial element of financial decisions (Hsu, Garside, Massey, & McAllister-Williams, 2003). There has not yet been a sufficient study on the financial outcomes after either short- or longer-term elevations of cortisol.

It should be emphasised that stress does not necessarily elevate cortisol and that all the consequences of stress are not necessarily due to raised cortisol. However, one study showed that stress increased risk-taking only in those subjects in which cortisol was elevated (Buckert, Schwieren, Kudielka, & Fiebach, 2014). Acute stress generally increases risky choices, particularly under conditions of high uncertainty. This seems to be associated with increased reward-sensitive behaviour (Starcke & Brand, 2016). But this initial increase in risk appetite may reverse after persistently elevated cortisol or stress, perhaps because of alterations in the interaction between adrenaline and cortisol or different effects of the two types of cortisol receptors (Bendahan et al., 2017; Kandasamy et al., 2014). An equivalent progression in the neural response to corticoids in the amygdala occurred over time (Henckens, van Wingen, Joels, & Fernandez, 2010). This illustrates the importance of the duration of stress, as well as its occurrence. It seems that the initial nature of the financial demand, which includes attention to threats, fear of failure, etc., is more associated with an acute elevations of cortisol (stress), whereas a pre-existing state in which cortisol is chronically elevated, which may be related or not to the current decision, will result in a strategy that is different (Putman, Hermans, & van Honk, 2007; van Ast, Cornelisse, Meeter, Joels, & Kindt, 2013). Acute elevations of cortisol may also influence subsequent decisions by enhancing the arousal response and consolidating memories of previous adverse events or experience (Abercrombie, Kalin, Thurow, Rosenkranz, & Davidson, 2003; Wolf, Atsak, de Quervain, Roozendaal, & Wingenfeld, 2016).

It has already been emphasised that individual differences in response to stress will have significant influence on financial (and other) decision making. Many of these factors are not understood in detail, but some general principles are emerging. Impulsivity, which is a trait in which decisions are often made quickly (and therefore sometimes prematurely), is one. Such individuals will exhibit reduced temporal discounting, preferring immediate reward over a more delayed, but greater, one (Lempert, McGuire, Hazeltine, Phelps, & Kable, 2018; Lempert, Porcelli, Delgado, & Tricomi, 2012). Their cognitive style resembles the 'fast' mode, in contrast to the more deliberate 'slow' approach (Kahneman, 2011), and is likely to be enhanced by stress. Impulsivity has been ascribed to activity in the central serotonin and dopamine systems (Dalley & Roiser, 2012). These systems have many of the anatomical and neurochemical features characteristic of the central noradrenergic system, such as a local collection of neurochemically distinct neurons limited to the brainstem, but a wide distribution of axons from those neurons to other areas of the brain, including the limbic system (amygdala, hypothalamus) and cortex (including the frontal cortex). Cortisol has powerful controlling actions on serotonin. One mechanism is its regulation of the enzyme tryptophan hydroxylase, a component on the synthesis of serotonin, but there are others, including actions on serotonin receptors in the brain (Chaouloff, 2000; Joels, 2011). Genetic variations in the serotonin transporter (hSERT, 5HTT, SLC6A4), which limits the synaptic action of serotonin, have been implicated in individual differences in impulsive behaviour (Cha et al., 2017; Walderhaug, Landro, & Magnusson, 2008), but whether this affects financial decisions has not been reported. The consequences of early-life adversity and individual differences in personality on subsequent stress responses and cortisol reactivity have already been mentioned.

There are pathological conditions (e.g. Cushing's disease) in which cortisol is raised above physiological limits, usually a result of either an adrenal or pituitary tumour. Such patients are likely to have impaired cognitive function and depressed mood (Herbert, 2013). Treating this condition usually restores mood to normality, but cognitive impairment may persist (Hook et al., 2007; Newcomer, Selke, & Melson, 1999; Starkman, Schteingart, & Schork, 1981). This indicates that high cortisol may adversely affect brain function, a conclusion supported by experimental studies. In rodents, administering excess corticosterone (the equivalent of cortisol in that species) has damaging actions on the hippocampus (which is highly sensitive to glucocorticoids), causing malformation in its dendrites, reducing the rate of formation of new neurons (a peculiarity of the hippocampus) and sensitising the brain to the damaging actions of other toxic agents (Cameron & Gould, 1994; Herbert et al., 2006; Magarinos, McEwen, Flugge, & Fuchs, 1996; Pinnock et al., 2007; Sapolsky, 1996). Whether stress-related elevations of cortisol in humans can have equivalent effects is still unknown, but it does seem likely.

Stress and the Brain

What do we know of the neural mechanisms that underlie stress-related behaviour? Most of the information comes from three sources: scanning (fMRI) studies on subjects making financial decisions under stress (but refer to the caveats about this technique made above); abilities in persons with various types of brain damage (e.g. traumatic, stroke), although such lesions are rarely localised or specific; and deductions made from experiments on animals, particularly non-human primates. These have enabled some information about the parts of the brain involved. For example, stress has been shown to activate the prefrontal and cingulate cortex, the ventral striatum (including the nucleus accumbens) and the limbic system (hippocampus, amygdala, hypothalamus) (Hermans, Henckens, Joels, & Fernandez, 2014; Mohr, Biele, & Heekeren, 2010), and the pattern of activation has been related to the magnitude of cortisol responses (Dedovic, D'Aguiar, & Pruessner, 2009; Pruessner et al., 2008). All these areas are known, from other work, to be concerned in emotions, assessment of the environment and decision making. The problem comes when we try to understand how variations in the activity in any of these areas underlie a given emotional or stress-related state. For example, although we know that the amygdala is concerned with both fear and joy (and other emotional states), contemporary neuroscience cannot tell us the composition of the corresponding pattern of neural activity. So the neural bases of the effects of stress, cortisol or any other influence on decision making and individual differences in these processes remain to be discovered. We also do not really understand the significance of stress-related cortisol surges. People taking corticoids are told to increase their dose if they become ill. Otherwise, they may become adrenal insufficient and much worse. This indicates that stress-activated cortisol surges are necessary. Despite much information on the metabolic, immunological, cardiovascular and other actions of glucocorticoids such as cortisol, the exact reasons for the need for stress-related increases are still somewhat obscure. This makes it difficult to assess whether stressful activation of cortisol is adaptive or mal-adaptive. As already mentioned, there are indications that moderate degrees of stress can be beneficial for decision making, but that more extreme levels are detrimental. The most plausible interpretation is that the effects of stress lie on an inverted U-shaped curve: there is a point of maximum benefit from a stress response, but diminishing returns after the zenith. The exact shape of the curve will depend on both circumstance and individuality.

The Nature and Function of Testosterone

Testosterone has some similarities with cortisol, but many important differences. Like cortisol, it has powerful effects on financial decision making. However, its biological role, which is responsible for that influence, is quite distinct.

Both testosterone and cortisol are steroids. The secretion of both is controlled by the pituitary, but the method differs. Testosterone, secreted largely by the testes, is regulated by gonadotrophins produced by the pituitary (mostly luteinising hormone: LH) which in turn are regulated by the hypothalamus. Kisspeptin-producing neurons in the anterior and mid-hypothalamus activate GnRH-producing neurons in the hypothalamic arcuate nucleus, which then passes to the anterior pituitary through the portal vessel link. GnRH activates the release of gonadotrophins which activate the testes to secrete testosterone. In this way, neural activity can alter levels of testosterone, both before puberty and during adult life (Comninos et al., 2017). As a result, testosterone levels are very labile. Both cortisol and testosterone are lipid-soluble and thus can enter the brain easily. Both are bound to plasma globulins (cortisol-binding globulin, CBG; sex hormone binding globulin, SHBG) which limit that entry. Testosterone is metabolised in its target tissues to other steroids (dihydrotestosterone: DHT and oestrogens) which are important for some of its actions. Both bind to intracellular receptors: cortisol to GR and testosterone (and DHT) to the androgen receptor (AR). The distribution of these receptors in the brain differs. Whereas those for cortisol are widespread, AR are more limited, largely to the limbic system though there is some expression in the cortex and brainstem (Claessens, Joniau, & Helsen, 2017; Hofer, Lanzenberger, & Kasper, 2013).

AR, like GR, is a large complex intracellular protein, essential if a tissue such as the brain, penis or prostate is able to respond to testosterone or other androgens. A large number of mutations have been reported for AR. Many have little effect, but some alter the ability of testosterone to bind to the receptor or the way that the steroid-AR complex binds to DNA. In particular, the length of a variable CAG repeat at the 5′ end is inversely proportional to its sensitivity to testosterone (Gottlieb, Beitel, Nadarajah, Paliouras, & Trifiro, 2012; Jaaskelainen, 2012). Some mutations render the individual completely insensitive to testosterone (Kosti, Athanasiadis, & Goulis, 2019). The effect of testosterone on the brain will, therefore, depend not only on the amount entering it and the distribution of AR, but on the latter's molecular structure, which is individually variable. Many studies on the way testosterone influences behaviour neglect the role of AR (Vermeersch, T'Sjoen, Kaufman, Vincke, & Van Houtte, 2010). As for cortisol, there is also evidence of a second, membrane-bound, rapidly acting receptor for testosterone (Shihan, Bulldan, & Scheiner-Bobis, 2014).

Testosterone has only one biological role in the male which is to enable reproduction (females also secrete some testosterone: see below). However, to accomplish this, it has to have many other associated and essential functions, and it is these that impact decision making.

Lifetime Trajectory of Testosterone

Testosterone has powerful determinant actions on the male brain, and this is reflected in its subsequent role in financial decision making. The male brain experiences three surges of testosterone. The first occurs during early intra-uterine life and has highly influential roles in gender identity and, perhaps, sexual orientation. It also sensitises the brain to the subsequent actions of testosterone during adult life. The ratio between the length of the second and fourth digits (2D:4D ratio) differs between the genders in adults (M < F), but overlap. XY individuals insensitive to testosterone have 2D:4D ratios that lie in the female range. However, there is no convincing evidence that individual measures of the ratio reflect corresponding differences in exposure to testosterone in males during embryonic life, though this is often assumed (Breedlove, 2010; McIntyre, 2006), and it should be noted that there is a similar variance in this ratio in females, who have not been exposed to prenatal testosterone. The second occurs shortly after birth, lasts for only a few weeks and has no recognised role. Unlike prenatal testosterone, this post-natal surge is largely confined to primates. The third occurs at puberty and is responsible for sexual maturity, reproductive capacity and all the other attributes of adolescence and persists during adult life (Balthazart, 2011; Bancroft, 2005; Berenbaum & Beltz, 2011; Vermeersch, T'Sjoen, Kaufman, & Vincke, 2008).

Along with its central role in reproduction, which includes both maturation of sperm and initiation of sexual motivation and ability, testosterone has to activate other behavioural features that are essential components of sexuality. These include competitiveness, aggression, a desire for social status and bonding with other males. Males of any mammalian species have to compete with others for females, if necessary by force, as well as establishing their social rank in the group and competing for food or territory. Testosterone, in some species, also supplies the weapons males require, such as long canine teeth or claws, horns and additional muscular strength. The role of testosterone in females is considered further below.

Testosterone, Risk and Rewards

The competitive, aggressive, risk-laden behaviour of young males is the result of the pubertal surge of testosterone (Herbert, 2017). There is an increased appetite for risks and rewards, including financial gain, which interacts with accentuated peer relationships and social status in both genders (Cardoos et al., 2017; Morrongiello

& Rennie, 1998; Steinberg, 2008). Activation of the nucleus accumbens, associated with reward (see above), increases, and there is experimental evidence that testosterone moderates dopamine transporters and receptors (Alarcon, Cservenka, & Nagel, 2017; Bell & Sisk, 2013; Purves-Tyson et al., 2014). However, the characteristic risky behaviour (financial, social and physical) of adolescence (Massie, Campbell, & Williams, 1995), though triggered by testosterone, may be accentuated by the relative immaturity of the frontal lobes. There is progressive thinning of the frontal cortex during late adolescence and early adulthood (Herting, Gautam, Spielberg, Dahl, & Sowell, 2015; Mills, Goddings, Clasen, Giedd, & Blakemore, 2014). This has usually been thought to represent reduction in grey matter, which presents a developmental puzzle. Recently it has been found that, in fact, this may be a consequence of increased myelination, which would appear on scans as white matter and not cortical thinning (Natu et al., 2019). The progressive earlier onset of puberty over the past century means that the advent of puberty relative to brain maturation is now mis-matched relative to earlier times, so that pubertally driven emotional and social development occurs several years before the frontal lobes have achieved adult status (DeWitt, Aslan, & Filbey, 2014). This interval, which represents adolescence, thus occurs before adult functioning of the frontal lobes, and this may contribute to its characteristic risky behaviour (Mills et al., 2014), though lack of appropriate experience may also be important. Damage to the frontal lobes in adults results in increased poorly judged and risk-laden behaviour (Floden, Alexander, Kubu, Katz, & Stuss, 2008).

There are gender differences in risk appetite, though these may vary with context. Males are consistently less risk-averse than females in financial, physical, legal and social contexts (Reniers, Murphy, Lin, Bartolome, & Wood, 2016). However, context matters: females may find risks more acceptable, for example, as part of child-care, so the nature of the risk is important (Rolison, Hanoch, Wood, & Liu, 2014; Schubert, Brown, Gysler, & Brachinger, 1999). The mechanisms for these differences are complex: males may perceive a particular pattern of behaviour as less risky than do females, or they may actually seek out situations of risk as an experience or be more impulsive than females; they may also be more sensitive to reward of particular kinds (e.g. money) and less concerned about possible social repercussions or sanctions (Alarcon et al., 2017; Morrongiello & Rennie, 1998). Laboratory studies show that males choose higher rewards with lower probabilities of success than females (Bryrnes, Miller, & Schafer, 1999; Harris & Jenkins, 2006).

How far can this be ascribed to testosterone? One way is to relate financial decision making to current levels of testosterone in men. There have been reports that higher levels predict increased risk-taking (Apicella et al., 2008; Stanton, Liening, & Schultheiss, 2011), but these have not always been replicated. In some reports, this was limited to those with low testosterone, in others that both those with high or low testosterone take more risks (Sapienza, Zingales, & Maestripieri, 2009; Stanton et al., 2011). There are also attempts to use the digit ratio as an indicator of the influence of prenatal testosterone on risk sensitivity (but see the caveat above) and that a lower ratio is correlated with increased risk-taking (Branas-Garza, Galizzi, & Nieboer, 2018). It would not be surprising if prenatal testosterone influenced subsequent actions of testosterone on risk appetite (and other aspects of financial behaviour) during adulthood. Both testosterone levels and genetic variations in the androgen receptor have been associated with increased competitiveness and more confidence in success (Eisenegger, Kumsta, Naef, Gromoll, & Heinrichs, 2017).

A complication is that testosterone levels are highly variable within individuals, so this moderates relating them at a one-time point to financial achievement or behaviour. Levels respond to environmental events. Sexual activity, or even talking to an attractive female, raises levels and increases subsequent risk-taking (Baker & Maner, 2008). Success in competitive environments, or even watching a video of previous triumphs, raises testosterone, a feature termed the 'winner effect' (Booth, Shelley, Mazur, Tharp, & Kittock, 1989; Geniole, Bird, Ruddick, & Carre, 2017; McCaul, Gladue, & Joppa, 1992). The prospect of a competitive challenge, particularly if this is seen as possibly advantageous, has a similar result (Camerer & Fehr, 2006; O'Connor, Arnold, & Maurizio, 2010). For example, entrepreneurs had higher levels of testosterone than a comparison group (White, Thornhill, & Hampson, 2006). All these factors may reflect social status, which is also a positive determinant of testosterone levels (Eisenegger, Haushofer, & Fehr, 2011). Testosterone levels may be markedly reduced in men exposed to loss or severe or dangerous conditions (e.g. war) to those that are hardly above castrate levels (Henning, Park, & Kim, 2011; Mehta & Josephs, 2006).

A real-life example of the way this might influence financial decisions comes from a study on London financial traders, who made more money on days when their testosterone was highest irrespective of their absolute values (Coates & Herbert, 2008). Why testosterone varied in this way in these subjects was not known. These correlations can only be termed causation if they can be repeated using treatment with testosterone. Giving testosterone to traders playing a game that replicated many of the features of real-life transactions resulted in increased mis-pricing (i.e. higher price offers) and over-optimism about the future price of assets (Nadler, Jiao, Johnson, Alexander, & Zak, 2017). In another study on students playing a game that allowed a choice between low-return rewards with a high probability and higher rewards with lower probability, testosterone increased both risk appetite and optimism about a favourable outcome (Cueva et al., 2015). Raised testosterone from whatever reason may also have carry-over effects on subsequent decisions. Men playing with a gun (which raised testosterone) were more likely to inflict discomfort on others subsequently, and a recent history of receiving rewards can reset estimation of future ones (Apicella, Dreber, & Mollerstrom, 2014; Khaw, Glimcher, & Louie, 2017; Klinesmith, Kasser, & McAndrew, 2006). This suggests there may be a 'staircase effect' on testosterone levels: a win increases levels, which then predisposes a second win, and so on. At some point, either testosterone increases optimism to an extent that results in a loss (crash) or luck runs out. Empathy or a sense of fairness plays a role in determining financial strategy and is generally considered to be more prominent in females than males (Auyeung et al., 2009). Giving testosterone to either males or females reduces generosity in games (e.g. the ultimatum game) that depend on this state of mind, and men with higher testosterone were more likely to reject offers that might otherwise be considered as fair (Burnham, 2007; van Honk et al., 2011; Zak et al., 2009).

The Menstrual Cycle and Decisions in Females

Females also secrete testosterone, though blood levels are about a fifth or less of those of males. This comes from both the adrenals and ovaries. Testosterone has a major role in the regulation of female sexual motivation ('libido'; Bancroft, 2005). There are a number of studies in which testosterone has been given to women, and various aspects of economically relevant behaviour have been studied. It is important to recognise that such studies have little value if they are directed towards making females more like males. Such an interpretation ignores the fact that females, as well as males, secrete testosterone (i.e. testosterone is not a 'male' hormone) and that, unlike males, there are no preceding exposure of the brain to testosterone during embryonic life and thus no organising or sensitising actions. Unlike males, competitive environments do not raise testosterone in women (Bermon et al., 2014). Giving women testosterone decreased sensitivity to punishment but increased it to reward, a behavioural pattern that would increase financial risk-taking (van Honk et al., 2004). It also reduces empathy (women normally score higher than men) and, as in males (see below), alters trust; for example, it increases the neural response in the amygdala to untrustworthy faces or threats (Radke et al., 2015; van Honk et al., 2011). There is therefore some evidence that giving excess testosterone to women has effects that seem similar to men.

A more pertinent endocrine influence is that exerted by the menstrual cycle, which has a median length of 28 days but has considerable individual variation. The first half is dominated by increasing levels of ovarian oestrogen (principally 17-β oestradiol), culminating in ovulation and the formation of the corpus luteum. This secretes progesterone which acts together with oestradiol during the second half until its degeneration results in menstruation and the start of the next cycle. Some, but not all, women experience a period of lowered mood and increased anxiety and irritability during the few days preceding menstruation (PMT).

At midcycle, women are less loss-averse and more risk-prone and competitive than at other stages, but are least competitive during the luteal phase (Buser, 2012; Lazzaro, Rutledge, Burghart, & Glimcher, 2016; Pearson & Schipper, 2013). At midcycle their consumer choices are particularly influenced by whether they affect sexually attractiveness (Durante, Griskevicius, Hill, Periloux, & Li, 2011; Saad & Stenstrom, 2012). Similar, in many ways, to the effect of testosterone in men, women at midcycle make more consumer choices that will enhance their social status (Durante, Griskevicius, Cantu, & Simpson, 2014). It is clear from these results that the influence oestrogens and progesterone have on economic decisions in women may be distinct and warrant much further investigation. In particular, the post-menopausal period, characterised by lack of both hormones but persistence (in many cases) of pre-menopausal levels of testosterone, would be interesting.

The Importance of Trust: Oxytocin

Trust is an important element of many financial transactions in some or all of the participants and is often reciprocal (King-Casas et al., 2005). Testosterone generally decreases trust in both genders, and this has been attributed to decoupling of the connections between the OFC and the amygdala (Bos, Hermans, Ramsey, & van Honk, 2012). However, another hormone, oxytocin, has a more established role.

Oxytocin, unlike cortisol and testosterone, is not a steroid but a small peptide (nine amino acids). Like many other peptides, it has both central (neural) and peripheral roles. Oxytocin destined for peripheral action is made by large (magnocellular) neurons in the paraventricular and supraoptic nuclei of the hypothalamus. These neurons project to the posterior pituitary, where their oxytocin is liberated directly into the blood. For many years it has been known that oxytocin played a central role in parturition and lactation, causing contractions of uterine muscle during late pregnancy, and stimulating milk ejection during the post-partum period. More recently, it became apparent that the induction of maternal behaviour was also encouraged by central oxytocin, secreted by more conventional small (parvicellular) hypothalamic neurons (Keverne & Kendrick, 1992). This indicated a coordinated action on reproduction in females, but left a function in males to be discovered, though they were known to secrete oxytocin, levels increasing, for example, after orgasm (Murphy, Checkley, Seckl, & Lightman, 1990).

The role of oxytocin in bonding between mother and infant suggested that it might have a wider role in social affiliation. Intranasal oxytocin (which would reach the brain) increased trust, not because of a general change in risk appetite, but an increased willingness to accept social risks (Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005). The effects of oxytocin were moderated by genetic variations of the oxytocin receptor (Krueger et al., 2012; Nishina, Takagishi, Inoue-Murayama, Takahashi, & Yamagishi, 2015). The general increase in trust resulting from intranasal oxytocin will also apply to financial transactions (Theodoridou, Rowe, Penton-Voak, & Rogers, 2009), and oxytocin reduced sensitivity to fairness in a financial game (Ultimatum; Radke & de Bruijn, 2012). Although the robustness of these findings has been questioned (Nave, Camerer, & McCullough, 2015), subsequent work has generally confirmed and extended central oxytocin's role, though this is modified by factors such as concurrent mood (Cardoso, Ellenbogen, Serravalle, & Linnen, 2013). Oxytocin seems to play a wide role in social cognition and other affiliative behaviours, including empathy and altruism, and may interact with the reward system to reinforce such relationships (Hu et al., 2016; Skuse & Gallagher, 2011). It is important to question studies that use plasma oxytocin as a correlate of trustworthiness because this does not necessarily reflect central oxytocinergic activity (magnocellular vs. parvicellular neuronal activity) and the two may not always be coordinated. As for many other instances, the effects that oxytocin will have on financial interactions are part of a more general function applicable to many other categories of social and personal engagement and decision making.

Interactions Between Hormones: The Importance of Endocrine Patterns

Reviews such as this one disaggregate hormones (and other factors) into single entities for the purposes of analysis (Fig. 3.2). But it is evident that a range of hormones will be acting at any one time within an individual and that these hormones interact with each other and with the neural systems that are sensitive to each of their actions. The overall influence on decision making, variable as it may be with time and context, will depend upon this endocrine pattern (inter alia). For example, there is a positive correlation between plasma testosterone and dominance status in men, but only in those with lower levels of cortisol (Mehta & Josephs, 2010). Higher testosterone was also associated with a 'hawk' strategy in a financial game, one that can maximise winnings and inflicts the most harm on the other player. This was also accentuated by concurrent lower cortisol (Mehta, Lawless DesJardins, van Vugt, & Josephs, 2017), and similar results followed another game that tested risk-taking (Mehta, Welker, Zilioli, & Carre, 2015). Intranasal oxytocin reduced the cortisol response to a stress test (Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003), though whether it alters financial behaviour carried out under stress has not been reported. In women, higher testosterone was associated with less attention to an infant, but this was mitigated by oxytocin (Holtfrerich, Schwarz, Sprenger, Reimers, & Diekhof, 2016), but neither has this interaction been studied in a financial context. It is clear that much more information is needed about patterns of endocrine profiles and how they might relate to strategies or practices of financial decision making.

The Covert Action of Hormones in Financial Decision Making

It took psychologists to tell economists that financial decisions were not made by 'rational man' but were subject to bias unsuspected by those who either carried out such transactions or who studied them (Tversky & Kahneman, 1974). Now it is becoming evident that hormones are another source of unsuspected influence as part of the mechanism underlying those described by psychology. Decision makers are not aware of the action of their hormones, unless these become deranged on a pathological scale. Yet there is increasing evidence, summarised here, that hormones have powerful but covert effects on financial decision making. Hormones have their effects at both individual and collective levels. Individual decisions are influenced by many factors, including risk appetite, calculation of probabilities, estimation of utility, processing of current and past information and the actions of colleagues and rivals. Wider considerations include social status and job security and the effects decisions might have on personal or professional relationships. All these are biased by current and previous levels of hormones in both genders, though nearly all our current information relates to males. Since the market is subject to concerted actions

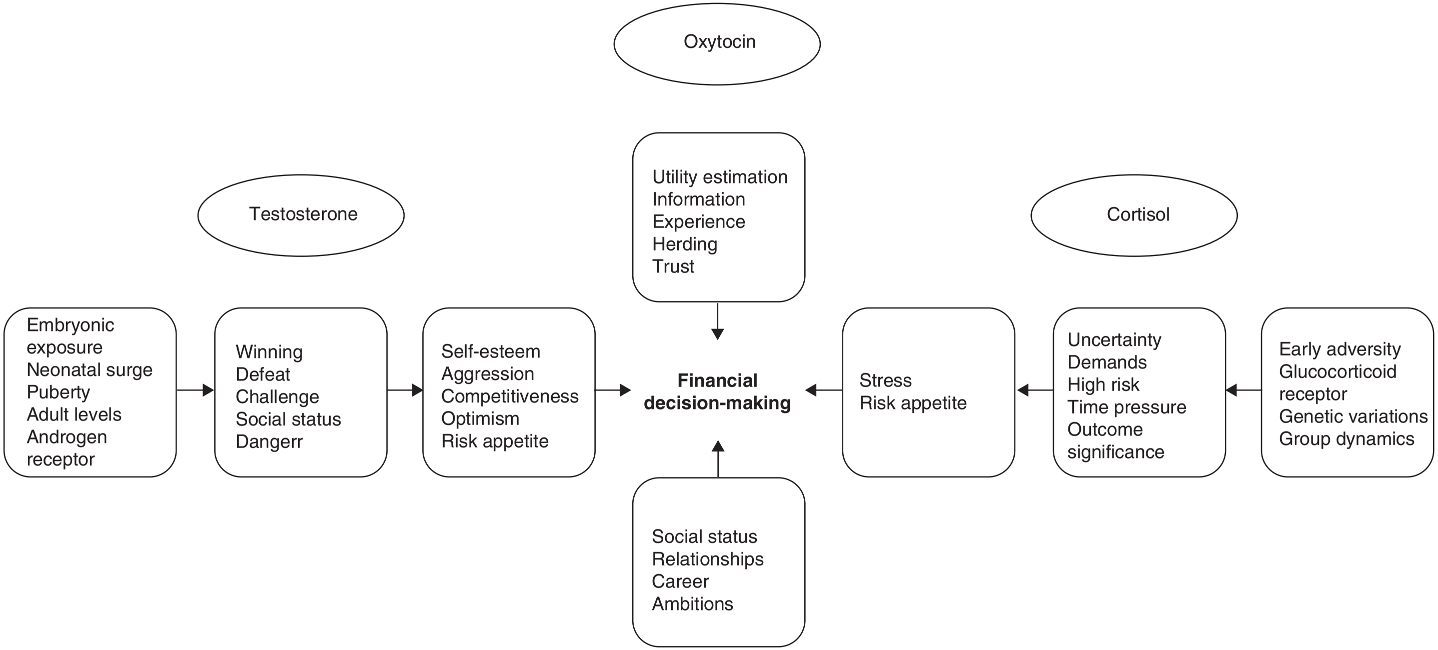

Fig. 3.2 The sequence of processes that determine financial decisions. Each sequence is influenced by both testosterone and cortisol, whilst oxytocin has actions on some of the common features

or beliefs by many individuals, if these endocrine events are generalised, or if they affect enough individuals with persuasive power over others, then prices at group, community or even international levels will be affected (Bikhchandani & Sharma, 2001). This will be particularly evident in situations when the market is making large and unpredicted movements.

It is therefore surprising that the financial world has had little or no interest in the physiological or neurobiological events within individuals that determine their decision making and hence the behaviour of the markets. Hormones are a prominent and powerful component of these events. But there are no large-scale studies of endocrine responses in those making real-life financial decisions. Neither are there adequate studies of the effects of administered hormones on both professionals and others making financial decisions in the laboratory under conditions that attempt to replicate those in the financial world. Since individuality is an important factor in decision making and the effects that hormones have on it, there would be huge interest in studying genetic variations in those employed in various ways in the finance industry or those making everyday decisions about money. For example: is there are genetic pattern that predicts a successful trader? Are there distinct patterns that are associated with success in bull or bear markets, and do these relate to individual responses to hormones? Are there patterns that distinguish those who prosper under the acute conditions of the trading floor from those who succeed in the more deliberative conditions of management? Do those attracted to be entrepreneurs have genetic patterns that distinguish them from those more content to work for others? There are many other endocrine and genetic questions very central to those attempting to understand why markets behave in the way they do. The relatively recent discipline of neuroeconomics has focussed mostly on neural correlates of decision making. This has opened out new and valuable perspectives on financial behaviour, but it needs to widen its approach to understand more about why the brain responds to financial demands in the way that it does.

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Part II
The Level of an Individual Decision Maker

Chapter 4
Cognitive Abilities and Financial Decision Making

Agata Sobkow, Dunia Garrido, and Rocio Garcia-Retamero

Introduction

Consider two sisters: Mary and Lucy. Mary is a successful entrepreneur. She lives in a nice house and considers herself a wealthy and happy person. Her income is satisfactory and she can afford most of the things that her family needs or desires. Nevertheless, she is still very careful and thoughtful about her investments and expenses. On the other hand, her sister Lucy is dissatisfied with her material situation. She has a part-time office job that she does not like, and she lives in a small and uncomfortable apartment. Because her salary does not satisfy her needs she took out a loan, but now she has difficulties with her installment payments.

While Lucy made a number of poor financial decisions in her life, Mary could be considered a very skilled decision maker. How is it possible that despite having the same parents and socio-economic background their current material situations differ so substantially? Is Mary more intelligent than her sister? Or, does she perhaps possess other cognitive abilities that may be important for financial decision making?

In this chapter, we will review and discuss current research on the role of cognitive abilities (such as intelligence and numeracy) in financial decision making and

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present potential applications of this knowledge to the design of methods and policies to help people with lower cognitive abilities make better decisions.

Intelligence

Intelligence is the most prototypical cognitive ability contributing to success in different domains (for a review, see: Strenze, 2015). For example, it has been found to be a good predictor of occupational attainment and income (Bertua, Anderson, & Salgado, 2005; Strenze, 2007). Moreover, higher intelligence in childhood is related to a lower risk of mortality ascribed to various causes such as coronary heart disease and stroke, cancers related to smoking, respiratory diseases, digestive diseases, injury, and dementia (Calvin et al., 2017). Nevertheless, research has revealed some surprising results: intelligence is only weakly associated with happiness and subjective well-being (Deneve & Copper, 1998).

Intelligence is not yet a unitary construct. There are many theories of intelligence and various classifications of cognitive abilities. However, the Cattell–Horn–Carroll theory of cognitive abilities (CHC theory; McGrew, 2009) is considered to be the most prominent and is recommended as offering a common nomenclature for intelligence scholars. Its umbrella taxonomy integrates two important, empirically-based models: Cattell–Horn's model of fluid and crystallized intelligence, and Carroll's Three-Stratum Theory. Within the CHC framework (for a brief overview, see McGrew, 2009), three strata are distinguished: Stratum I (contains more than 80 narrow cognitive abilities), Stratum II (contains 15 broad cognitive abilities), and Stratum III (represent a general latent factor—*g*). For the purposes of this chapter, Stratum II is especially interesting. This stratum contains broad cognitive abilities, such as fluid reasoning/fluid intelligence (*Gf*), comprehension-knowledge/crystallized intelligence (*Gc*), short-term memory/general memory and learning (*Gsm/Gy*), and processing speed (*Gs*).

In this chapter, we focus on *Gf* (fluid intelligence) and *Gc* (crystallized intelligence), which are well-known and commonly used in research. Fluid intelligence/fluid reasoning (*Gf*) can be briefly defined as the ability to: "use of deliberate and controlled mental operations to solve novel problems that cannot be performed automatically" (McGrew, 2009, p. 5). Under this broad ability, several narrow abilities can be distinguished (i.e., general sequential [deductive] reasoning; induction; quantitative reasoning, Piagetian reasoning, speed of reasoning). Conversely, comprehension-knowledge/crystallized intelligence (*Gc*) is defined as a "person's breadth and depth of acquired knowledge of the language, information and concepts of a specific culture, and/or the application of this knowledge" (McGrew, 2009, p. 5). Under this broad ability, narrow abilities such as lexical knowledge, listening ability, general (verbal) information, oral production and fluency, and grammatical sensitivity are included. The question that arises is whether people with higher abstract reasoning ability (fluid intelligence) or higher acquired knowledge (crystallized intelligence) make better decisions.

In general, a body of research has shown that in fact both of these broad abilities are related to superior decision making. For example, Bruine de Bruin, Parker, and Fischhoff (2007) demonstrated that both fluid and crystallized intelligence predicted the overall score on the Adult Decision Making Competence (this battery contains hypothetical decision tasks drawn from behavioral decision research: resistance to framing, recognizing social norms, under/overconfidence, applying decision rules, consistency in risk perception, path independence, and resistance to sunk costs). Moreover, Sinayev and Peters (2015) showed that a better composite score of intelligence (involving measures of both fluid and crystallized intelligence) was significantly related to fewer decision biases and better financial outcomes (i.e., avoiding crippling loans, avoiding being denied credit, saving money for retirement, paying back loans on time, and paying credit card bills in full) even when other variables were controlled for.

Nevertheless, some researchers from the judgment and decision making field (e.g., Bruine de Bruin, et al., 2020; Cokely et al., 2018; Stanovich, West, & Toplak, 2011) have suggested that constructs of decision making and of intelligence are relatively independent. In particular, in the Skilled Decision Theory, Cokely et al. (2018) discussed in detail (on both theoretical and empirical levels) relationships between intelligence, general decision making skill, and other cognitive abilities such as statistical numeracy. These authors recommended that decision making skill should be included as another factor (broad cognitive ability) in the second stratum, perceiving it to be as important as fluid intelligence and crystallized intelligence. These ideas have been tested empirically (Allan, 2018) in a study in which a large sample of students completed several measures of numeracy, fluid intelligence, crystallized intelligence, and general decision making skill (e.g., Adult Decision Making Competence, ecological risk literacy, and paradigmatic risky decision making task). Exploratory factor analysis suggested that, indeed, numeracy together with decision making skill should be treated as a factor separate from fluid and crystallized intelligence, thus supporting the argument for extending Carroll's Three-Stratum Model (see Fig. 4.1 for a schematic integration of the CHC framework and the Skilled Decision Theory). In the next section, we will discuss the role of numerical abilities in financial decision making, focusing on their predictive power and cognitive mechanisms.

Statistical Numeracy

Everyday decision making (e.g., buying a car, buying flood insurance, shopping on Black Friday) requires the processing of numbers representing probabilities, costs, and benefits (e.g., How do the prices of new cars differ? What are the chances that our house will be damaged in a flood? What is the price of a product after a 25% discount?). However, many people experience difficulties when faced with even simple numerical problems such as: "In the BIG BUCKS LOTTERY, the chances of winning a $10.00 prize is 1%. What is your best guess about how many people

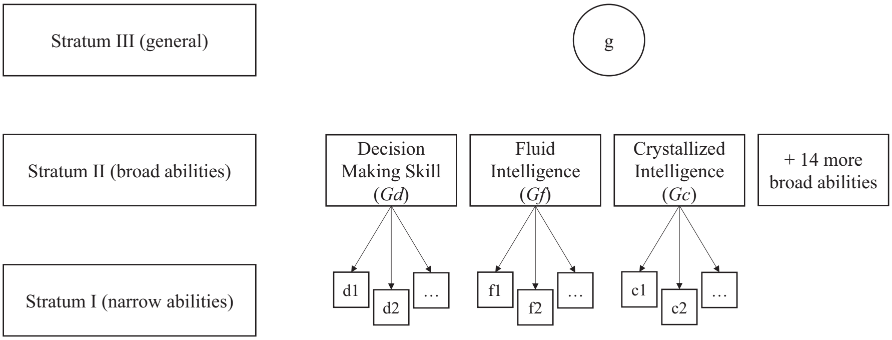

Fig. 4.1 A schematic illustration of the Cattell–Horn–Carroll (CHC) model of cognitive abilities, modified by adding "Decision Making Skill" to the second stratum by Cokely et al. (prepared on the basis of Fig. 5 in Cokely et al., 2018; and Fig. 1 from McGrew, 2009). Missing arrows between Stratum III and II acknowledge disagreement between the authors of the model (Cattell, Horn, Carroll) on the validity of the general factor. Some Stratum II (broad) abilities and all Stratum I (narrow) abilities are missing from this figure because of space limitations

would win a $10.00 prize if 1,000 people each buy a single ticket to BIG BUCKS?" (in the case of this task, approximately 40% of highly educated participants responded incorrectly; Lipkus, Samsa, & Rimer, 2001).

The bulk of research in this area shows that statistical numeracy[1]—the ability to understand statistical and probability information and use it in everyday contexts—is an important predictor of superior decision making in various domains, from medicine to finance (for a review see Cokely et al., 2018; Garcia-Retamero, Sobkow, Petrova, Garrido, & Traczyk, 2019; Reyna, Nelson, Han, & Dieckmann, 2009).

For example, people with higher numeracy, in comparison with people with lower numeracy, accumulate more personal wealth in real life (Estrada-Mejia, de Vries, & Zeelenberg, 2016; Estrada-Mejia et al., 2020). Interestingly, wealth can be defined and operationalized in various ways, but each is still consistently related to numeracy. On the one hand, in the case of the Dutch (Estrada-Mejia et al., 2016), their personal wealth was estimated on the basis of declared assets and liabilities (e.g., saving accounts, stocks, bonds, real estate, mortgages, loans, credits); on the other, for one agrarian population (the Quechua people from Peru; Estrada-Mejia et al., 2020) non-monetary indicators such as housing quality (e.g., the floor being made of cement vs. earth) and household durables (e.g., possessing a fridge) served as proxies for personal wealth. Thus, importantly, the significant relationship between numeracy and wealth is present not only in modern European society,

[1] We use the term *statistical numeracy* to refer to the concept proposed by Cokely et al. (Cokely, Galesic, Schult, & Garcia-Retamero, 2012) and measured by the Berlin Numeracy Test (sample item: "Imagine we are throwing a five-sided die 50 times. On average, out of these 50 throws how many times would this five-sided die show an odd number (1, 3 or 5)? ________ out of 50 throws."). We also use the terms *numeracy* or *objective numeracy* more broadly to refer to numeracy as measured by other similar cognitive ability tests (Lipkus et al., 2001; Schwartz, Woloshin, Black, & Welch, 1997; Weller et al., 2013).

where people are relatively well educated and have access to many financial products of varying complexity (Estrada-Mejia et al., 2016) but also in a community where cultivating the land is the primary source of wealth (Estrada-Mejia et al., 2020). Moreover, these correlations were robust and remained significant even when other important variables, such as financial knowledge, risk preferences, need for cognition, gender, age, education, and income (Estrada-Mejia et al., 2016) or fluid intelligence, crystallized intelligence, age, gender, mother tongue, being married, and residence (Estrada-Mejia et al., 2020) were controlled for. Furthermore, the size of the effect obtained was non-trivial and similar in magnitude to the effects of income or having a university degree: on average, a one-point increase on an 11-item numeracy scale (Lipkus et al., 2001) was associated with 5% more personal wealth (Estrada-Mejia et al., 2016). Moreover, numeracy was found to be a key determinant of wealth accumulation over a five-year period (Estrada-Mejia et al., 2016).

The basic mechanisms underlying the relationship between numeracy and financial decision making have been explored using paradigmatic risk tasks (e.g., monetary lotteries). Interestingly, the power of numeracy has been found to go beyond the ability to perform mathematical calculations. That is, people with higher numeracy not only perform calculations (e.g., the expected value—the sum of payoffs multiplied by their probabilities) but also engage in more elaborative processing of numerical information in general and build a representative understanding of decision problems (Cokely & Kelley, 2009). Additionally, numeracy is related to superior performance because of longer deliberation and the higher metacognitive accuracy of judgments (Ghazal, Cokely, & Garcia-Retamero, 2014). People with higher numeracy also tend to sample more information (Ashby, 2017; Jasper, Bhattacharya, & Corser, 2017; Traczyk, et al., 2018a), which helps them built better representation of the decision problem (e.g., regarding the distributions of payoffs and probabilities). People with higher numeracy could be thought of as adaptive decision makers: they are more prone to matching their decision strategy to the requirements of the task or the structure of the environment (Jasper et al., 2017; Traczyk, et al., 2018b). They also draw more affective[2] meaning from numbers (Peters, 2012; Petrova, van der Pligt, & Garcia-Retamero, 2014), are less prone to incidental affect (Traczyk & Fulawka, 2016), and have a better understanding of the gist of decisions (Reyna et al., 2009). Finally, numeracy can also provide the "computational engine" behind financial operations, resulting in higher financial literacy[3]—knowledge and skills regarding financial products and concepts such as interest compounding, inflation, and risk diversification (Skagerlund, Lind, Strömbäck, Tinghög, & Västfjäll, 2018).

[2] For more information about the role of emotions in financial decision making, see Chap. 6 of this Handbook.

[3] For more information about financial literacy, see studies by Lusardi et al. (Lusardi, 2012; Lusardi & Mitchell, 2014) or Chap. 5 of this Handbook.

Multiple Numeric Competencies

Recent research has indicated that numeracy, like intelligence, is not unitary. For example, Peters and Bjälkebring (2015) theorized that there are multiple numeric competencies (objective numeracy, approximate numeracy, and subjective numeracy) that predict distinct decision outcomes. While objective numeracy (statistical numeracy) is related to performance on mathematical tasks and formal knowledge about mathematical concepts, approximate numeracy is related to a "sense of number"—the intuitive ability to perceive and manipulate numerosities and to map symbolic numbers to magnitudes; the third, subjective numeracy, is a combination of these objective abilities, math-related emotions, self-efficacy, and motivation to solve tasks containing numerical information.

Approximate Numeracy

Consider the following situations: estimating the total cost of your daily shopping, choosing the shortest line to a cash desk, and estimating the size and number of pizzas to order for a small party. In many real-life situations, people probably do not count exactly but rather estimate quantities and magnitudes.

According to mathematical cognition and developmental research (e.g., Campbell, 2005; Dehaene, 1997; Feigenson, Libertus, & Halberda, 2014; Libertus, Odic, Feigenson, & Halberda, 2016), people are equipped with an innate cognitive system responsible for representing and differentiating quantities without relying on language or symbols—the Approximate Number System. For example, even a child can correctly estimate (without exact counting) on which of two plates there are more chocolates. These approximate numerosities are represented in the form of activations on a mental number line. On this continuum, smaller numbers are represented on the left side, larger numbers on the right. Next, these non-verbal activations are translated into exact, verbal, symbolic numbers with differing acuity (Izard & Dehaene, 2008).

The acuity of approximate numeracy can be measured in several ways, for example, using the dot-discrimination task or the symbolic-number mapping task. In the former, the dot-discrimination task, participants are asked to indicate which of two briefly presented sets of dots is greater in quantity (Chesney, Bjälkebring, & Peters, 2015). In the latter, the symbolic-number mapping task (Chesney et al., 2015; Opfer & Siegler, 2007; Siegler & Opfer, 2003), participants are asked to indicate the location of a specific number (e.g., 43) on a number line (e.g., with anchors 0 and 100), where absolute deviance from the target number serves as an index of performance. The first task operates using simple, non-symbolic stimuli while the second requires the transformation of symbolic numbers to magnitudes, so they may capture slightly different cognitive processes and abilities.

In this context, it is worth observing that while performance on simple dot-comparison and numerical estimation tasks have not been found to be directly linked to decision making outcomes, more complex approximation tasks (such as the Risk Estimation Task, which requires one to apply the results of rapid, non-symbolic number comparisons to risk ratings) have been found to significantly predict decision making performance under objective risk (Mueller, Schiebener, Delazer, & Brand, 2018). As these authors found, this effect was apparent even when controlling for executive functions (working memory) and objective numeracy.

A body of research in the judgment and decision making field has suggested that approximate numeracy as measured by the symbolic-number mapping task may be of special importance in predicting financial decision making. For instance, better performance on this task was associated with a more linear value function (Schley & Peters, 2014), a more linear probability weighting function (Petrova, Traczyk, & Garcia-Retamero, 2019), more advantageous intertemporal making (Peters, Slovic, Västfjäll, & Mertz, 2008), and normatively superior valuations of risky gambles (Park & Cho, 2018; Peters & Bjälkebring, 2015; Sobkow, Olszewska, & Traczyk, 2020). Finally, recent research (Sobkow, et al., 2020) revealed that approximate numeracy predicted avoiding negative decision outcomes in real life, such as buying new clothes and never wearing them or declaring bankruptcy (the Decision Outcome Inventory; Bruine de Bruin et al., 2007). Importantly, the effects of approximate numeracy on decision and memory outcomes were robust and remained significant even when controlling for other variables including fluid intelligence, cognitive reflection,[4] statistical numeracy, and subjective numeracy (Sobkow, et al., 2020).

Subjective Numeracy (Numeric Confidence)

The third numeric competency—subjective numeracy—distinguished by Peters and Bjälkebring (2015), is not a cognitive ability per se but rather could be considered an attitude or preference. Nevertheless, a brief self-report measure of people's beliefs about their skill in performing mathematical operations (e.g., "How good are you at working with fractions? 1 – not at all, 6 – very good") developed by Fagerlin et al. (2007) is often used as a proxy for assessing objective numeracy. However, recent research has indicated that even if these scales—objective and subjective—are correlated, they might predict distinct outcomes and be based on different

[4] This thinking disposition captures whether people are prone to inhibit the first ("intuitive") incorrect response and follow a correct ("reflective") solution. It is usually measured by a brief set of puzzles, e.g., "A baseball bat and a ball cost $1.10 together, and the bat costs $1.00 more than the ball, how much does the ball cost?" (correct answer: 5 cents). Research shows that performance on similar tasks was related to various outcomes, such as risk and time preferences (Białek & Sawicki, 2018; Sajid & Li, 2019), susceptibility to cognitive biases (Sirota & Juanchich, 2018; Teovanović, Knežević, & Stankov, 2015; Toplak, West, & Stanovich, 2011, 2014, 2017), and experiencing negative decision outcomes in real life (Juanchich, Dewberry, Sirota, & Narendran, 2016).

psychological mechanisms (Dolan, Cherkasky, Li, Chin, & Veazie, 2016; Liberali, Reyna, Furlan, Stein, & Pardo, 2012). For example, Peters and Bjälkebring (2015) showed subjective numeracy to be an adequate proxy of objective numeracy with respect to only one measure: the absolute difference between a participant's valuation of a risky gamble and its expected value. Moreover, while females scored only marginally lower on an objective numeracy measure, they subjectively rated themselves as worse to a greater extent than did males.

Subjective numeracy might be associated with motivational and emotional aspects of decision making more than is objective numeracy: people characterized by higher subjective numeracy appear more likely to perceive numerical tasks as solvable (i.e., within their reach), and can therefore be encouraged to invest more effort and cognitive resources into solving such tasks. For example, Traczyk et al. (2018b) found that while people with higher objective numeracy adapted their strategy to the importance of decision problems, people with higher subjective numeracy used more complex strategies (compared with simple heuristics) for both meaningful and trivial financial problems.

Importantly, subjective and objective numerical abilities might not only operate independently but may also interact with each other in predicting decision outcomes. In particular, Peters et al. (2019) examined the role of numeric confidence (subjective numeracy) and objective numeracy on financial outcomes in a large ($n = 4572$) and diverse sample of Americans. They found that both of these competencies correlated with each other and with self-reported financial outcomes (such as having investments, filing for bankruptcy, having a mortgage balance higher than the value of one's property), financial well-being (e.g., "I could handle a major unexpected expense," "I have money left over at the end of the month"), and financial knowledge (e.g., "Bonds are normally riskier than stocks. True/False"). Most importantly, Peters et al. (2019) observed a significant interaction between subjective and objective numeracies: people with a high level of both abilities experienced the best financial outcomes, while those who were "mismatched" (with high objective/low subjective or low objective/high subjective numeracy) experienced the worst financial outcomes. In particular, a person who has objectively low numerical skill but is very confident about it could make worse financial decisions than those made by a person with similar objective numerical abilities but an appropriate level of numeric confidence. The problem of potential overconfidence in people with high subjective numeracy was also raised by Sobkow, Olszewska, and Traczyk (Sobkow, et al., 2020). They observed that when other individual difference measures (statistical numeracy, approximate numeracy, fluid intelligence, cognitive reflection) were controlled for, subjective numeracy predicted negative real-life decision outcomes (Bruine de Bruin et al., 2007) in a surprising way: people who scored higher on the subjective numeracy scale declared that they experienced more negative decision outcomes. While very intriguing, these results call for more research investigating the boundary conditions of this effect.

How to Improve Financial Decision Making?

The above-mentioned research systematically shows the meaningful role of cognitive abilities in financial decision making. The question then arises, whether cognitive abilities are stable and innate or whether they can be improved to achieve better financial outcomes in the future?

Cognitive Training and Education

Cognitive Training

Fluid intelligence is perceived to be a very powerful but quite stable cognitive ability. However, some research has suggested that relatively short (of a few weeks' duration) and simple cognitive training of working memory can improve fluid intelligence by up to six IQ points (Jaeggi, Buschkuehl, Jonides, & Perrig, 2008; Jaeggi et al., 2010). Subsequent meta-analyses (Au et al., 2015; Melby-Lervåg & Hulme, 2013) confirmed that working-memory training did indeed improve performance on intelligence tests, but the effect was smaller (3–4 IQ points) and disappeared after eight months. Moreover, many of the studies investigating the effectiveness of cognitive training suffered from substantial methodological flaws. For example, they were underpowered or included only a passive control condition. Thus, participants in a training condition may have performed better following the intervention because of a placebo effect (Simons et al., 2016).

To the best of our knowledge, to date only one study on cognitive training has revealed the potential to improve cognitive abilities and to transfer the effects of these training to financial decision making. Specifically, Sobkow et al. (Sobkow, Fulawka, Tomczak, Zjawiony, & Traczyk, 2019) developed and validated a form of mental number line training which, in comparison with an active control condition, enhanced the acuity of symbolic number-mapping (approximate numeracy). This cognitive training initiative was inspired by Rescue Calcularis (Kucian et al., 2011)—a game dedicated to, and tested on, dyscalculic children. In the study by Sobkow et al., participants (mostly undergraduate students) were randomly assigned to a mental number line training condition or an active control condition. In both conditions, participants completed nine training sessions (approximately 20–30 minutes each) on different days. In each trial, they were asked to quickly estimate the result of a mathematical operation (i.e., addition, subtraction, multiplication, division) and indicate the response using a numerical keyboard (control condition) or a slider (number line training condition). After each trial and block, participants received feedback; in addition, the difficulty of subsequent blocks was adaptively adjusted to their individual performance.

After controlling for performance in a pretest, participants given mental number line training exhibited more precise mappings of numbers onto a number line than did those in the active control condition. Moreover, the effect of training also transferred to the ability to quickly estimate the sums of numerical quantities (as measured by the precision of estimates of the total prices of everyday products in a table resembling a shopping bill). Interestingly, Sobkow et al. also found that after training in both conditions, people declared higher subjective numeracy, made normatively better financial decisions, and provided better valuations of risky prospects. However, despite the interesting and promising results of this study, there are still some unresolved questions regarding both the extent of transfer and its stability over time.

Education

While research on cognitive training is relatively new, and much work remains to be done to develop effective, evidence-based interventions that may have an impact on real-life financial decision making, the role of formal education in improving cognitive abilities has been explored to a much great degree. For example, a recent meta-analysis (Ritchie & Tucker-Drob, 2018) containing data from more than 600,000 participants revealed that each year of education improves intelligence by approximately from one to five IQ points. This effect was observed for tests measuring various types of intelligence—fluid, crystallized, or a mixture of both—and persisted across the life span. Importantly, only studies using a design that implied causal relationships were included in this meta-analysis. That is, the meta-analysis included only those studies whose authors controlled for prior intelligence (i.e., they used an earlier score as a control variable in a model in which results on a cognitive test were predicted by education duration) or that described a natural experiment in which a policy change was introduced affecting the duration of education. Even though this meta-analysis yielded consistent results concerning the impact of education on intelligence, the authors argued that it is still unclear whether improvement in intelligence transfers to real-life outcomes.

Estrada-Mejia et al. (2020) set out to test this hypothesis. They decided to conduct a study on a very specific population: the Quechua people from Peru. This sample was chosen deliberately because people in this community are characterized by considerable variation in the number of years they attended school (ranging between 0 and 16) but a high degree of homogeneity in other important features such as occupation, parental education, and access to financial services. In many Western countries, there is little variation in educational attainment, so it is difficult to separate the effect of formal education from other variables such as intelligence and numeracy. The results of this study suggested that schooling (i.e., number of years an individual attended school) predicted cognitive abilities—fluid intelligence, crystallized intelligence, and numeracy—as well as personal wealth, as measured by the quality of housing and the possession of household durables (see Fig. 4.2). Importantly, only numeracy, and not intelligence, served as a significant mediator of the relationship between education and wealth. Despite the correlational design of this study that does not fully allow for causal inferences, the

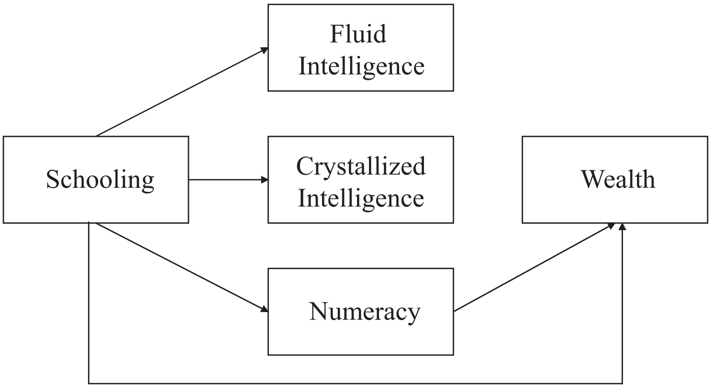

Fig. 4.2 Significant relationships between schooling (education), cognitive abilities (fluid intelligence, crystallized intelligence, and numeracy), and wealth in a Peruvian, agrarian population (Prepared on the basis of Fig. 3 in Estrada-Mejia et al., 2020)

findings suggested that formal education might be a fruitful way of improving numeracy and real-life financial decision making.

Recently, Peters et al. (2017) experimentally investigated the effectiveness of an intervention intended to boost the effect of education on numeracy and financial outcomes. First, they selected a sample of students enrolled in a statistics course and randomly assigned them to one of two experimental conditions: value affirmation vs. control condition. In the value affirmation condition, students ranked values such as religion, knowledge, etc., by personal importance and described why their most important value was important and meaningful to them. The authors hypothesized that this intervention would increase objective numeracy during the course because value affirmation would change students' perceptions of statistics classes and cause them to benefit more from them.

The results showed that in the control condition, the level of objective numeracy after completing the course remained the same as it was at the beginning. Moreover, the level of subjective numeracy declined over time. Importantly, this was not the case in the experimental condition. Students who affirmed their values at the beginning of the statistics course scored higher on the objective numeracy test and their subjective numeracy remained stable. In addition, the results of this study also indicated a possible transfer of increased objective and subjective numeracies to financial literacy (as measured by five investment-related questions, such as: "considering a long time period [e.g., 10 or 20 years], which asset normally gives the highest return?"). Moreover, only objective numeracy explained the relationship between the intervention and better financial outcomes (e.g., "Do you have a savings account or emergency fund?," "Do you know your credit card balance?").

Decision Aids

Apart from cognitive and educational training, the use of visual aids and analogies may show substantial benefits at minimal costs, particularly when designed to serve vulnerable populations with limited numeracy (Galesic & Garcia-Retamero, 2013; Garcia-Retamero & Cokely, 2013, 2017). Visual aids strongly improve risk understanding (including real-life financial decision making) in diverse individuals by encouraging thorough deliberation, enhancing cognitive self-assessment, and reducing conceptual biases in memory. Thus, improved designed graphs may help to avoid interpretive errors that, in turn, can affect important financial, medical, and legal decisions (Arunachalam, Pei, & Steinbart, 2002; Cooper, Schriger, Wallace, Mikulich, & Wilkes, 2003).

Visual aids are simple graphical representations of numerical expressions of probability, including bar and line charts, and icon arrays among others (Ancker, Senathirajah, Kukafka, & Starren, 2006; Hildon, Allwood, & Black, 2012; Spiegelhalter, Pearson, & Short, 2011). However, not all visual aids are equally efficient. Visual aids tend to provide an effective means of risk communication when they are transparent (Garcia-Retamero & Cokely, 2013)—that is, when they promote representative (or unbiased) risk understanding and evaluation. Generally, this transparency means that the elements of the visual aid are well defined and they accurately and clearly represent the essential risk information by making part-to-whole relationships in the data visually available and comparable.

Several studies show that transparent decision aids causally improve decision making by enhancing risk literacy (for reviews see Garcia-Retamero & Cokely, 2013, 2014, 2017). All studies were explicitly designed to be naturalistic and ecologically valid, accurately reproducing actual problems that people commonly encounter when they evaluate personally relevant information about health, money, relationships, and the like. Visual aids have long been known to confer benefits when communicating risk information about health (Edwards, 2002; Lipkus, 2007; Paling, 2003). Most investigations that evaluate visual aids are focused on the accuracy of perceptions of health and disease risk, and risk reductions; inferences about the predictive power of medical tests and treatment effectiveness; assessments of subjective confidence in choices and risk perceptions; assessment and trajectories of health outcomes; and high-stakes informed decisions.

Recent studies have demonstrated that visual analytic presentations improve understanding of financial concepts (Rudolph, Savikhin, & Ebert, 2009; Savikhin, 2012). For instance, Lusardi et al. (2017) developed and evaluated an educational program based on visual aids based on a particular notion of financial literacy: the concept of risk diversification. They decided to conduct a study on a representative sample of almost 1000 participants, showing that even short interventions can help improve financial literacy (i.e., risk literacy). Specifically, they compared four educational programs (i.e., an informational brochure, a written narrative, a video narrative, and an interactive visual tool). The results showed that visual aids were the most effective interventions at increasing financial literacy (i.e., increasing the number of correct responses to questions such as "In general, investments that are riskier tend to provide higher returns over time than investments with less risk", "If I need to make an investment decision, I can select a mix of investments that are in line with how much risk I want to take on").

Summary

Financial decisions are predicted by various cognitive abilities—in particular, by intelligence and multiple numeric competencies: statistical numeracy, approximate numeracy, and subjective numeracy. Importantly, these abilities should not be reduced to a single cognitive ability because they operate on different cognitive levels, employ different psychological mechanisms, and predict distinct decision outcomes. Knowledge about these mechanisms could help to design evidence-based aids, interventions, and policies to help people make better financial decisions.

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Chapter 5
The Arrested Deployment Model of Financial Literacy

Eyal Carmel, David Leiser, and Avia Spivak

Introduction

Amid the 2008 global financial crisis, US President George W. Bush launched a *President's Advisory Council on Financial Literacy* aiming to "improve financial literacy among all Americans." The establishment of the council reflects a common perception among decision-makers who see the enhancement of financial literacy as a tool to protect citizens from making costly financial mistakes. But while supporters of the financial literacy approach point to correlations between financial knowledge and behavior (Lusardi & Mitchell, 2007a, 2007b; Van Rooij, Lusardi, & Alessie, 2011), others argue for a non-causal relationship between the two and claim that financial education has minimal impact that decays rapidly (Fernandes, Lynch Jr, & Netemeyer, 2014). Other critics of financial education state that governments focus on education as a poor replacement for firm and effective regulation (Willis, 2008). While the controversy around the contribution of financial literacy is unlikely to be settled soon, the aim of this work is to reshape the discussion from a results-driven debate to a theory-based dialog. Based on recent advancements in psychology, we propose a model to explain the meager influence of financial knowledge on behavior, a model that would point toward circumstances under which financial literacy does contribute to adequate financial behavior.

The model, named the *Arrested Deployment Model of Financial Literacy*, growth out from the ongoing discussion in behavioral economics about human rationality. In the previous century, scholars such as Herbert Simon, Amos Tversky, and Daniel Kahneman challenged the assumption of human rationality, highlighting the role of heuristics and cognitive biases (Kahneman, 2011; Simon, 1972; Tversky & Kahneman, 1974, 1981). In recent years, this approach has found its way into public

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policy and was embraced by policymakers who used cognitive mistakes and biases such as the status quo bias, social comparison, and framing to encourage adequate behavior. The term "nudge" was coined to describe this type of subtle intervention and became very popular following the publication of Richard Thaler and Cass Sunstein's best-selling book (Thaler & Sunstein, 2008). The idea that people are irrational agents with limited knowledge, limited cognitive capacity, and poor self-control spread quickly and made regulators acknowledge the frequent uselessness of direct incentives and legislation to promote public policy. Nevertheless, the rapid emergence of new financial education initiatives suggests that many researchers and practitioners still believe that limited financial knowledge is the reason for why customers do not maximize their utilities (Willis, 2011). Supporters of the financial literacy approach assume that merely imparting knowledge will lead customers to consume more wisely and make better decisions. Incorporating the concept of financial literacy into the discussion about human rationality offers fresh thinking about the reasons for the minimal impact of financial knowledge. While research on financial literacy is relatively new, the investigation of irrationality has a long tradition. Thanks to countless studies, we understand the circumstances that promote rational behavior. Ample evidence has shown that irrationality is often a result of limited cognitive capacity and depletion of emotional resources (Kahneman, 2011). This suggests that lack of cognitive and mental resources might explain why some individuals are unable to apply their financial knowledge when needed.

The Arrested Deployment Model aims to uncover the roots of the inconsistent influence of financial literacy. Its guiding insight is that the prediction of the efficacy of financial literacy requires the analysis of the conditions for its successful deployment. Many and varied obstacles stand in the way of this deployment. To help people achieve appropriate economic behavior, it is essential to map those obstacles.

The literature review below provides the necessary background for this enterprise. First, we present major findings from the research of financial literacy, discuss its limitations, and describe the difference between the concepts of financial literacy and financial capability. Next, we describe the connection between cognitive resource and decision making and frame financial literacy in the context of irrationality and dual-system theories. Lastly, we introduce the Arrested Deployment Model and show the interplay between financial literacy and limited resources, that determines the efficacy of financial knowledge.

Financial Literacy

The times are changing and bring new challenges to people throughout the world. A combination of an aging population, the transfer of risk from governments to citizens, and a gloomy economic climate increase people's responsibility for their financial well-being during their working lives and at retirement. Unfortunately, evidence suggests that people are poorly informed about basic issues in personal finance and make decisions that are difficult to interpret as rational (De Meza, Irlenbusch, & Reyniers, 2008; Lusardi & Mitchell, 2007a, 2007b; Sherraden, 2013).

A common approach to improve people's financial decisions is to increase their "financial literacy," defined (Huston, 2010) as "the knowledge, ability, skills and confidence to make good financial decisions." According to the Organisation for Economic Co-Operation and Development (OECD), individuals with higher financial literacy are better at (a) handling their money; (b) participating in the stock market; (c) choosing mutual funds with lower fees; and (d) having better retirement plans (Atkinson & Messy, 2012). This claim is supported by many studies. For example, workers chose better pension plans after participating in a pension seminar (Clark, Morrill, & Allen, 2012); Hilgert, Hogarth, and Beverly (2003) linked financial literacy to more effective financial behaviors, and Van Rooij et al. (2011) showed that it correlates with successful investments in equities.

The causal direction between financial literacy and financial behavior needs examining, though (Van Rooij et al., 2011). A meta-analysis performed by Fernandes et al. (2014) revealed that, despite the strong correlations between financial literacy and financial behavior, attempts at imparting financial literacy were ineffective, and interventions to improve financial literacy explained only a minuscule (0.1%) proportion of the variance of financial behavior. Similarly, Cole and Shastry (2009) showed that financial literacy educational programs at school had no effect on participation in the financial market, unlike cognitive differences and level of education that were found to be significant. Willis's review of the cost of effective financial education revealed that even semester-long high school courses and 18 months of adult credit counseling failed to make financial education more effective (Willis, 2011).

From Literacy to Rationality

The difference between financial literacy and capability might be interpreted in terms of rational vs. actual behavior. Rational agents are expected to show instrumental behavior, to be consistent, and to use all the information available to them. Likewise, financially literate people are expected to use their skills, to ponder short- and long-term considerations, and to apply their knowledge to achieve their financial goals. Alas, in both cases the evidence shows that individuals fail to meet these expectations (Fernandes et al., 2014; Kahneman, 2011). Kahneman (2011) explains deviations from rationality by a dual-system theory that separates reasoning from intuition. According to Kahneman, reasoning requires mental effort. It involves slow, deliberate thinking that demands attention and cognitive resources. Kahneman labeled this type of cognitive process "System 2." Since deliberate thinking demands high energy, people mostly rely on their intuition, instead. This often yields "good enough" decisions based on experience, heuristics, and various rules of thumb. Kahneman named this type of thinking "System 1."

Returning to the difference between financial literacy and capability, literacy implies knowledge and sophisticated skills; financial capability relies on know-how and is the outcome of experience and habit formation. While applying knowledge with deliberation would be beneficial, this thinking mode is wearying and people tend to avoid it. Financial capability is more likely to be based on the easily used approached System 1, and not on the skilled and literate System 2.

Several researchers have offered dual-process theories to explain why perfectly capable people present inconsistent and irrational behavior (e.g., Chaiken & Trope, 1999; Stanovich & West, 2000). The economists Richard Thaler and Hersh Shefrin proposed a dual system that includes two selves—the *planner* and the *doer* (Shefrin & Thaler, 1988; Thaler & Shefrin, 1981)—to explain intertemporal choices and saving behavior. Using the distinction between the two selves, Thaler and Shefrin developed a behavioral life cycle model that opposed the classic model that posits that individuals plan their consumption to secure a stable lifestyle throughout their entire lifetime (Ando & Modigliani, 1963; Modigliani & Brumberg, 1954). According to their model, a trade-off exists between clients' satisfaction from consumption and their understanding that it may be better to save money for the future. To save for the future, the *planner* ought to impose self-control over the *doer*, but people are impatient and often fail to do so. For that reason, people intentionally choose to restrict themselves, using commitment devices, rules of thumb, and mental calculations that reduce the need for self-control. By adopting the psychological concept of self-control, the authors were able to minimize the gap between expected and actual behavior in their economic model. The planner and the doer represent the inherent tension between short- and long-term perspectives. As we show later, this tension explains why knowledge predicts decisions that provide immediate but not deferred gratification.

The application of the dual-system, or two selves, theories to the field of financial literacy is straightforward. Supporters of financial literacy argue that the development of knowledge and skills will yield better financial decisions. In other words, they offer to strengthen customers' *System 2* to improve their financial behavior and to support their *planner-self* to increase savings. Critics for their part argue that financial decisions are mostly influenced by personal and situational features rather than knowledge (De Meza et al., 2008; Willis, 2008). According to this view, knowledge has little influence on financial behavior since people mostly rely on *System 1*, or the myopic *doer-self*. Our goal being to help people to improve their financial habits, the main questions are: Which circumstances will encourage people to use deliberate thinking during their financial activities? When do people rely on their System 2, rather than their impulses and intuition? And how can they avoid the negative influences of cognitive overload and limited mental resources? By answering these questions, we could identify the situations in which people use their financial knowledge.

Advances in the decision making research seem to provide answers to the above-listed questions. Evidence shows that lack of cognitive resources disrupts deliberate thinking. When time is short, people are more likely to present instinctive and impatient behavior and rely on cognitive shortcuts (Finucane, Alhakami, Slovic, &

Johnson, 2000), poor reasoning (Evans, Handley, & Bacon, 2009; Stanovich & West, 2000), and even dishonesty (Shalvi, Eldar, & Bereby-Meyer, 2012). Furthermore, ego depletion and cognitive load influence self-regulation, presumably due to the weakening of deliberate control by System 2 (Kahneman, 2011; Schmeichel, Vohs, & Baumeister, 2003). In their recent work, Leiser and Shemesh (2018) describe how reliance on System 1 inferences leads people untutored in economics to a distorted understanding of economic causation and to superficial and wrongheaded predictions and expectations.

To avoid the negative effects of reduced cognitive and mental resources, people often use coping mechanisms that obviate deliberate thinking. For instance, Thaler suggested that people avoid the need to resist temptation by segregating their funds into separate mental accounts (e.g., liquid money, savings, and investments). This results in considering a meaningful part of their financial resources as unavailable for consumption (Thaler, 1985). Similarly, techniques that reduce the need for self-regulation, such as pre-commitment, rules of thumb, and avoiding risky environment, enable peoples to save more money (Rabinovich & Webley, 2007; Rha, Montalto, & Hanna, 2006). Gollwitzer proposed that strategic pre-planning that goes all the way to ready specific implementation intentions is effective, because such planning links intentions and actions. The resulting behavior is automatic; no mental effort is required to unfold it (Gollwitzer, 1999).

The Arrested Deployment Model

The central insight of the Arrested Deployment Model is that people's aptitude to deploy their financial literacy relies on their ability to use cognitive and mental resources. We define this ability as psychological conditions (see Fig. 5.1), which covers both emotional and cognitive factors. These involve various factors, some endogenous (i.e., personality and cognitive traits such as intelligence and quality of self-control and executive functions) and some external. Among the variety of external factors, we concentrate on two important ones that affect individuals' psychological condition: their economic circumstances and the features of the task at hand.

Let us take a closer look at these factors.

1. *Psychological Conditions*: The ability to deploy financial literacy is impacted by personality traits, such as excessive dispositional anxiety which causes avoidance of an issue, making the knowledge about how to handle it irrelevant. Insufficient cognitive abilities make it hard for individuals to acquire financial knowledge and to use it properly. More generally, situations or personal characteristics that hamper the availability of cognitive and mental resources (e.g., emotions, self-control) reduce the use of deliberate thinking and prevent decision-makers from relying on their financial knowledge.
2. *Task Features*: This factor relates to features of the economic engagement. We conjecture that complex financial tasks or tasks that provide only deferred

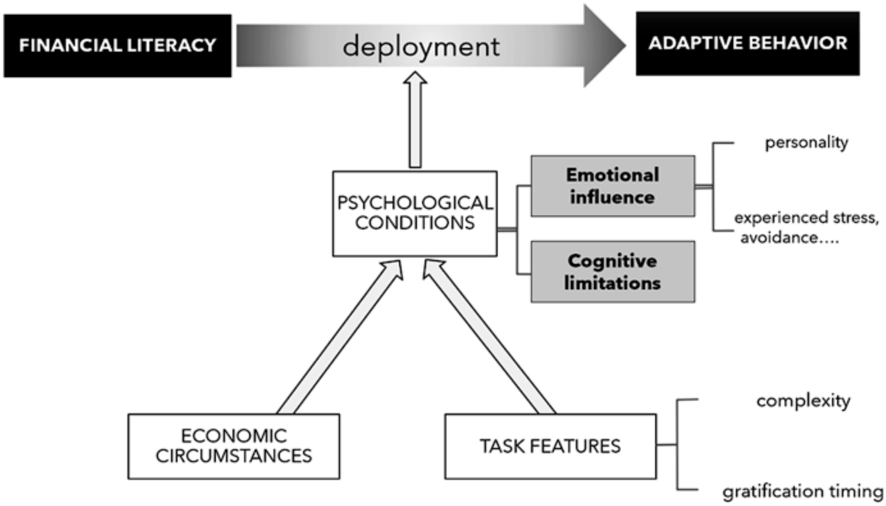

Fig. 5.1 The arrested deployment model of financial literacy

gratification demand more mental resources than other economic engagements. For instance, deciding to buy a cheap but adequate product rather than a prestigious brand provides immediate positive feedback, since consumers know exactly how much money they save. On the other hand, keeping track of bills and planning future expenses could save consumers a great deal of money, but it is hard to assess how much is really saved that way, and, moreover, the contribution of this discipline will only become apparent in the long term. These different features imply different cognitive demands and create variations in the influence of financial literacy on economic behavior.

3. *Economic Circumstances*: Ample evidence has shown the negative effect of financial stress on financial decisions and behaviors. Explanations for this effect range vary between culture, personality, self-efficacy, and cognitive abilities (Haushofer & Fehr, 2014; Loibl 2017; Chakravarti, 2006). A cognitive explanation advanced by Shafir, Mullainathan, and coauthors attributes financial constraints to cognitive overload, leading to impaired thinking, and cognitive abilities (Mani, Mullainathan, Shafir, & Zhao, 2013; Mullainathan & Shafir, 2013; Shah, Mullainathan, & Shafir, 2012). The scarcity theory aptly defines poverty as the “gap between one’s needs and the resources available to fulfill them” (Mani et al., 2013), rather than in terms of income or living conditions. This description entails that under the right circumstances, non-poor individuals will exhibit the same short-sightedness that characterizes the poor, enabling us to apply its principles to members of the general public that experience financial hardship. We will argue that financial constraints hinder the mental processes required for literate behavior, and account for the deviation from the expected

influence of financial literacy, as they hinder the mental processes required for literate behavior.

The Arrested Deployment Model allows to predict when financial literacy would prove helpful, depending on the cognitive resources available. By crossing the influence of knowledge with other determinants of financial behavior, we aim at determining the upper bound of knowledge for different populations and personalities. A better understanding of peoples' limitations may lead to better intervention programs but also to the establishment of an informed and effective regulatory framework, as well as to conduct theory-based research.

Implications of the Model

The model implies that when the demand for cognitive and mental resources is high, people are less likely to deploy their knowledge. Whereas earlier dual-system theories simply rely on features of the cognitive system, the current model also considers the features of the task. The practical implications of this notion are crucial to our understanding of the boundaries of financial education. For instance, the meta-analysis by Miller, Reichelstein, Salas, and Zia (2015) concluded that financial education programs can improve savings and record keeping, but are less effective in preventing loan default. While the authors explain their findings with reference to the participants' ability to exert control over the situation, we believe that the complexity of the task deserves more attention. Dealing with debts involves a long and exhausting process of monitoring the loan, negotiating with lenders, and sticking to long-term commitments. Saving and record keeping, on the other hand, tax internal resources much less.

Another observation is that interventions based on using rules of thumb are more effective than interventions based on standard education programs. This too is readily explained by the model, since knowing those rules simplifies the task (Drexler, Fischer, & Schoar, 2014).

The Arrested Deployment Model in Action

To test the usefulness of the model, we analyzed data obtained from past and current participants in a long and intensive financial intervention program run by Paamonim, the main NGO in this domain in Israel. We will first present the independent variables examined, before analyzing this data. Emotional factors will be represented by financial avoidance and self-control.

Emotional Influences

To investigate the role of emotional influences, we focused on self-control and financial avoidance, two factors that may explain individuals' failure to deploy financial knowledge. We acknowledge that other factors should be considered as additional explaining variables and hope to further develop this line of research in the future.

Financial Avoidance

Financial avoidance is a result of an aversive response to finance-related issues. According to Shapiro and Burchell (2012), people who exhibit negative emotions toward financial matters are passive and indifferent to their financial mistakes. A nice illustration is provided by Rosen and Sade (2017) who show that Israelis with low confidence in their financial ability were oblivious to a temporary opportunity to withdraw money from inactive retirement accounts, thereby losing a substantial amount. The authors argue that this failure to act may be explained by negative emotions toward financial matters, which creates financial avoidance and, in this case, ignorance. Financial avoidance can also weaken the influence of knowledge on behavior, since negative emotions induce inadequate financial behavior, such as time discounting, risk aversion, and impatience (for a detailed review, see Haushofer & Fehr, 2014).

Low income may lead to financial avoidance. According to Webb, Chang, and Benn (2013), financial avoidance stems from the will to escape negative emotions associated with the desire to preserve self-perception and avoid a sense of personal failure. Galai and Sade (2006) used the phrase "ostrich effect" to describe investors' avoidance of negative information about their assets, a tendency explained by Karlsson, Loewenstein, and Seppi (2009) as meant to escape psychological discomfort. In a similar vein, low income may explain why certain individuals eschew monitoring their finances and avoid planning for the future, in order to avoid the negative feelings elicited by facing poor financial achievements. Based on this notion, we hypothesized that financial avoidance would mediate the link between low income and financial management such as monitoring, keeping track, and planning future expenditures.

Self-Control

The other emotional variable we examined is self-control. Lack of self-control is associated with poor consumption and planning (Baumeister, 2002; Vohs, 2013). It is also related to deviations from reasoning and rational behavior (Kahneman, 2011; Schmeichel et al., 2003). Hence, we conjectured that low self-control would hurt individuals' ability to act in a way consistent with their financial knowledge.

Tasks' Features: Complexity and Timing Gratification of Financial Engagements

The characteristics of the economic task being conducted strongly influence the ability to apply financial knowledge. Research has shown that people prefer immediate gratification over future extended payoffs. Hyperbolic discounting describes the tendency to discount the value of future rewards (Loewenstein & Prelec, 1992; Thaler & Shefrin, 1981). Hence, we expect that the time of gratification would influence individuals' propensity to invest time and effort in a given task. Complex tasks are generally aversive (Kahneman, 2011). This explains why people avoid complicated financial tasks. Tasks that are both complicated and provide only delayed gratification are most likely to be affected by habits, heuristics, and false perceptions.

To investigate the influence of tasks' features, we adopted an accepted taxonomy, the one devised by Atkinson, McKay, Collard, and Kempson's (2007):

(a) Managing money—people's ability to make ends meet and their ability to keep track of their finances
(b) Planning ahead—financial precautions taken for the future
(c) Choosing products—choice and purchase of financial products
(d) Staying informed—engagement with current economic developments

Let us now contrast two common financial practices—*comparing prices*, an essential part of the category "choosing products"—and *budgeting*, a task that stands at the heart of the "planning ahead" category. Budgeting involves data collection and numerical calculations and requires future orientation and planning. Price comparison also requires attention but is focused on one specific product and takes less time and effort. Budgeting is, therefore, a more complex task than a price comparison.

The two tasks distinguished above also differ in the timing of gratification. When people choose to buy a cheap product rather than a highly regarded brand, they might have to resist temptation, but they also know exactly how much money they save. On the other hand, while consumers can save a great deal of money by keeping track of bills and planning future expenses, it is hard to specify the amount saved, thanks to these activities. Whereas any customer can evaluate the savings offered at a discount, the implications of proper money management and planning become apparent only in the long run.

Table 5.1 presents a categorization of financial capabilities based on the two proposed dimensions. Note that the category "Money management" was subdivided into "Management" and "Making ends meet" and that "Choosing products" was also subdivided into "Choosing products" and "Choosing *financial* products."

Table 5.1 allows to make precise predictions about the influence of knowledge on economic behaviors. Complicated tasks that provide only delayed gratification require more mental resources and will be affected by a lack of financial resources, self-control, and negative emotions, but not by knowledge. Tasks that are simple and

Table 5.1 Categorization of financial capabilities by complexity and gratification timing

	Complexity	Gratification
Planning ahead	High	Delayed
Management	High	Delayed
Making ends meet	High	Immediate
Choosing financial products	High	Variable
Staying informed	Low	Delayed
Choosing products	Low	Immediate

provide immediate gratification do not require the same resources, and people can therefore apply their knowledge readily.

The Long-Term Influence of a Financial Intervention Program: A Case Study

To evaluate the Arrested Deployment Model, we analyzed data collected during and after an intensive intervention program designed for families and individuals who experience financial hardship (for a detailed description of the program, the analysis, and the detailed statistics, see Carmel, 2018). The program includes a yearlong guidance to the household by a trained volunteer consultant that serves as a mentor that helps them to devise a financial recovery plan and to acquire necessary financial skills.

We used two types of measurements to evaluate the impact of the program:

1. Administrative data obtained from the NGO that runs the program. This includes information about income, expenditures, and debts, before and after the intervention, together with the demographic variables of 3645 households who participated in the program.
2. Financial capability surveys that were answered by program participants before ($N = 251$) or after ($N = 181$) completing the program, as well as two follow-up surveys administered to program graduates who had completed the intervention 2–5 years prior to the study. Data was collected in two waves: a preliminary study with 98 respondents and an enhanced sample of 390 respondents. Some changes in the survey and sampling methodology were made between the two waves (see Carmel, 2018 for more details).

According to the model, we expected that differences between program participants' ability to apply the knowledge acquired in the course of the intervention would be predicted by the two components of the model: (a) personal and situational characteristics such as self-control, anxiety, and financial constraints and (b) the features of the task—its complexity and timely gratification.

Specifically, we looked into the influence of financial hardship of program participants. The follow-up surveys also measured self-control and anxiety. Based on the model, we expected to see differences in participants' ability to adopt management-related behaviors, due to its complex nature and lack of immediate gratification. We conjectured that people who suffer financial hardship, have high level of financial anxiety, or have poor self-control would not demonstrate such behaviors after several years. By contrast, we did not expect to find such differences in simple activities that provide instant return such as wise consumption tasks. Lastly, our prediction was that financial hardship would not affect participants' financial capability at the end of the program, since both the program contents and the presence of the mentor were expected to encourage them to act responsibly.

The results matched our expectations. The findings supported the privileged status of simple economic practices that provide immediate benefits. While we witnessed a significant decline in management ability over time among respondents who reported financial hardship, choosing products scores were stable among all participants. Moreover, financial difficulties, self-control, and anxiety (as measured by two different measures we used—neuroticism and financial avoidance scale; Shapiro & Burchell, 2012) impeded the adoption of principles of management and planning, but proved of little importance for proper consumers' behavior.

Figure 5.2 shows the changes in financial capabilities over time, as measured by the second follow-up survey. We looked into the scores of consumption-related and managemental behaviors. While the results are cross-sectional and do not establish causality, their pattern fits well with the predictions of the model. People under financial stress don't have the cognitive capacity to perform the managemental tasks

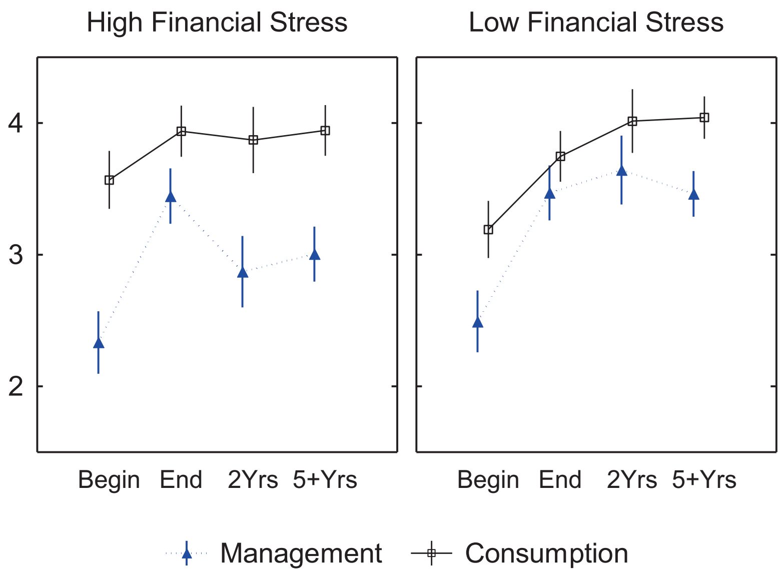

Fig. 5.2 Long-term trends in financial capabilities. The left panel shows the differences in financial capability scores for the high financial stress group and the right panel for the low financial stress group

that are complicated and provide only deferred gratification. Yet those same individuals were able to perform the simple and rewarding tasks that characterize wise consumption (e.g., compare prices, looking for alternatives, etc.). A longitudinal analysis (on a relatively small sample ($N = 90$), for lack of data) supports this interpretation. Respondents' financial situation at the end of the program had a significant main effect on their financial capabilities a few years later. Participants who were able to balance earnings and spending (including debt servicing) at the end of the program outperformed other participants' management at the follow-up survey. No differences were found for consumer choices.

The Arrested Deployment Model provides new insights about the contribution of financial education. While it is easy to understand why low-income populations gain less from interventions (Fernandes et al., 2014), income differences alone do not explain differences in participants' behavior in the long term. Financial distress should not be considered only in terms of objective values of income and expenses; there is a clear dimension of subjective, emotional experience. The inclusion of neuroticism and avoidance in this study reveals the influence of emotions on economic behavior, which is strikingly parallel to the impact of financial hardship. Since neuroticism is a stable personality trait, our findings/model suggests a causal direction in which stress and negative emotions toward financial manners are the source of bad management, rather than the other way around.

Our integrative perspective enables us to interpret the inconclusive evidence regarding the impact of financial education. Financial education is beneficial for relatively simple behaviors that provide immediate positive returns. However, we cannot expect financial education to be effective for people unable to deploy their financial knowledge when it comes to behaviors such as planning and managing that are both complex and provide only long-term benefits. Specifically, for low-income populations or for individuals that experience insolvency, financial education that focuses on those types of behaviors is ineffective.

Conclusions

In an economically complex world, the will to provide people with adequate financial skills has become a central objective for many social activists and policymakers. Until recently, financial literacy training was considered the obvious solution for this aspiration. This view is being challenged by a growing number of scholars. To be sure, knowledge is a virtue, but for most people, financial activity is not necessarily based on an understanding of inflation or on interest calculation, but is more a case of emotions, biases, and short-term decisions (De Meza et al., 2008; Fernandes et al., 2014; Van Raaij, 2016; Leiser & Shemesh, 2018). The present work, too, criticizes the traditional role ascribed to financial literacy. However, it aims to go beyond criticizing this approach and proposes a theoretical account of the way knowledge impacts behavior.

Our *Arrested Deployment Model* could enhance the efforts made by so many to develop better and more effective financial education programs. In line with the model, individuals' ability to act according to their knowledge is mediated by psychological factors, which are of two kinds: emotional and cognitive. These terms are affected by various factors, some endogenous (aspects of personality and cognitive traits, such as general intelligence and the quality of executive functions), and some external ones. The latter include both economic circumstances (which affect cognitive functional via feelings of scarcity and precariousness) and features of the task at hand.

Complicated behaviors and behaviors that provide only long-term advantages require self-regulation and deliberate thinking. The resources needed for the specific task and the resources available to the individuals, due to situation or personality, jointly determine their ability to deploy financial knowledge when needed.

When mental resources are scarce, people tend to operate intuitively and to rely on their habits and perceptions rather than their formal knowledge. This perspective is supported by both the literature and our own data. Knowledge is associated with wise consumption, but not with financial management. While the former includes simple tasks such as comparing prices at the store, the latter includes complicated behaviors such as creating an annual budget and planning for the future. The different time frames of the two tasks are also clear. The contribution of wise consumption is immediately felt, but recognizing the positive influence of annual planning is much harder and requires deliberate reflection on potential losses that might have been incurred in the absence of a budget. The model we offer and the results of the case study presented above indicate that despite its weaknesses, financial education does contribute to some economic engagements provided certain conditions are met. Specifically, financial education will contribute to economic behavior that does not overly tax cognitive resources.

The motivation for this research came from advancements in the field of financial education. Studies that challenged the methodology of financial literacy research and the logic behind investment in financial education have rightly broadened the discussion from a narrow focus on financial literacy to financial capability, a concept that goes beyond knowledge. Sherraden and Ansong (2016), notably, stress the importance of what they term the *opportunity to act*, by which they mean that behavior is shaped by the economic environment of the individual, which is largely shaped by social institutions and regulations. For our part, we point to psychological conditions that limit the deployment of existing knowledge, conditions that involve economic circumstances and features of the task at hand.

That said, one mustn't disregard the importance of knowledge. A strong link between financial knowledge and behavior was demonstrated. Two meta-analyses that were published in recent years (Miller et al., 2015; Kaiser & Menkhoff, 2017) concluded that, under certain conditions, financial education does positively influence certain areas of behavior, Accordingly, their authors urge researchers to distinguish between different financial engagements in order to achieve better understanding of the contribution of financial literacy. This is what we attempted here.

The main principle that stands at the basis of this work is the similarity between literacy and rationality. By adopting the concept of rationality, we were able to apply a model of limited resources on financial literacy. This seemingly simple idea paves the way for a sophisticated investigation of the mechanism by which financial knowledge influences behavior. The reason for irrational behavior has been extensively investigated in the past, and many researchers offered explanations for human behavior (Chaiken & Trope, 1999; Stanovich & West, 2000), some focusing on limited cognitive ability (Kahneman, 2011) and others on the time perspective and separate short- and long-term considerations (Shefrin & Thaler, 2004; Thaler & Shefrin, 1981). The results presented here integrate all these ideas. While knowledge had an influence on simple behaviors, it did not impact individuals' ability to perform complex economic engagements. Our model also gives its place to the time frame of the decision. Knowledge strongly affects those economic engagements that provide immediate and noticeable gains. Conversely, knowledge weakly influence behaviors whose benefits are less immediately apparent.

Implications

As we were analyzing the finding of the study presented above, we were troubled by their meaning. Should we accept the notion that a large majority of the population is limited to acquiring simple financial principles only? The answer to this question came from work about human rationality. In their famous book, *Nudge*, Thaler and Sunstein state that: "The more choices you give people, the more help with decision making you need to provide." Recognizing that we need to work around humans' weaknesses changes our perception of the role of financial literacy.

To increase the effectiveness of the intervention described in the case study, we conducted several meetings with the management of the NGO that runs the intervention program. Our understanding that "we cannot choose our clients" led us to think about the best ways to adjust the architecture of the program to support its graduates as they struggle to preserve their achievements. We have asked the attendees of those meetings to think of ways that would reduce their need for self-control. In response, we received several creative ideas, such as providing participants with a set of simple rules of thumb to follow, stressing the importance of advanted planning of their response to various contingencies, and using automated periodic reminders to remind them to work on their budgets.

Actually, past studies had already confirmed the effectiveness of such practices. For example, Drexler, Fischer, and Schoar (2014) demonstrated the effectiveness of rules of thumb; Gollwitzer's interventions, also known as *implantation intentions*, are formed around the concept of pre-planning (Gollwitzer, 1999); and automatic reminders were shown to be very effective in several studies (Ericson, 2017; Karlan, McConnell, Mullainathan, & Zinman, 2016). But the majority of participants in those management meetings had never heard of them before, and it was their fresh insight about the role of self-regulation and deliberate thinking that led them to such solutions. We feel this story illustrates the contribution of a supportive theory that provides guidance and direction for action.

The research implications of a theoretical model of financial literacy are considerable. It enables to assess the contribution of many different factors involved and may serve as the conceptual foundation to develop specific intervention programs among different populations. For example, we could identify that people from low economic status struggle to manage their money but can easily adopt simple principles and rules of thumb. For the high-income population, on the other hand, a more demanding training might be offered, because they have mental capacity needed to acquire and adopt complicated financial engagements such as planning, budgeting, and money management. Most importantly, we consider that the main contribution of this work is that it set the ground for developing theoretical advances in the field of financial literacy. While research into financial literacy often focuses on the final outcome, the Arrested Deployment Model proposes a reasoned way to account for the uneven influences of financial literacy on economic behavior, paving the way for new insights and theoretical developments that are still much needed in this field.

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Chapter 6
Emotions and Financial Decision Making

Tomasz Zaleskiewicz and Jakub Traczyk

Introduction

Many—if not most—of the decisions people make in different spheres of life are associated with feelings.[1] As Lerner, Li, Valdesolo, and Kasam (2015) put it, "many psychological scientists now assume that emotions are, for better or worse, the dominant driver of most meaningful decisions in life" (p. 801). Emotional experiences that accompany and modify the decision process may be: (1) positive or negative (Cohn & Fredrickson, 2010; Cohn, Fredrickson, Brown, Mikels, & Conway, 2009; Rozin, Lowery, Imada, & Haidt, 1999), (2) conscious or unconscious (Smith & Lane, 2016; Winkielman & Berridge, 2004), (3) directly experienced by a decision maker while solving a problem at hand or anticipated as future feelings (Lerner et al., 2015; Loewenstein & Lerner, 2003), and (4) felt either in the form of strong affects or as less intense and nonspecific moods (Isen & Labroo, 2003). The effect of feelings on the quality and accuracy of choice also varies depending on a myriad of factors (Keltner & Lerner, 2010). Emotions sometimes act "against us" by biasing our decisions when, for example, they render us not sensitive enough to probability changes (Rottenstreich & Hsee, 2001) or stimulate an incorrect

[1] When referring to various emotional phenomena, researchers use different terms, such as feeling, emotion, mood, or affect, which may be somewhat misleading. However, the main goal of this chapter is not to concentrate on this issue and investigate it thoroughly. For the sake of brevity, we use terms and definitions provided by the authors of the original articles we cite in this chapter. Readers who are interested in this topic can find more information in handbooks on emotions (e.g., Lewis, Haviland-Jones, & Barrett, 2008).

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understanding of the relation between expected risks and benefits (Slovic, Finucane, Peters, & MacGregor, 2007). Nevertheless, as Baumeister, Vohs, DeWall, and Zhang (2007) very rightly ask, "Why would evolution have instilled and maintained a strong repertoire of emotional responses in the human psyche, if it mainly caused foolish or otherwise irrational behaviors?" (p. 167) In other words, emotions also fulfill useful informative functions, for example, by providing us with feedback on whether choosing a specific alternative is safe and, in this sense, adaptively restraining us from taking too high risks (Bechara & Damasio, 2005; Schwarz, 2001).

All the above-listed peculiarities also concern financial decisions made by lay people (e.g., individual investors) and professionals (e.g., institutional investors). Emotions may have an influence on decisions regarding saving and borrowing money because they are involved in psychological mechanisms related to the delay of gratification (Zayas, Mischel, & Pandey, 2014; see also Chap. 12 in this book). Strong feelings are involved in the choices investors make on the stock market; they regulate their willingness to buy or sell stocks and make them more or less avoidant toward risk (Fenton-O'Creevy, Soane, Nicholson, & Willman, 2011; Liu, Govindan, & Uzzi, 2016; Shiv, Loewenstein, Bechara, Damasio, & Damasio, 2005; see also Chap. 10 in this book). Emotions motivate people to either engage in or quit gambling (Kushnir, Godinho, Hodgins, Hendershot, & Cunningham, 2016; Yip, Wei Zhai, Balodis, & Potenza, 2019; see also Chap. 11 in this book). Finally, affective experiences regulate consumer judgments and choices and make people more or less reluctant to spend money on buying products and determine their reactions to marketing communication (Achar, So, Agrawal, & Duhachek, 2016). In the present chapter, we discuss how theorizing about the role of emotions in financial decision making has changed over the years. We also review the results that indicate the impact of feelings on different stages of the decision process. We highlight a distinction between integral and incidental emotions and the role these two categories play in financial decision making. We also focus on specific integral emotions that are elicited by mental imagery and provide empirical evidence from our own research that demonstrates how the interplay between emotions and mental imagery provides inputs to decisions in uncertain circumstances. Finally, we discuss how integral and incidental emotions may guide financial decision making and how we can use this knowledge to improve the decision making process.[2]

Emotions in Financial Decision Making: How Theoretical Views Have Changed over the Last 20 Years

One of the most important and spectacular contributions of psychology to the theory and practice of finance is associated with applying the psychological science of emotions to understand how people make decisions in economic contexts. The field

[2] Readers who are interested in a more detailed investigation of the relationship between emotions and risk perception can find a thorough review of the most prominent theories and studies in a recent chapter by Tompkins, Bjälkebring, and Peters (2018).

of economics that is, by definition, the analysis of choice (Samuelson & Nordhaus, 2009) has developed the normative model of rational decision making that is based on the assumption that people are utility maximizers and have stable preferences (Wilkinson, 2007). Loewenstein, Weber, Hsee, and Welch (2001)—the authors of one of the essential models of affective decision making named the "risk as feelings hypothesis"—suggested that normative theory of choice represents a consequentialist perspective in the sense that it portrays decision makers as rational agents who carefully consider the consequences of choosing different alternatives (including probabilities related to these alternatives). Figure 6.1 displays a graphical interpretation of such an understanding of decision making under risk. The consequentialist approach predicts that decision is the result of (un)conscious analysis of accessible options moderated by both dispositional (e.g., individual risk aversion) and situational (e.g., the presence of time constraints) factors. Emotions appear only as one of many outcomes following the decision made. In the context of finance, the normative model of rational choice assumes that people experience positive feelings (e.g., happiness) when they earn money and negative feelings (e.g., anger) when they lose money, but it says nothing about the potential influence of affect on the decision process before one of the alternatives is chosen. As Loewenstein et al. (2001) metaphorically say, "Many choice theorists are deliberately agnostic about the psychological processes underlying the patterns of choice that their models predict" (p. 267).

Over the years, the behavioral approach to the study of choice has revealed that people violate many normative principles of rational behavior when making their decisions. Researchers have offered original descriptive models of decision making (Baron, 2008; Fox, Erner, & Walters, 2015; Kahneman & Tversky, 1979; Katsikopoulos & Gigerenzer, 2008; Starmer, 2000). This approach, drawing from various areas of psychology, has documented that the accurate description of the

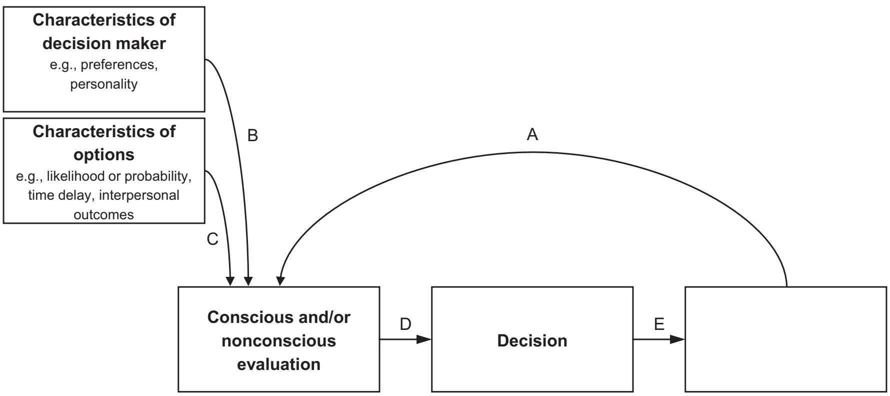

Fig. 6.1 The classical approach to interpreting the decision making process. This approach includes emotions only as one of the outcomes of a decision made (prepared on the basis of Figure 2 in Lerner et al., 2015)

decision process should incorporate different functions of emotions (Lerner et al., 2015; Loewenstein & Lerner, 2003; Loewenstein et al., 2001; Slovic, Finucane, Peters, & MacGregor, 2004). The pertinence of such an approach has also been confirmed by extensive empirical evidence from neuroscience, which shows that decision making involves specific activation of brain areas associated with affective processing (Bechara & Damasio, 2005; Lempert & Phelps, 2013; Mohr, Biele, & Heekeren, 2010; Phelps, Lempert, & Sokol-Hessner, 2014; Poppa & Bechara, 2018). Moreover, behavioral and neuroeconomic models of choice indicate that decision making involves several types of emotions that drive and regulate decision making (Lerner et al., 2015; Loewenstein & Lerner, 2003; Loewenstein et al., 2001). Here, we mainly focus on two broad categories of emotions from the perspective of their source and regulatory functions in financial decision making: incidental and integral emotions. Integral emotions arise from a dilemma at hand and may be either immediately felt while deciding or anticipated as a potential affective outcome of making a choice. Incidental emotions (affects or moods) are not relevant to decision making; rather, they endorse the impact on how one makes choices. We propose how these two categories of emotions can shape decision making in various ways. Figure 6.2 displays links between integral/incidental emotions in the decision making process.

The regulatory role of integral and incidental emotions also applies to financial decisions. To demonstrate just one out of many possibilities of how financial choice is regulated by emotions, we consider here the example of deciding about the allocation of money among several investment funds that differ between each other in the sense of risk and expected profit. Cognitive evaluation—conscious or unconscious—may regard the likelihood of possible gains and losses or the distribution of

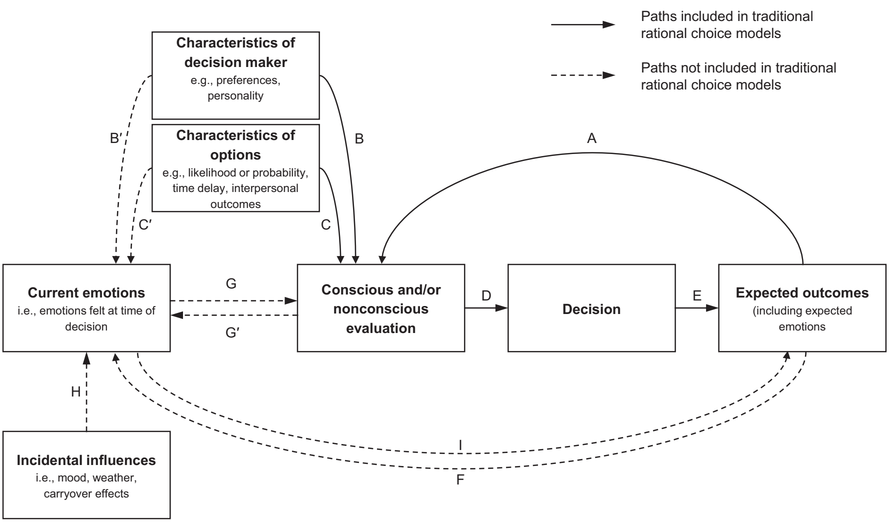

Fig. 6.2 The descriptive approach for interpreting the decision making process. This approach includes different types of emotions (prepared on the basis of Figure 2 in Lerner et al., 2015)

risks and benefits over time (path C), but the model assumes that it remains in a mutual interplay with affective experiences (paths C′ and G′). For instance, the conviction that the probability of loss is very high for one of the considered funds might produce the feeling of fear (an integral emotion) and impact the final risk estimation in either a direct (path C) or an indirect (paths C′ and G) way. However, as already highlighted earlier in this chapter, decisions also depend on incidental emotions, whose sources are not directly related to the decision at hand (path H). An investor who is considering the distribution of financial resources among different funds might feel angry because her or his computer broke down the day before or experience sadness because her or his lovely pet is sick. Such feelings indirectly influence decisions we make even if we are not aware of them. Finally, when comparing different funds and trying to recognize which of them are worth considering as profitable investments, one might also anticipate emotions that can be experienced after the decision is made. For example, decision makers may predict that if a highly risky alternative is chosen and it produces losses, they would regret that a less attractive but not as uncertain option had been rejected. Such an anticipation, which may be considered a special case of integral emotions, has the capacity to influence the decision and make the investor reluctant to choose a riskier fund (paths A and F).

In the following sections, we elaborate further on the specific functions of different types of emotions and survey examples of studies that demonstrate the effects of these emotions on the process of financial decision making.

Integral Emotions

The Functions of Integral Emotions in Decision Making

To illustrate the nature of integral emotions in financial decision making, let us imagine the following situation. Two people bought the same smartphone (worth $300) from an online store. The store offered insurance to cover the cost of any potential smartphone damage during its shipping. While the first person does not have any special feelings for the smartphone and believes that it is worth its price, the second person feels that it is priceless because it is the same model that is advertised and used by her or his favorite athlete. Despite the fact that the smartphones are technically the same and the probability of their damage is also identical, the second person may be more likely to purchase insurance because of positive emotions elicited by the smartphone and more affection she or he has for it (see Hsee & Kunreuther, 2000, for the concept of the affection effect). In such a case, integral emotions directly related to and induced by the product may have the capacity to bias decision making because they were not accurately related to a decision problem or the object of the decision. In other words, we would say that positive integral emotions for the smartphone were uninformative because they were not correlated with the objective probability of damage. Rather, they were boosted by an advertisement of the smartphone being used by a celebrity. Nevertheless, based on this example, integral emotions can also be adaptive and informative (i.e., they are ecologically valid; Gigerenzer, Todd, & ABC Research Group, 1999) if they are generated by relevant aspects of a decision problem (e.g., the probability of damage). For instance, if the second person knows or estimates that the probability of damage during shipping is very low (e.g., it happens in 1 in 10,0000 cases), and this information generates the integral emotion of fear that is accurately correlated with the damage probability, then integral emotion may support the decision making process by providing emotional markers or gut feelings that guide beneficial decisions (Bechara & Damasio, 2005).

In this section, we discuss the functions of integral emotions in financial decision making. Based on prior evidence, we will present two conditions under which integral emotions either support or distort financial decision making.

Integral emotions may be elicited by various factors that are directly related to a decision problem. For example, they may be evoked by personal values and preferences toward choice alternatives (Hsee & Rottenstreich, 2004; Mukherjee, 2010; Petrova, van der Pligt, & Garcia-Retamero, 2014); the analysis of numerical values, such as probabilities and outcomes (Peters, Vastfjall, et al., 2006); familiarity and personal experience (Bechara, Damasio, Tranel, & Damasio, 2005; Ganzach, 2000; Sobkow, Traczyk, Polec, & Tyszka, 2017); or the vividness of mental images of potential choice consequences (Sobkow, Traczyk, & Zaleskiewicz, 2016; Traczyk, Sobkow, & Zaleskiewicz, 2015; Zaleskiewicz, Bernady, & Traczyk, 2019). Contrary to incidental emotions, integral emotions represent the "'genuine' subjective reaction to a target" (Västfjäll et al., 2016, p. 2). Thus, they have the potential to improve the quality of the decision making process if they are accurately correlated with the characteristics of a decision problem. In particular, Peters and collaborators (Peters, Västfjäll, Gärling, & Slovic, 2006) highlight four functions of emotions that might be beneficial for better decision making. We elaborate on them below.

First, emotions may serve as a *specific type of information* that supports decision making. In this context, integral emotions associated with a choice dilemma are usually formed on the basis of prior experience (Bechara et al., 2005; Damasio, 1994) and operate implicitly and unintentionally. A decision maker learns the structure of the environment (e.g., payoffs and their probabilities) and "marks" mental images of the decision problem with positive or negative feelings related to the current somatic states. Such somatic states (also named *markers*; Bechara & Damasio, 2005) may act as an alarm system—they prevent a decision maker from choosing alternatives that were disadvantageous in the past. For example, recent research showed that people who personally experienced a natural disaster felt more worried about the future and, consequently, were more likely to pay more for insurance on their property (Sobkow et al., 2017).

Second, emotions *translate more complex thoughts into simpler affective evaluations* and help to *integrate information* (Peters, Västfjäll, et al., 2006). They provide "common currency" (the feeling of goodness or badness) even if alternatives and their attributes seem incomparable to each other (e.g., money vs. health vs. time). To illustrate, we might imagine an individual going skydiving during a holiday and considering whether to purchase additional extreme sports insurance. It is difficult to make a rational decision in such a case because the price of the insurance, health, and time needed to make the decision are incomparable. However, the common affective currency might help in solving this problem. If the individual compares feelings elicited by negative health consequences (e.g., an injury), a high price of the insurance, and a time-consuming procedure for purchasing it, making the decision would become easier because it would only be based on integral feelings.

Third, emotions may function as a *spotlight* (Peters, Västfjäll, et al., 2006), a role that would make information congruent with the current affective state more available. They also alter information processing by *focusing attention* on specific aspects of a decision (Wichary, Mata, & Rieskamp, 2016). For instance, negative affect evoked by considering new and uncertain stocks has the capacity to focus attention on details related to the liquidity of the company in which one intends to invest. Consequently, investors analyze information more thoroughly, an endeavor that eventually leads to making better decisions.

Fourth, emotions *motivate decision makers to invest additional resources in processing information* about the decision (Peters, Västfjäll, et al., 2006). For example, it has been demonstrated that people who reported more fear evoked by solving a decision problem (e.g., when making medical vs. financial choices) sought more information about potential outcomes and their probabilities. This undertaking was associated with maximizing the experienced payoffs (Traczyk et al., 2018). However, this effect was present only when emotion (fear, in this case) was directly related to a decision problem and only among skilled decision makers (i.e., those with high statistical numeracy—an ability to properly understand statistical and probability information and to use it in everyday contexts; Cokely et al., 2018; Cokely, Galesic, Schulz, Ghazal, & Garcia-Retamero, 2012; Garcia-Retamero, Sobkow, Petrova, Garrido, & Traczyk, 2019; see also Chap. 4 in this book).

To summarize, on a behavioral level, integral emotions can serve as adaptive and valuable information to guide better financial decisions. In this sense, people who take advantage of integral emotions are likely to perform better in financial tasks compared to people who are reluctant to utilize such affective cues. One of the possible psychological mechanisms underpinning this effect is associated with a higher sensitivity to probability changes. Petrova et al. (2014) investigated how integral affect influences sensitivity changes in the probability scale in a simple insurance task. In their experiment, participants were asked to read a scenario describing the purchase of a camera. Depending on the experimental condition, the participants were informed that the camera was bought in an online shop (affect-poor) or was a birthday present from their grandfather (affect-rich). The main task was to declare the maximum price the participants were willing to pay for insurance against losing the camera with a given probability. The participants also rated how fearful they were about losing the camera and how hopeful they were about not losing it. The results showed that participants who provided more differentiated ratings of fear and hope were more sensitive to probabilities compared to people whose emotional reactions were less differentiated. These findings suggest that integral affect (in this example ratings of fear and hope) that is directly related to a decision problem (i.e., elicited by the probability of loss) may be beneficial to decision making.

However, as we mentioned before, integral affect may be misleading in making financial decisions under some conditions. Rottenstreich and Hsee (2001) provided evidence to support such a claim in their study involving simple monetary lotteries. These authors assumed that the way of presenting information about a decision problem would influence the sensitivity to probabilities in making financial decisions. Specifically, they hypothesized that presenting a decision problem in a relatively affect-rich manner, in comparison to an affect-poor manner, would lead to lower sensitivity to changes in probabilities. In one of their experiments, the participants were randomly assigned to one of the four between-subject conditions. Half of the participants were informed that they would play a lottery in which they had a 1% chance of winning a $500 coupon, while the other half was informed that they had a 99% chance of winning the same coupon. Additionally, half of the participants assigned to these two groups were informed that they could redeem the coupon toward expenses associated with a European summer vacation (affect-rich condition), while the rest of the participants were informed that the coupon could be redeemed toward tuition payments at their university (affect-poor condition). All the participants were asked to provide a price that they would have to be offered to be indifferent between receiving $500 for sure and playing a lottery with a given probability. The results indicated that in the affect-rich condition, participants were less sensitive to changes from a 1% to 99% probability of winning a coupon, even though the actual price of the coupon was the same as in the affect-poor condition. This finding suggests that emotions that are integral to a decision problem—but uninformative from the perspective of solving the decision problem accurately—biased the decision making through distorted processing of the probabilities.

Taken together, the results reviewed in this section seem to indicate that integral emotions are in many cases beneficial to financial decision making. When emotions are informative (e.g., they are accurately induced by some aspects of a decision problem such as probabilities), they serve as an essential cue that makes the choices more accurate. However, when these emotions are uninformative to the decision problem (e.g., negative integral emotions were boosted by fake news or advertisements), they are likely to bias the decision making process and guide inferior decisions. In the following two sections, we discuss in more detail a particular case of integral emotions—anticipated emotions—and a possible psychological mechanism that can be responsible for their elicitation: mental imagery.

Anticipated Emotions

Many of the examples presented so far in this chapter illustrated the direct effects of emotions on financial behaviors. For instance, we discussed how fear might stimulate the fleeing reaction and people's reluctance to accept a risky course of action. In the context of finance, dramatic manifestations of rapid and direct influences of intense emotions on decision making can be observed on the stock market when the panic of losing money prompts investors to sell stocks quickly, and, on the contrary, the excitement of earning money drives them to buy excessively (Shefrin, 2007; Shiller, 2000). The view that emotions directly shape behavior is common in scientific and popular psychology research (Baumeister et al., 2007). However, even if such a view is very intuitive, it tells only part of the story. Baumeister et al. (2007) developed a theory of *emotions as a feedback system* to show how conscious emotional experiences may stimulate cognitive processing after the outcome of a decision is known. The theory proposes that mutual relations between emotions and behaviors are circular in nature. People have the capacity to learn associations between affect and behavioral responses, and such associated affective traces shape future decisions. As these authors emphasize, "people learn to anticipate emotional outcomes and behave so as to pursue the emotions they prefer" (p. 168). If prior decisions produced feelings such as regret, disappointment, guilt, or shame, they would be avoided. On the contrary, when prior decisions resulted in pleasant emotional experiences, including pride, excitement, or joy, they will be repeated. In sum, the feedback theory shows various possibilities of indirect effects of emotions on people's decisions.

One specific example of how the theory introduced by Baumeister et al. (2007) may be used to better understand financial decision making refers to the psychological functions of the feeling of guilt. Imagine a consumer who decided to take a high loan to defray the purchase of a brand new, expensive car. Unfortunately, the consumer subsequently starts feeling guilty because it became clear that such a purchase was nothing more than a whim. The conscious feeling of guilt commands the consumer's attention and evokes the motivation to analyze what was done wrong and how such impulsive and possibly irrational decisions can be avoided in the future. When the situation arises again, the consumer may automatically experience the feeling of guilt that would help in inhibiting the impulse to buy and in choosing a more reasonable course of action. This example—which represents the consumer decision making domain—indicates that people learn connections between decision outcomes and the emotions that accompany them and become able to use these connections to predict their future emotional reactions in similar contexts. In other words, this example brings us to the concept of anticipated emotions—the idea that people are not only influenced by momentary emotions (integral or incidental) when analyzing information, contemplating accessible options, and finally making choices (Loewenstein et al., 2001), but that they can also travel in time to the future and foresee how they will feel after they learn the consequences of their decisions. In this sense, people use their self-knowledge about affective reactions to decide in a way that would make them feel better.

Even if the apparent role of anticipated emotions such as regret or disappointment has been recognized in some formal models of choice developed in both classical decision theory (Bell, 1982; Loomes & Sugden, 1982) and game theory (Savage, 1954), the relationship between such emotions and decision making (financial and nonfinancial) only began to be studied more extensively in modern affective psychology (Lerner et al., 2015; Loewenstein et al., 2001; Mellers &

McGraw, 2001). Rich empirical evidence has documented that current decisions may depend on anticipating regret, guilt, disappointment, shame, stress, elation, satisfaction, or rejoicing (Zeelenberg, Nelissen, Breugelmans, & Pieters, 2008). For example, it has been shown that experimentally inducing the anticipation of guilt had a positive effect on people's intentions to donate bone marrow and on the actual level of donations (Lindsey, 2005).

The illustrative example presented earlier in this chapter showed how the anticipation of guilt might impact the decision as to whether to obtain a bank loan. Zeelenberg, van Dijk, Manstead, and van der Pligt (2000) demonstrated how foreseeing the experience of disappointment—yet another emotion engaged in the regulation of judgment and decision making—may endorse the impact on different aspects of the decision process. Disappointment follows the failure of someone's expectations to manifest, mainly due to some external causes (van Dijk, Zeelenberg, & van der Pligt, 2003; Zeelenberg et al., 2000). Investors may feel disappointed when their profits appeared lower than expected because of unexpected fluctuations in the stock market (Duxbury, Gärling, Gamble, & Klass, 2020). Consumers are exposed to the feeling of disappointment when the actual service delivery violates prior held expectations. This feeling potentially leads to dissatisfaction and the readiness to complain (Zeelenberg & Pieters, 2004a).

Even if the category of anticipated emotions covers a wide range of feelings, one emotion that especially caught the attention of decision researchers is regret (Baumgartner, Pieters, & Bagozzi, 2008; Mellers, Schwartz, & Ritov, 1999; Simonson, 1992; Zeelenberg, 2018; Zeelenberg & Pieters, 2007). Zeelenberg (2018, p. 276) defines regret as the emotion "experienced when looking back at decisions that went awry" that "is typically associated with feeling responsible for the bad outcome and kicking oneself over the mistake made." Regret is undoubtedly a negative emotion (Saffrey, Summerville, & Roese, 2008), and its painful essence most likely arises from the fact that people experience it when they are aware that they made a wrong decision—the decision that produced harmful consequences (e.g., financial losses). In other words, two factors contribute to the negative valence of regret: one, the undesired outcomes of choice, and two, the decision maker's responsibility for experiencing those bad outcomes. In one of their classic papers, Kahneman and Tversky (1982, p. 173) analyzed the case of two investors who may have experienced regret:

> *Paul owns shares in Company A. During the past year he considered switching to stock in Company B, but he decided against it. He now finds that he would have been better off by $1200 if he had switched to the stock of Company B. George owned shares in Company B. During the last year he switched to stock in Company A. He now finds that he would have been better off by $1200 if he had kept his stock in Company B.*

As Kahneman and Tversky argued, both Paul and George experience regret. Even if they differ in whether they took action (George) or restrained from acting (Paul), they are similar in two ways: both of them suffer negative financial outcomes and both are responsible for the decisions they made.

Table 6.1 Outcomes and probabilities of options A and B

	States of the world		
Choice	Blue (33.3%)	Yellow (33.3%)	Red (33.3%)
A	$50	$100	$0
B	$0	$50	$100

Adapted from Zeelenberg et al. (1996)

Another example of how the regret-based decision motivation works in the context of finance refers to a simple monetary choice between the two options presented in Table 6.1 (Zeelenberg, Beattie, van der Pligt, & de Vries, 1996). The outcomes of both Option A and Option B depend on which ball out of three (blue, yellow, or red) will be picked from a basket. The likelihood of picking the ball of a specific color is always equal to 1/3.

As can be seen in Table 6.1, one of the possible outcomes for both options is the $50 win. Let us consider two examples of how the player might obtain a profit of $50. If option A was chosen and the blue ball was picked from the basket, the result is $50 and the decision maker knows that the alternative result was $0. If option B was chosen and the yellow ball was picked, the outcome is also $50, but this time the alternative result was $100. Formally, winning $50 means exactly the same in both cases. Psychologically, however, earning $50 in the second case is less attractive than earning $50 in the first case. In the latter situation, the utility of $50 is lowered because the decision maker is very likely to regret rejecting option A, which would have paid twice as much money if chosen.

From the perspective of the idea of anticipated emotions, it is important to note that people not only feel regret when they have learned about the unsatisfactory consequences of their choices; they can also feel it beforehand (i.e., before a choice is made, Zeelenberg, 2018). Let us consider how the feedback theory of emotions (Baumeister et al., 2007) would interpret the effects of anticipated regret in the context of the decision on purchasing insurance. Consider the case of a homeowner who decided not to insure the property and suffered losses afterward (e.g., his or her house has been flooded), an event that evoked the feeling of regret because choosing differently would not result in such harmful material consequences (the insurance would cover losses). If this person associates such a negative emotion with the decision of rejecting insurance, she or he would be likely to change the decision when facing another insurance dilemma to prevent her- or himself from experiencing regret in the case something bad (e.g., flooding) happens again. Here, the decision maker used the experience of anticipated regret as a cue to make a safe choice (i.e., to purchase the insurance policy). In the concluding part of this section, we will briefly review empirical evidence that illustrates the impact of anticipated emotions on financial decision making in three areas: consumer behavior, monetary choices under risk, and investment behavior.

We begin with examples regarding the consumer decision making domain. In his classic study, Simonson (1992) documented that inducing anticipated regret led participants to prefer more expensive and better-known brands over cheaper and worse recognized brands. If consumers who are reluctant to spend a lot of money avoid buying expensive products, they take the risk of feeling regret if the cheaper products that they purchased do not meet their expectations. In this sense, regret anticipation is involved in the regulation of risk that is always present when people make their buying choices. The effects of anticipated regret on consumer decision making were also found in more recent research by Bagozzi, Belanche, Casaló, and Flavián (2016). Here, the authors examined the functions of unpleasant (e.g., regretful, anxious, worried, discontent, and ashamed) as well as pleasant (e.g., proud, self-assured, happy, pleased, and worthy) anticipated feelings in consumer behavior. In a series of studies, they found that anticipated emotions predicted people's intentions to buy certain products or to ignore them. Using the experimental design, they also documented that anticipated feelings mediated the relationship between being informed about either positive or negative aspects of the product and the intention to purchase it.

Anticipated emotions are involved in people's choices among alternatives that differ in the levels of risk and expected outcome. Mellers, Schwartz, and Ritov (1999; see also Mellers & McGraw, 2001) studied how anticipated pleasure (in the sense of valence, the opposite of anticipated regret) changed depending on people's comparisons of the results they got in a gamble and the results they might have obtained when choosing a different option. The participants in their experiment made choices between two risky gambles and then, depending on the condition, learned either only the result of the gamble they chose or the results of both gambles (chosen and non-chosen). This experiment clearly showed how being exposed to the results of the chosen as well as the rejected option impacts anticipated feelings of winning money. First, people declared less anticipated pleasure from gaining $8 when the unchosen outcome was $32 compared to −$32. Second, the anticipated pleasure of losing −$8 when the unchosen outcome was −$32 was comparable to the anticipated pleasure of winning $8 when the unchosen outcome was $32. It seems that: (1) profits are much less sweet when one learns that the rejected option offered yet higher profits than the chosen option, and (2) losing money may produce satisfaction if one realized that she or he might have suffered even bigger losses if another option had been selected but was happy to avoid them.

The influence of anticipated regret on risky decision making was also examined in more naturalistic contexts. For example, Zeelenberg and Pieters (2004b) investigated how foreseeing this negative feeling may impact decisions made by actual lottery players in the Netherlands. People who more or less regularly participate in lotteries try not to miss drawings because realizing they might have won a prize (when, for instance, "their" lucky numbers were drawn) would evoke a painful regret. Some companies that sell lottery tickets often use this psychological effect to motivate people to participate, namely, by informing people about what they would have won had they played the game. Zeelenberg and Pieters (2004b) studied decision makers' behaviors in the Dutch Postcode Lottery, in which winning numbers and associated monetary prizes are based on randomly drawn postcodes. Importantly, the lottery informs non-players with feedback about how much they would have won if they had participated in the drawing. If one did not play but learned that his or her postcode was picked, one would potentially experience regret. The two authors showed that thinking about the participation in the Postcode Lottery had a greater capacity to produce regret compared to thinking about the participation in another lottery (State Lottery) that did not provide feedback if one did not participate. What is more, they found that the motivation to participate in the Postcode Lottery was stronger than the motivation to play in the State Lottery—in the former case, anticipated regret regulates decision making.

Finally, we turn to studies that examined the effects of anticipated emotions in the context of investing and begin with referring to the experimental laboratory research by Zeelenberg and Beattie (1997). They presented half of their participants with the following story:

> *Your uncle has just died and left you £1000. You now have to decide how to invest the money for five years. Your uncle has also left your sister £1000, but her money is already invested for the same five-year period in a government bond, which is guaranteed to pay back a total sum between £1000 and £1800 at the end of five years. You can choose to invest your money in this type of investment too. A friend has just told you about another type of investment which you could choose, a high-interest account, which is guaranteed to pay back a total sum between £1250 and £1350 at the end of five years. You know that at the end of five years you will find out how much money you would have made if you had chosen the government bond because your sister will tell you.*

The second half of the participants read a similar story, but without information that feedbacks on how much money the sister earned (in this version of the story, both options were presented by a friend). In other words, this subgroup of participants was exposed to the outcomes of the chosen investment but not to the results of the rejected investment. Assuring people from the first group that they will learn the results of all investments (both chosen and non-chosen) aimed to evoke anticipated regret that might have influenced their risk preferences. If one chooses a safer option, one may predict that if the riskier option brings better profits, she or he will experience unpleasant regret. This thought, in turn, would motivate the decision maker to select the riskier option. Such theorizing was supported by Zeelenberg and Beattie (1997). They found that participants presented with the version of the story that provided feedback on the sister's results took more risk (i.e., more often chose the riskier government bond investment) compared to participants who read the story without feedback on the outcomes of the rejected option.

Research that investigated real-life investment decisions also revealed the potential effects of anticipated regret on financial decision making. Shefrin and Statman (1985) showed that when investors anticipate regret, they may be predisposed to selling winning stocks too early and holding losing stocks too long. They named such a tendency *the disposition effect* (see also Lopes & Oden, 1999; Summers & Duxbury, 2012). To illustrate this effect, we will consider an investor who holds two stocks: X and Y. The former earned a 10% return, and the latter lost 10%. Which one out of these two stocks would the investor be more willing to sell if she or he needed cash? According to the disposition effect, the readiness for selling stock X should prevail over the readiness for selling stock Y because decision making is in such a case skewed by anticipated regret. The feeling of regret might arise if the winning stock is not sold and its price subsequently drops or if the losing stock is sold and its price then rises. If the investors anticipate this event—and empirical evidence suggests that they do—they indeed will be more eager to sell winners and to hold losers.

Evidence shows that anticipated regret may also influence investment decisions related to retirement savings. Croy, Gerrans, and Speelman (2015) conducted a large questionnaire-based study with more than 2000 Australian citizens to investigate such psychological determinants of the intention to make extra voluntary retirement savings as attitudes or social norms. Anticipated regret was measured with two questions: "If I did not perform the behavior, I would feel regret," and "If I did not perform the behavior, I would feel upset." Not surprisingly, when people held more positive attitudes toward retirement saving, they were more prone to declare their intentions to engage in this kind of financial behavior. Similarly, when people felt stronger social pressure to save (i.e., when they were convinced that people important to them, or whose opinion they valued, thought that they should perform the target behavior), they were also more willing to engage in retirement saving. However, crucially from the perspective of this section's topic, anticipated regret partially mediated the relationship between attitudes and social norms on the one hand and retirement saving intentions on the other. Positive attitudes and strong social norms had a positive effect on anticipated regret, which was, in turn, positively related to retirement saving willingness. This study showed how the feeling of regret might impact financial behavior and also indicated that attitudes and subjective norms are involved in people's anticipations of regret. The more decision makers think that a particular behavior (e.g., retirement saving) is good, right, and valuable, the stronger the social pressure they feel, and the more they are likely to experience regret when they consider not performing such a behavior.

Mental Imagery as an Affective Input to the Decision Making Process

Integral emotions may be evoked by recalling the direct experience of events (such as losing money after investing in risky assets) as well as by imagining and simulating the possible future consequences of choices (Holmes & Mathews, 2005; Ji, Heyes, MacLeod, & Holmes, 2016; Sobkow et al., 2016; Traczyk et al., 2015; Zaleskiewicz et al., 2019). Previous research has demonstrated that when facing a risky or uncertain dilemma, people spontaneously visualize the consequences of their decisions (Traczyk et al., 2015); this process elicits positive and negative emotions. Furthermore, emotional reactions to the consequences of a choice may modulate cognitive evaluation of risk and result in making a risky or safe choice. Let us think about a person who intends to buy a new, bigger apartment and considers different methods of financing this purchase. A financial advisor suggested this person take a long-term credit (mortgage). This option is attractive but uncertain because the person cannot be sure of possible changes in her or his future income.

In the case of a worsening financial situation, he or she would suffer severe material problems. In this situation, a person may produce mental images of possible consequences of risky behavior. For example, decision makers may imagine serious financial problems if they take a long-term credit but lose a good job. On the other hand, they may visualize themselves spending a pleasant time in a cozy new apartment. Both of these two images are tagged with affect: financial problems would evoke negative affect, while an image of a nice apartment would evoke positive affect. In turn, the valence of affect may influence the evaluation of risk and the willingness to take a risky course of action. When affect elicited by mental images of the consequences of risky behavior is negative, then the risk is assessed as higher and the likelihood to take it decreases. On the contrary, if mental images of risk are rather positive, then risk is judged to be lower, and a person is more likely to accept it.

The general idea behind the relationship between mental imagery and emotions is based on theoretical models positing that on the neural and evolutionary levels, these phenomena are strictly interrelated. For instance, Stephen Kosslyn (1994) argued in his seminal book *Image and Brain* that anticipatory emotions are strongly related to mental imagery. Furthermore, Öhman and Mineka (2001) argued that feelings are more sensitive to imagery than to narration because language evolved later than basic emotions such as fear. Finally, some researchers (e.g., Lang, 1979) even use the term *emotional imagery* to stress the close reciprocal connections between mental images and emotional reactions. Mental imagery allows for simulating real-life behavior without experiencing it directly. Integral emotions that are evoked by these mental images of consequences of risky behavior are capable of shaping future financial decisions because they allow one to perform mental "time travel" (Suddendorf & Corballis, 2007) to simulate and mentally experience the possible courses of one's decisions.

There is at least one study that has investigated the role of mental imagery and emotions in making decisions in the financial domain. Zaleskiewicz, Bernady, and Traczyk (2019) asked entrepreneurs and lay people to make decisions in a series of business (e.g., spending a large amount of money for product promotion when competition in the market is high) and nonbusiness (e.g., spreading negative and untrue information about a person you do not like) situations. For each scenario, the participants were asked to report the vividness of mental images of the consequences of their decisions, emotional reactions, and risk ratings associated with these situations. The results of this study demonstrated that there were no differences between entrepreneurs and non-entrepreneurs in the willingness to take the nonbusiness risk. Nevertheless, entrepreneurs were more willing to take the business risk compared to the participants who did not have experience in business. Importantly, entrepreneurs, in comparison to non-entrepreneurs, produced more positive and vivid images of business scenarios that were, at the same time, rated as less fearful and more intense in emotions. This finding suggested that entrepreneurs were generally more optimistic about their future financial decisions and that integral emotions evoked by imagining consequences of financial decisions were related to the willingness to take financial risk.

While integral emotions are generally beneficial to financial decision making, if they are relevant and accurately elicited by a decision problem or its characteristics (e.g., probabilities), the other category of emotions—incidental emotions—often leads to worse decisions because they do not carry any informative cue for the decision making process. In the next section, we review research that discusses the role of incidental emotions in financial decision making, with a unique role for mood in this process.

Incidental Emotions

The Functions of Incidental Emotions in Decision Making

Incidental emotions are neither directly nor normatively related to a decision problem or the decision making process. In other words, they carry over from other situations or internal states to a decision, even if they are normatively irrelevant to this decision (Lerner et al., 2015; Västfjäll et al., 2016). Incidental emotions can bias subsequent judgments, preferences, and decisions. This phenomenon was demonstrated in the classic research by Johnson and Tversky (1983). In this study, the participants were asked to read different newspaper stories designed to induce either positive or negative emotions. Next, they were asked to rate the frequency of various risks (e.g., a flood) that were similar to the content of the brief newspaper story they read (e.g., natural disasters) or not (e.g., diseases). The results indicated that the participants who read negative stories produced more pessimistic ratings of risks when compared to those who read positive stories. Interestingly, this effect was not moderated by the similarity between the content of the story and the rated risk; this finding suggests that emotions induced by a newspaper story generalized on risk perception irrespective of the congruence between the source of its elicitation and the rated hazard.

The effects of incidental emotions on cognition and behavior have been extensively investigated, resulting in advanced theoretical models (Forgas, 1995; Schwarz, 2001; Schwarz & Clore, 1983), which we briefly report and discuss in the following section. Here, we highlight two factors that may be of special importance in explaining the psychological mechanisms underpinning the effect of incidental emotions on financial decision making.

First, several studies have demonstrated that incidental affect that is not causally related to a decision itself may influence processing probabilities by distorting decision weights (Fehr-Duda, Epper, Bruhin, & Schubert, 2011; Kliger & Levy, 2008; Traczyk & Fulawka, 2016). That is, emotions, affect, or mood may impact subsequent financial decisions by diminishing sensitivity to changes in probabilities. For example, Traczyk and Fulawka (2016) asked participants to take part in two unrelated cognitive tasks. In the first task (perceptual task), the participants were informed that they would see different pictures displayed sequentially on the computer screen and their task was to detect a target stimulus in a stream of distractors. Depending on the experimental condition, the distractor stimuli were of a negative or neutral valence. The perceptual task was followed by the insurance task in which the participants were asked to declare how much they would pay to insure a $500 coupon to cover its entire value in case of its loss, with a given probability from a 1 to 99%. The participants were not informed about the real aim of the experiment and the manipulations used. The results indicated that negative affect induced by pictures that were not related to the insurance task led to lower sensitivity to changes in probabilities. Interestingly, this effect was significant only among people with low numeracy; this finding suggests that some groups of people are not prone to the biasing impact of negative incidental emotions (for similar results see Peters et al., 2009).

Second, incidental affect is likely to impair decision making because it diminishes the motivation to extensively process decision-relevant information. For instance, imagine that an investor is considering whether to invest money in risky stocks or safer bonds. In this case, a rational decision would involve processing information about stock price variability, portfolio diversification, bonds ratings, etc. Nevertheless, incidental emotions that are not directly related to the investment, such as sadness from the loss of a pet or fear of flying, are likely to limit the time we intend to spend on making the decision. Such an effect has been observed in empirical research; this outcome showed that negative incidental affect (e.g., emotional stress) narrowed attention, which resulted in a limited information search about a decision problem and using simpler choice strategies in comparison to a control condition (Wichary et al., 2016). In a similar vein, the participants who recalled fearful events from memory explored less information about decision problems (e.g., about outcomes and probabilities), a phenomenon that was associated with lower mean returns in a lottery task (Traczyk et al., 2018).

Taken together, both distortions in processing probabilities and limited time to process all vital information may be responsible for the biasing effect of incidental emotions on financial decision making. The findings reported above are based on controlled laboratory experiments in which incidental emotions were induced with standardized materials and protocols. In the next section, we focus on mood, which is a special case of incidental emotions and is often experienced by people when making real-life financial decisions.

Mood as a Special Case of Incidental Emotions

One of the examples of how incidental emotions impact the decision process is the influence of affective states (also termed moods). Mood, as compared to affect, is less intense and less specific, but similar to stronger emotions, it may have either a positive or negative valence, and occur on different levels (e.g., as a subjective experience and physiological activation; Isen, 1993; Lazarus, 1991; Reeve, 2009). Although mood is not as strong as core affect, it lasts longer and is more diffuse and global (Frijda, 2009), in which sense its influence on the decision making process might be substantial, especially in complex and uncertain situations (Forgas, 1995).

Different emotion theories sometimes offer concurrent or competing explanations of the effects of mood on decision making. For example, the classical "emotion-as-information" model developed by Schwarz and Clore (1983) suggests that mood provides inputs to the decision process that are similar to other types of information. In this sense, people make judgments based on how they feel at the moment, a phenomenon that makes these judgments congruent with current affective states. Consistent with this interpretation, decision makers who are in a positive mood evaluate reality in a more positive manner than those who experience a negative mood. Assuming the accuracy of such theoretical arguments, we might expect financial decision makers who are in a good mood are less prone to save or insure themselves but reveal a stronger willingness to take higher risks in investing because such behaviors would be the natural consequence of perceiving the future more optimistically. Forgas (1995) also suggested that the effects of mood on cognition may be interpreted in terms of priming. A positive mood would prime optimistic thoughts and memories, while a negative mood would prime pessimistic thoughts and memories. For instance, consumers who experience a bad mood (compared to those in a good mood) might more easily recall memories of difficulties they faced in repaying a bank loan in the past and be more reluctant to take another loan even if its cost is relatively low.

However, the functions of mood in judgment and decision making may also be more nuanced. Prior research has indicated that people in a positive affective state are more prone to use simplified, heuristic, and intuitive processing (Forgas, 1995, 1998), while those in a negative mood are more likely to process information deliberately and systematically (Alloy & Abramson, 1988; Elsbach & Barr, 1999). In case of the latter, people have also been found to be less susceptible to biases (e.g., related to making evaluations based on stereotypes) and more correct in their choices. This phenomenon seems to be a consequence of a more systematic processing and applying more effortful cognitive strategies (Forgas, 1998; Park & Banaji, 2000). One example of how differences in mood translate into financial decision outcomes comes from research conducted by Au, Chan, Wang, and Vertinsky (2003). These authors experimentally manipulated the participants' mood to compare their decisions in simulated foreign exchange trading based on historical market data. The results convincingly showed that decision makers in a positive mood were more confident in their choices on the experimental market but they were more often wrong compared to people in a negative mood who behaved in a more conservative—but at the same time—more accurate manner. In other words, whereas a good mood was related to losing money, a bad mood led to making profits. This outcome is a clear indication of how differences in affective states may remain in union with measurable financial results.

Another interpretation of the role of mood in decision making stems from the "mood maintenance hypothesis (MMH)" proposed by Isen (1993, 2000). According to this theoretical model, people are strongly motivated to maintain their positive affective states, which makes them reluctant to engage in situations involving the likelihood of worsening their good mood. The MMH might also explain why being in a positive mood discourages people to process information in a systematic manner because detailed processing has the potential to undermine pleasant emotional experience (Kliger & Kudryavtsev, 2010). However, the most prominent tests of the MMH were performed in the context of risky decision making. In one of the classical studies, Isen and Patrick (1983) invited their participants to play games of roulette with different probabilities of winning. They found that those who were induced with a positive mood were less likely to take substantial monetary risk compared to participants in a neutral mood. In other words, the former placed fewer bets compared the latter in the high loss probability condition. Similar effects were also found in other studies (Arkes, Herren, & Isen, 1988; Isen, Nygren, & Ashby, 1988), all of which showed that decision makers are more conservative or self-protective when acting in a positive affective state. Nygren, Isen, Taylor, and Dulin (1996) continued investigating the effects of positive mood on judging risk and making risky choices. They documented that even if a good mood was related to more optimistic assessments of the probability of winning, it produced less risk-taking in gambling compared to the neutral condition.

Taken together, the results reviewed in this section seem to indicate that: (1) people use their mood as information in the decision making process in such a way that a specific interpretation of information is congruent with current affective state (e.g., they make more optimistic predictions of their future success and are less cautious in analyzing information when being in a good mood), but (2) there is an "inverse" impact of mood on choice—people in a good mood, even if they perceive the situation more optimistically, seem to avoid risk, because risk-taking may lead to losses and change the valence of the affective state in an undesired direction. In the next section, we review empirical evidence that confirms some of the predictions described above in the context of financial decisions.

The Effects of Mood on Stock Market Behaviors

Changes in mood are not provoked by strong and specific stimuli or events (as in the situation in which meeting an enraged dog produces intense fear). These changes typically result from environmental or biological factors such as fluctuations in the weather or a lack of sleep. For example, people may experience seasonal drops in mood caused by a lack of daylight, a phenomenon named seasonal affective disorder (Rosenthal et al., 1984). An extensive number of studies in behavioral economics have been conducted to document how changes in weather stimulate mood fluctuations and impact various aspects of financial decision making. Here, we review some of the results.

Two studies widely cited in the behavioral finance literature analyzed the relationships between stock returns and investors' behaviors, preferences, and sentiments caused by changes in morning sunshine (Hirshleifer & Shumway, 2003) or fluctuations in daylight levels (Kamstra, Kramer, & Levi, 2003). The assumption behind this research is straightforward and intuitive: When the sun is shining, we feel good, experience a positive affective state, and are more optimistic. On the contrary, a lack of sunshine leads to feeling bad or even depressed and forming more pessimistic expectations. How might these mood changes influence financial decisions on the stock market? The authors cited above predicted that in the sunny weather conditions, investors in a good mood are more prone to buy stocks because they are more optimistic about future economic prospects. However, in the cloudy and depressing weather conditions, investors tend to experience a bad mood and become more willing to sell because they have more pessimistic expectations about the future. If such a relationship between weather and mood is systematic, it might have the capacity to influence market indexes. Hirshleifer and Shumway (2003) examined the daily returns in 26 stock markets throughout the world and found that they were higher for sunny days than for non-sunny days. In other terms, sunny days outperformed cloudy days by almost 25% per year. Similarly, Kamstra et al. (2003) investigated the potential effects of the so-called "winter blues" (a negative mood shift during darker days of fall and winter) on stock market results in various countries. They found that stock returns were significantly lower during the fall when daylight decreases. This finding supported the prediction that bad mood caused by external factors influences financial decisions people make. Interestingly, such effects concern the behavior of individual investors as well as professionals (institutional investors), who were found to be more critical of stock pricing during bad weather days revealing stronger selling propensity (Goetzmann, Kim, Kumar, & Wang, 2015).

Weather is not the only source of mood changes that may impact financial decisions. Another source is the results of sports competitions. Two independent groups of researchers provided empirical evidence that showed: (1) soccer game losses were related to market decline the day after, especially in countries in which this game is very popular (Edmanse, Garcia, & Norli, 2007), and (2) National Football League team losses led to lower next-day returns for locally headquartered stocks, and the effect was stronger for a surprising or critical game loss (Chang, Chen, Chou, & Lin, 2012). Different—and even more surprising—potential causes of good or bad mood that were shown to modify investors' behavior and following fluctuations on stock market were positive or negative endings of popular TV series (Lepori, 2015) or opinions expressed by social media users (Sun, Liu, Chen, Hao, & Zhang, 2019).

The research reviewed above indicates that independent of its specific source, mood can be considered a specific type of incidental emotion that impacts financial decision makers' judgments, expectations, and preferences. Furthermore, this factor has enough power to modify the entire decision process.

Concluding Remarks

In this chapter, we showed how thinking about the role of emotions in financial decision making has changed over the last 20 years. Beginning with the notion that emotions are only side products of decisions, the current theoretical models (Lerner et al., 2015; Loewenstein et al., 2001) have highlighted the pivotal and causal role

Table 6.2 How can incidental and integral emotions impact financial decision making?

	Incidental emotions	Integral emotions
Improve	Nudges (evoking emotions not directly related to a decision problem, for example, to enhance the likelihood to purchase life insurance)	Experienced or anticipatory emotions coherent with the current situation (negative affect evoked by mental images of investing in very risky stocks)
Bias	Mood (the effects of mood induced by the weather on investment behavior)	Fake news (untrue information about the company's financial situation evoking positive affect toward the company)

of affect in financial decision making. Researchers seem to agree that under some conditions, emotions may be crucial factors that shape financial decision making. Contrary to early views that suggested the negative and destructive impact of emotions on the decision making process, affect, emotions, and feelings can exert advantageous effects on decisions when they serve as a cue or additional information to help deal with time constraints, the complexity of a decision problem, or trade-off between multiple goals. We also discussed the regulatory role of the two categories of emotions in financial decision making: incidental and integral emotions. In Table 6.2, we hypothesize potential ways that these emotions can either improve or bias financial decision making.

As we proposed in this chapter, incidental emotions are not normatively related to financial decisions or the decision making process. Therefore, incidental emotions are likely to systematically bias financial decisions (e.g., investing in extremely risky stocks due to a positive mood induced by good weather without analyzing risks and benefits). On the other hand, external emotional information that is accurately induced by a decision problem may be adaptive and helpful in improving financial decisions. For example, if one lives in an area that is at risk of flooding, it seems reasonable to purchase insurance against this hazard. However, some people are not interested in such preventive actions even if it pays off (Zaleskiewicz, Piskorz, & Borkowska, 2002). Combining nudging techniques (Thaler & Sunstein, 2008) and the induction of positive feelings toward flood insurance may lead to better decisions steered by incidental emotions. In the case of integral emotions, such an intervention would operate in a distinct manner. In particular, integral emotions that are identified as being accurately elicited by a decision problem (e.g., negative feelings related to a high risk of losing money after investing in an uncertain business or positive feelings evoked by mental images of consequences of a long-term retirement savings plan) should be advantageous for financial decision making. However, if integral emotions are not relevant to a decision problem (e.g., they were induced by fake news), they may lead to biased decisions (Martel, Pennycook, & Rand, 2019).

These interventions, however, require further investigation on two research questions: (1) How can an individual identify the source of emotions (i.e., how does a decision maker know whether the emotion is incidental or integral to a decision problem; Traczyk et al., 2018), and (2) how is affective information (from incidental and integral emotions) integrated into the current affective state (Asutay et al., 2019; Västfjäll et al., 2016)?

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Chapter 7
Financial Decision Making and Individual Dispositions

Katarzyna Sekścińska and Łukasz Markiewicz

Introduction

In this chapter, we review the literature explaining how individual dispositions (in particular, personality) influence people's financial behaviors.

Although personality concepts have usually been well defined by personality psychologists using detailed descriptive models, the concept of a "financial decision" lacks a clear-cut definition. For the purposes of this review, we therefore focus on decisions related to money involving some element of risk. Although a list of such potential activities is long and perhaps almost infinite, we selected four commonly studied activities which involve some financial risk for scrutiny: saving, investing, borrowing, and cheating.

The definition of risk used by individual investors does not concur with that used by financial theorists (Kubińska & Markiewicz, 2012). While the latter view risk as having an objective value, defined by the undesirable volatility of an asset's value across time, individual investors usually define risk as the probability of losing some capital (or simply as the extent of any loss). Both individual investors (Ganzach, 2000; MacGregor, Slovic, Dreman, & Berry, 2000; Slovic, Finucane, Peters, & MacGregor, 2002) and financial professionals (MacGregor, Slovic, Berry, & Evensky, 1999; Shefrin, 2001) attach different affective images to saving and investing, suggesting that the difference between saving and investing cannot simply be reduced to one concerning a difference in perceived risk. Although financial behaviors such as saving and investing are seemingly similar activities, they are influenced by different individual and/or situational factors.

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Bromiley and Curley (1992) listed six approaches to the study of individual and situational determinants of risk taking. Experimental studies using a behavioral decision theory approach have focused upon the influence of situational factors on risk taking, largely ignoring individual differences. This stems from the traditions of experimental psychology where participants are assigned randomly treatments to control individual differences without measuring them. Thus, here, researchers have attempted to ensure that people with particular characteristics (e.g., extraversion) are roughly equally represented across treatments, while showing that, for example, people are more risk averse in gain contexts than in loss contexts (Kahneman & Tversky, 1979), even when the contexts are created by usage of particular words (Tversky & Kahneman, 1986). Although specific to the situations investigated, this effect has been assumed to be universal regardless of individual differences.

In contrast, a general trait approach ignores variability across different situational contexts, assuming that risk-taking behavior generalizes across situations (see the recent promising research of Frey, Pedroni, Mata, Rieskamp, and Hertwig (2017) and Highhouse, Nye, Zhang, and Rada (2017)) but that risk-taking behavior varies with certain individual characteristics (Markiewicz, Muda, Kubińska, & Augustynowicz, 2019). A modification of this approach, the “within situation trait approach,” loosens the assumption that risk-taking behavior can be generalized across situations while identifying multiple individual differences within particular situations, e.g., explaining how the Big Five personality traits influence investing propensity. It should be noted that while most of the studies reviewed in this chapter have adopted this paradigm, this is not because we favor this approach but, rather, because most of the research investigating the influence of individual difference factors on financial decision making has used the approach.

But what if individual differences are unstable across different situations? Take, for example, if, with respect to regulatory focus theory (Higgins, 1997, 1998), people with a promotion focus are risk takers in gain contexts (investing in risky assets) but not in loss contexts (buying different types of personal and property insurance). Such a possibility requires models allowing interactions between individual and situational factors in describing their joint influence on risk taking (Figner & Weber, 2015). Interactional models of risk taking (Figner & Weber, 2011; Sitkin & Weingart, 1995) thus investigate both “who” takes risks and “when.” Here, according to Figner and Weber (2011, p. 111):

> Who? refers to individual differences in risk taking, among them age and gender differences. When? addresses situational differences, among them the decision domain (Weber, Blais, & Betz, 2002) and the extent to which the decision is emotionally charged (Figner, Mackinlay, Wilkening, & Weber, 2009; Loewenstein, Weber, Hsee, & Welch, 2001). Additionally, individual differences may interact with situational characteristics such that different whos react differently to different whens.

Thus, Figner et al. (2009) demonstrated that some individual differences (such as age) matter for risk taking, but only in emotionally rich situations (and they do not matter in emotionally uncharged situations). Such models are troublesome for financial decision making as the possible number of different contexts is unlimited. We stress here that “context” can be considered at both a general level (investing, saving, and borrowing) and more detailed levels such as different types of saving strategy (e.g., saving a predetermined amount each month; saving an amount not set in advance each month; saving some amount from time to time) and motives (e.g., saving for a specific purpose or just as a precaution). Similarly, an individual's disposition may influence a binary investing decision but not their investment horizon or their choice of investment products from the broad spectrum of available options.

Given the above, the review of individual differences in financial decision making presented below is organized in terms of the different situational contexts in which financial risks are taken.

Saving

Saving and Personality

The role of personality traits in explaining people's financial behavior has been studied widely. Some researchers have even treated personality traits as the fundamental roots of consumers' financial behavior (e.g., Mowen & Spears, 1999). Probably the most extensively studied personality system is the Five Factor Model of personality (commonly known as the Big Five Model) proposed by McCrae and Costa Jr. (1997). As the name of the model suggests, these researchers enumerate five personality traits: extraversion (defined by positive emotions such as gregariousness and the tendency to seek out stimulation), neuroticism (characterized by negative emotions such as anxiety and depression and commonly defined as emotional instability), conscientiousness (which is related to carefulness and organizational ability), agreeableness (which describes an individual's level of cooperativeness and compassion), and openness to experience (which refers to the extent of a person's imagination and intellectual curiosity). In the following part of this section, we summarize studies concerning associations between these five personality dimensions and financial behaviors related to saving and individual investing.

High *extraversion* is associated with accumulating fewer savings (Brandstätter, 1996; Nyhus & Webley, 2001) and is negatively related to the holding of financial assets regardless of type (Brown & Taylor, 2014). When extraverts possess a disposable sum of money, they prefer to invest it rather than save it (Gambetti & Giusberti, 2017) and are more inclined to engage in short-term investing (Mayfield, Perdue, & Wooten, 2008), although their long-term investments tend to be more profitable than their short-term investments (Chen, Ho, & Liu, 2019).

Emotional stability (a low level of neuroticism) promotes saving behaviors in general. It is positively linked to the possession of discretionary savings (Brandstätter, Gigerenzer, & Hertwig, 2006; Brandstätter, 1996) and to the likelihood of persevering with savings plans once they are adopted (Nyhus & Webley, 2001). Moreover, emotional stability is associated with possessing more savings gleaned from liquid household money (Nyhus & Webley, 2001).

Conscientious people exhibit positive attitudes towards saving (Nyhus, 2002) and engage in long-term thinking about their financial future, which is reflected in a tendency to focus on retirement planning and the possession of greater retirement savings (Duckworth & Weir, 2010; Hershey & Mowen, 2000). Further, conscientiousness is positively related to the development of regular saving habits. Davey and George (2011), citing Schmölders' (1982) classic study, indicated that, compared to easy-going, carefree people, conscientious, self-disciplined people are three times more likely to be regular savers and that on average they save 10–12% of their incomes (compared to 5–7% for easy-going, carefree people). It has also been found that conscientiousness is positively related to financial self-control (Wärneryd, 1996).

Openness to experience is positively linked to having a greater total amount of savings (Nyhus & Webley, 2001). However, studies by Duckworth and Weir (2010) showed that this relationship is reversed for retirement savings: openness to experience appears to be positively related to saving only when the amounts saved may bring joy or pleasure in the near future. Openness is also positively related to the willingness to invest. Brown and Taylor (2014) found that the mean openness to experience of couples making financial decisions together was positively associated with the probability that they would hold financial assets regardless of their type.

While *agreeableness* is less associated with saving behaviors than the other Big Five personality dimensions, it has been found that households consisting of both couples and single individuals characterized by agreeableness have lower amounts of liquid savings (Nyhus & Webley, 2001).

From the above, it can be concluded that the Big Five personality traits' roles in explaining variability in saving behavior differ depending on the context of saving decisions. For example, although the studies we reviewed so far do not demonstrate causality, openness to experience may be important where the decision making horizon is short-term (a positive relationship with saving behavior existing), but where the decision making horizon is long-term, emotional stability and conscientiousness may be more important (a positive relationship with saving again existing). Moreover, the Big Five traits' relationships with saving behavior also differ depending on the aspect of saving analyzed. For example, extraversion has been found to be related to amount of savings but not to the nature of the saving strategy employed (e.g., regularity of saving).

Saving and Time Perspectives

The decision as to whether to spend immediately or to save for the future requires mental time travel and may be considered to be an example of intertemporal choice since it involves trade-offs between various consequences (positive and negative) occurring at different points in time (Frederick, Loewenstein, & O'Donoghue, 2002). Numerous studies have shown that one's *time horizon*, defined as the length of period that is taken into account by an individual in the process of planning their expenditure and saving, is important in financial decision making (Rabinovich & Webley, 2007). Empirical evidence suggests that a subjectively longer future time horizon (which reflects a greater focus on the future) is supportive of (a) saving behaviors (Hershey & Mowen, 2000; Loibl, Grinstein-Weiss, Zhan, & Red Bird, 2010; Lusardi, 2000); (b) the likelihood of saving successfully and regularly (Fisher & Montalto, 2010); and (c) saving for reasons other than basic and safety needs (Devaney, Anong, & Whirl, 2007).

Another psychological factor connected with the subjective processing of time is *temporal framing*, which is also referred to as *time perspective* (TP; Zimbardo & Boyd, 1999. TP is a psychological construct concerning the cognitive process of portioning human experience into past, present, and future temporal frames (Zimbardo & Boyd, 1999). In their time perspective theory, Zimbardo and Boyd (ibid. 2008) distinguished five TPs, namely: past negative, past positive, present hedonistic, present fatalistic, and future. Studies by Sekścińska, Rudzinska-Wojciechowska, and Maison (2018) have confirmed that TPs influence people's choices as to whether to save or invest. A future TP was found to be positively associated with a preference for investments over savings and savings over present consumption; this was also reflected in the total amounts of money people allocated to each of these categories. A focus on the present, however, does not appear to support saving and investment behaviors since a present fatalistic TP was associated with a preference for consumption over saving or investing, this being consistent with earlier results of Rodermund (2012). Moreover, a present hedonistic TP was found to be positively related to a preference for consuming rather than for saving or investing and to actually spending more money on consumption than on saving or investing. Focusing on the past was also related to people's financial preferences: here, a lower past negative TP was found to be related to preferences for investments over savings and savings over immediate consumption.

To summarize, a focus on the future and a low degree of concentration on negative past events is associated with general saving behaviors (especially investing money), while a focus on one's present situation is positively related to a preference for current consumption. However, when specific aspects of saving behavior are considered (e.g., saving strategies or saving motives), only a future time perspective may be implicated. Therefore, to correctly interpret the role of time perspectives as possible explanations of people's saving behaviors, the decision context (in its broad meaning) should be taken into account.

Saving and Self-Control

Postponing consumption and saving or investing for the future, and persevering in such decisions, necessitates refraining from current pleasures and resisting various emerging temptations. To save, decision-makers need to control their desires (see also Chap. 12 discussing the antecedents and consequences of consumer borrowing, in this book). Self-control is the ability to alter one's dominant response tendencies and to regulate one's behaviors, thoughts, and emotions (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012) in line with long-term goals (Baumeister, Vohs, & Tice, 2007). Behavioral life cycle theory (Shefrin & Thaler, 1988) suggests that self-control is one of the main factors influencing willingness to save. Studies conducted on both adults and adolescents have shown that a higher level of self-control predicts saving behaviors (Brandstätter & Güth, 2000; Otto, 2009; Trzcińska & Goszczyńska, 2015). Also, in a study analyzing relationships between self-control and people's financial behaviors using data representative of the resident German population (2005 to 2009 data from the SAVE panel ["Sparen und AltersVorsorgE in Deutschland"; in English "Saving and old age provision in Germany"]), Liu, Yilmazer, Loibl, and Montalto (2019) found that a 0.1 unit increase in a measure of self-control predicted increases in total annual savings, total financial assets, and total assets (financial and illiquid) by 16.9%, 3.8%, and 2.6% respectively.

Level of self-control is also related to preferred saving strategy and in particular is positively related to regularity of saving. Strömbäck, Lind, Skagerlund, Västfjäll, and Tinghög (2017) documented that level of self-control was positively related to the extent to which participants reported that they had saved money in the last 6 consecutive months.

On the other hand, people with self-control problems often find it difficult to resist the temptations of immediate gratification (Laibson et al., 1998). When a person's self-control capacity is low, their behavior is often dominated by impulsive tendencies, which are often reflected in impulsive or even compulsive buying (Achtziger, Hubert, Kenning, Raab, & Reisch, 2015; Vohs & Faber, 2007). Baumeister (2002) noted that a failure in self-control can be responsible for a failure to save at all or result in a person who has previously saved abandoning their current saving aims and stopping saving: such behaviors are shunned in exchange for the pleasures of immediate consumption. Moreover, households with self-control problems associated with lack of planning, monitoring, or commitment accumulate less wealth (Biljanovska & Palligkinis, 2018). Also, people who spend their money on consumption often promise themselves that they will begin saving (e.g., for retirement) at a future date, but when the planned date arrives, they often tend to carry on spending their money on immediate consumption (Mastrobuoni & Weinberg, 2009). In this context it is worth stressing that a number of studies have shown that self-control problems and procrastination are major reasons for under-saving for retirement (e.g., Madrian & Shea, 2001; Thaler & Benartzi, 2004).

To conclude, high self-control seems to be crucial for saving behaviors. Its role is visible with respect to both the general extent to which people save (a positive relationship existing) and with respect to more detailed aspects of saving (e.g., the regularity with which people save, their success in maintaining a saving habit, and, as a consequence of sticking to a disciplined strategy, the total amount of wealth that people accumulate). Thus, the role of self-control seems to be stable across different saving decision contexts.

Saving and Motivational Systems

Out of many possible motives to save (or invest), we highlight two: people do that out of greed (to consume goods – or engage in experiences- that would be otherwise unavailable) or out of fear (to protect themselves against the necessity of consumption reduction when times of financial hardship arrives. In other words, saving may be stimulated by various motives.

In his self-regulation theory, Higgins distinguished two separate systems of motivation: promotion and prevention (Higgins, 1997, 1998). Promotion-oriented people are focused on achievements, aspirations, challenges, and growth. Prevention-oriented people focus on fulfilling their safety needs and achieving security and are concerned about commitments, duties, and avoiding negative outcomes. Here, importantly, Sekścińska, Maison, and Trzcińska (2016) have shown that higher levels of both promotion and prevention motivation may support a preference for postponing consumption. However, people with different regulatory foci (i.e., promotion vs. prevention) tend to make different financial choices: inducing promotion-oriented motivation results in a higher propensity to invest and a lower propensity to save (i.e., accumulate liquid savings), while inducing prevention-oriented motivation results in precisely the opposite effects. These results show that promotion-oriented motivation is related to meeting one's growth needs and the realization of promotion goals (investing), while prevention-oriented motivation is related to meeting one's safety needs and the realization of prevention goals (secure saving). Such findings are in line with those of Cho, Loibl, and Geistfeld (2014) who found promotion-oriented people to be less willing to save for prevention goals (saving for emergencies to avoid the negative financial consequences of unexpected life events), while prevention-oriented people were found to be more willing to save for such goals.

From the above it can be concluded that both a promotion and a prevention regulatory focus may be positively related to postponing consumption. However, pursuing the goal of saving may depend not only on strength of regulatory focus but also on the congruency between a reason for saving and an individual saver's motivational orientation. Higgins (2009) termed the extent of this congruency regulatory fit.

The studies reported in this part of the chapter suggest that individual dispositions are important factors in explaining people's tendencies to save and to invest money. However, the role of each trait reviewed may vary both with the context in which financial decisions are made (e.g., a person's time horizon for saving) and with particular aspects of decisions (e.g., saving strategy, motive for saving, etc.). Thus, as has been proposed (Figner & Weber, 2011) in interactional models of risk taking, to fully understand people's saving and investing behaviors, it is necessary to take into account interactions between individual factors and decision contexts.

Investing

When people decide not to spend all their money on immediate consumption or paying off their debts in favor of saving, they must choose how to allocate money among different forms of saving. They need to consider various instruments that differ in both rate of return and level of risk of losing their capital. As people differ in how they make financial decisions, their individual dispositions may be related to variables such as risk preference and risk perception. The following part of the chapter presents a review of selected individual difference factors that impact on the propensity to take financial risks and affect people's investment strategy preferences.

Investing and Personality: The Big Five Model

Extraversion generally encourages risk taking, mostly through lowering risk perception (Markiewicz et al., 2019). Consistent with this, Gambetti and Giusberti (2019) showed the perception of risks related to different forms of financial assets to be negatively predicted by extraversion. Given such findings, results of Brown and Taylor (2014) seem surprising since they found that holding stocks and shares (one of the riskiest forms of financial assets in terms of rate of return) by households comprised of couples was inversely associated with couples' mean extraversion. However, this result may have been biased by discrepancies in levels of extraversion between couple members and by the possible dominance of one member of a couple in making financial decisions. This result therefore needs further investigation.

Looking at studies of extraversion in another financial context, findings concerning the role of this personality dimension in explaining trading frequency on the stock market are inconsistent. Durand, Newby, and Sanghani's (2008) study of Australian investors investing in Australian equities found a negative extraversion–trading frequency relationship, which is explainable in terms of a natural tendency of extraverts to require a higher bid-ask spread and, therefore, to be less willing to trade frequently. On the other hand, research by Tauni, Fang, and Iqbal (2017) conducted on Chinese investors investing on the Chinese stock market showed extraversion to be positively associated with trading frequency. These authors explained this by referring to prior studies showing that sociable individuals trade more (Barber & Odean, 2001; Pompian & Longo, 2004). Lastly, in what appears to be the only study analyzing the connection between extraversion and trading frequency on the exchange market, using an interactive-simulated foreign exchange market, Durand, Newby, Tant, and Trepongkaruna (2013) showed that more extraverted Australians were inclined to trade more frequently than those with lower levels of extraversion.

People characterized by high *openness to experience* typically have higher risk preferences. This probably occurs for two reasons: (a) their greater focus on benefits and (b) the fact that they identify more benefits in potential risky actions compared to people characterized by low openness (Markiewicz et al., 2019). It is, then, unsurprising that openness to experience is positively correlated with both accepting a greater level of risk in making investment decisions (De Bortoli, da Costa Jr, Goulart, & Campara, 2019) and the likelihood of holding stocks and shares (the riskiest form of financial assets; (Brown & Taylor, 2014). Moreover, it has been found that long-term investors are usually highly open to experience (Mayfield et al., 2008), this corresponding with other results showing that investors characterized by high openness perform better in the long run than in the short run (Chen et al., 2019). Such findings are also in line with evidence showing that successful professional traders with high levels of risk acceptance tend to be open to new experiences (Fenton-O'Creevy, Nicholson, Soane, & Willman, 2005). Finally, in terms of trading, Tauni et al. (2017) observed a negative trading frequency–openness relationship, this being said to be consistent with the view that open-minded individuals trade less because of their skepticism.

Conscientiousness is negatively related to risk taking in general and financial risk taking in particular. This has been explained by conscientious people (a) perceiving more risk in uncertain actions and (b) assigning heavier decision weights to perceived risk (extra units of perceived risk have been shown to discourage conscientious individuals from taking risky actions more strongly than other decision-makers; Markiewicz et al., 2019). Although the role of conscientiousness in explaining people's risky financial decisions has not been studied extensively, it has been documented that (as also mentioned with respect to agreeableness and [low] neuroticism below) investors with greater conscientiousness perform better over the long run than the short run and that they trade more frequently than those with lower levels of conscientiousness (Chen et al., 2019; Durand, Newby, Peggs, & Siekierka, 2013).

Turning to *agreeableness*, decision-makers scoring highly on this personality dimension tend to avoid risk taking in general, mainly because they perceive risks as high (Markiewicz et al., 2019). Not surprisingly then, the agreeableness dimension also appears to be implicated in people's investment choices, with agreeableness being inversely associated with the likelihood of taking investment risks (Bucciol & Zarri, 2017), especially when the propensity to invest in shares is considered (Brown & Taylor, 2014). Investing performance also seems to be related to the extent of a person's agreeableness, (again) investors high in agreeableness performing better over the long term than over the short term (Chen et al., 2019) and trading more frequently than those lower in this personality trait (Durand, Newby, Tant, & Trepongkaruna, 2013).

Finally, *neuroticism* appears to be linked to the general performance of investors but not to the type of financial assets they hold. Yet, again there is a time dimension here, the long-term performance of people scoring highly on neuroticism being worse than their short-term performance (Chen et al., 2019). Additionally, successful professional traders, who have high levels of risk acceptance, tend to be emotionally stable (i.e., low in neuroticism; Fenton-O'Creevy et al., 2005). Also, Durand et al. (2008) and Tauni et al. (2017) both found that neuroticism and trading frequency exhibited a positive relationship, this being attributed to more neurotic investors trading more frequently in the hope of reducing negative feelings.

Overall, the above studies can be said to show that the Big Five personality traits are important in explaining people's investment risk taking, both in terms of preferred investment strategies and achieving investment success. However, the role of neuroticism appears to be less meaningful than that of the other traits. Taking into account the results reviewed earlier in the chapter, emotional stability (low neuroticism) appears instrumental in decisions as to whether people spend or save money and in whether or not saving plans are persevered with, but it seems to be of little importance in influencing *how* people invest their money. On the other hand, agreeableness seems to be more important in explaining peoples' risky investment choices than in explaining any tendency to postpone consumption and to save or invest their money instead. In ending, it is worth emphasizing that extraversion, openness to experience, and conscientiousness seem to be the most highly implicated of the Big Five factors in explaining people's investment behaviors, both at the level of decisions as to whether to save/invest money or to consume immediately and at the level of decisions as to what to do with savings.

Investing and the Dark Triad of Personality

In this section, we consider how the so-called "dark" traits of personality ("dark triad") can be invoked to explain risky financial choices. The dark triad concept, originally introduced by Paulhus and Williams (2002), is based on three personality traits: psychopathy, Machiavellianism, and narcissism. Psychopathy is a personality construct associated with interpersonal and affective deficits, including callousness, impulsive thrill-seeking, and disruptive interpersonal behavior (Jones & Paulhus, 2011). Narcissism is characterized by grandiosity, egocentrism, and a sense of personal entitlement (Jones & Paulhus, 2011). Last, Machiavellianism is associated with manipulativeness, callous affect, and a strategic-calculating orientation (Jones & Paulhus, 2014). A considerable amount of research has been conducted to examine relationships between the dark triad dimensions and risk-taking behaviors in general, and in the area of finance specifically. In the following part of this section, we review results related not only to investing but also to gambling which is sometimes shown (mainly on the psychological level) as an analogy to speculative stock-market trading oriented on short-term profits (Arthur, Williams, & Delfabbro, 2016).[1]

The greater one's *narcissism*, the more prone one is likely to be taking general financial risks, including investment and gambling risks (Sekścińska & Rudzinska-Wojciechowska, 2020). With regard to investment risks, compared to people low in narcissism, narcissists are more willing to invest in riskier stocks and to create hypothetical investment portfolios which include both stocks (rather than other

[1] For a more detailed analysis of the psychological aspects of gambling, see Chap. 10 in this book.

types of financial instruments which are less risky in terms of rate of return) and highly volatile assets (Foster, Reidy, Misra, & Goff, 2011; Sekścińska & Rudzinska-Wojciechowska, 2020). This link between narcissism and the employment of aggressive investment strategies (e.g., investing in volatile stocks rather than stable bonds) has been shown to be mediated by both a strong approach motivation and a weak avoidance motivation (Foster, Misra, & Reidy, 2009).

Studies investigating the psychological functions of narcissism in gambling behaviors have demonstrated that the trait is related to greater self-reported gambling frequency, predicts amounts of money spent while gambling, and is associated with a greater reported degree of gambling-related pathology symptoms among frequent players (Lakey, Rose, Campbell, & Goodie, 2008). Furthermore, narcissists display a greater willingness to bet than non-narcissists (Campbell, Goodie, & Foster, 2004), especially in blackjack games (Crysel, Crosier, & Webster, 2013). Also, interestingly, when people are given the opportunity to choose between a certain loss or a certain gain and a lottery, those preferring to gamble tend to be more narcissistic than those deciding to stick with a sure option (Sekścińska & Rudzinska-Wojciechowska, 2020).

Moving on, *psychopathy* seems to be the most important dark triad trait in explaining people's general propensity to take financial risks. People scoring high on psychopathy display risky financial behaviors more often than those scoring lower on this dimension (Sekścińska & Rudzinska-Wojciechowska, 2020). Moreover, it seems that psychopathy encourages risky investment choices: the higher the level of psychopathy, the larger the proportion of stocks there are in a person's investment portfolio (Sekścińska & Rudzinska-Wojciechowska, 2020). However, when investment decisions are considered, narcissism is a better predictor of risk taking than psychopathy (Foster et al., 2009, 2011; Sekścińska & Rudzinska-Wojciechowska, 2020).

Previous studies on gambling behaviors have also shown that psychopathy positively predicts pathological gambling behavior (Onyedire et al., 2019; Trombly & Zeigler-Hill, 2017). It has also been found that when making decisions under loss framing, where people can choose to either (1) accept a certain loss or (2) gamble in order to avoid a certain loss but risk losing much more, those choosing to gamble are more psychopathic than those deciding to accept a sure loss (Sekścińska & Rudzinska-Wojciechowska, 2020).

Machiavellianism does not seem to be as important as the two other dark triad dimensions in explaining people's risky financial choices (Sekścińska & Rudzinska-Wojciechowska, 2020), observing no significant connection between level of Machiavellianism and propensity to take risky investment choices. Also, with respect to gambling, while the study of Trombly and Zeigler-Hill (2017) found Machiavellianism to be correlated with pathological gambling, this relationship became nonsignificant when the other two dark triad traits were controlled.

The abovementioned studies show that of the three dark triad traits, only narcissism and psychopathy are of great importance for understanding people's risky investing choices, with narcissism being the most important. Although these traits are important in understanding how people invest their money (e.g., the types of investment instruments they prefer to possess in their investment portfolios), questions about relationships between the dark triad traits and people's decisions as to whether to spend money immediately or to save/invest it remain to be answered by further studies.

Investing and Time Perspectives

Earlier in the chapter, we discussed time perspectives (TPs) as predictors of people's propensities to save or invest. Here we consider the function of TPs in explaining people's risky financial choices. Two dimensions of the time perspective construct seem to be critical in explaining such choices: the future and present hedonistic perspectives.

Experimental studies using both single- and multiple-choice tasks show that *future-oriented* people like to invest, but in a relatively safe way: they prefer less risky investment options (e.g., bonds) over more risky and potentially more profitable options (e.g., stocks; Sekścińska et al., 2018). However, the studies of Jochemczyk, Pietrzak, Buczkowski, Stolarski, and Markiewicz (2017) identified negative correlations between future TP scores and risk-taking propensity in numerous domains (including the gambling domain), but the propensity to take risks in the investment domain was an exception. This inconsistency in results across studies may originate from the use of different measurement methods. Thus, in the Sekścińska et al. (2018) study, participants were asked to divide a total of PLN 10,000 ($2700 USD) between bonds, balanced mutual funds (investing 50% in stocks and 50% in bonds), and stocks to create an investment portfolio. They could allocate between PLN 0 and PLN 10,000 to each of these financial instruments. However, in the Jochemczyk et al. (2017) research, participants responded to the investment risk subscale of the DOSPERT scale (Blais & Weber, 2006), which contains three questions related to investing in stocks. Given that these different methods gave inconsistent results, caution is needed in drawing conclusions about any role that a future TP may have in explaining people's investment decisions.

The *present hedonistic* perspective is another TP that influences investment decisions. People with a higher present hedonistic TP tend to build riskier investment portfolios, preferring risky investment options (e.g., stocks) over less risky ones (e.g., bonds; Sekścińska et al., 2018). In the study conducted by Jochemczyk et al. (2017), present hedonistic TP scores were positively correlated with the propensity to take risks regardless of risk domain (which included, inter alia, financial investing and gambling domains). This study also indicated that a present hedonistic TP can explain risk preferences over and above all the Big Five personality traits.

We conclude that time perspectives seem to be important across different aspects of financial decisions, both in terms of people's decisions concerning whether they should spend or save their money and when they decide what to do with their savings. However, to correctly understand the role of TP, it is necessary to distinguish between propensity to invest and risk taking when investing. Focusing on the future is related to a greater propensity to invest money, but at the same time, it is negatively related to preferred level of investment risk. It may be concluded that future-oriented people want to invest, but only in relatively safe financial instruments. People focusing on the present prefer immediate consumption over investing money; however, when they invest, they choose risky financial assets. It seems reasonable to suggest that, in addition to propensity to take risks when investing, other contextual variables should also be taken into account when analyzing the role of TPs.

Investing and Motivational Systems

Zhou and Pham (2004) postulated in their work that investors identify and categorize financial instruments using separate mental accounts in which the instruments are seen as being representative of either promotion or prevention. This assumption is related to the self-regulation theory of Higgins (1997, 1998)) introduced earlier in the chapter.

A promotion motivation is positively related to investing in stocks, while a prevention motivation stimulates investing in balanced mutual funds and individual retirement accounts (IRA; Sekścińska et al., 2016; Zhou & Pham, 2004). In line with such observations, Florack and Hartmann (2007) showed that prevention-motivated people tend to invest in financial instruments characterized by minimal risk and small returns because such instruments are perceived as relatively safe. The two motivational orientations may also interact, empirical evidence showing that people low in promotion orientation build risky investment portfolios only if they have a low prevention orientation too (Sekścińska et al., 2016).

With respect to gambling behaviors, a higher level of chronic promotion motivation supports risk-seeking behaviors (Sekścińska et al., 2016). Furthermore, Scholer, Zou, Fujita, Stroessner, and Higgins (2010) found that individuals whose prevention motivation dominated were risk-seeking in the context of loss framing when the risky option was the only way to return to the status quo. However, if a sure option was available, prevention motivation predicted risk aversion.

Both promotion and prevention regulatory foci are positively related to a general propensity to save, but the role of each regulatory focus is different when it comes to decisions as to what to do with the savings. A promotion focus is positively related to a preference to invest rather than save money and is positively related to risk taking in making the investments, while a prevention focus often denotes a preference for saving instead of investing money and promotes safe investment choices. Thus, to correctly understand how regulatory focus can explain people's financial behaviors, it is important to analyze the specifics of financial choices; otherwise incorrect conclusions may be reached.

Summarizing the results of studies recounted up to this point in the chapter, people's saving and investing behaviors are related to their individual dispositions. Any particular individual disposition may be related to a given behavior at a higher level of generality (e.g., to a general propensity to invest), but at a more detailed level (e.g., the propensity to invest in a particular investment instrument), this individual disposition may not be related to the behavior at all or may remain important but in a manner which is either consistent or inconsistent with the behavior occurring at the more general level. For example, emotional stability, a future time perspective, and openness to experience are positively related to the general propensity to invest money. However, when it comes to the decision regarding which financial instruments one would like to allocate one's money to, emotional stability appears to be of little importance, while openness to experience seems to remain relevant (with greater openness predicting greater investment in more risky investment portfolios), and future time perspective is also still important, displaying a negative relationship with the riskiness of the assets chosen. Therefore, to fully understand the role of individual traits, researchers should independently analyze the role of individual dispositions in explaining saving and investment behavior at various levels of detail, taking into account different decision contexts. This suggests that the interactional model of risk taking (Figner & Weber, 2011) should provide a fruitful framework in analyzing how individual dispositions explain people's investment decisions.

Borrowing

Psychological Dispositions and Borrowing

The overall extent of people's financial obligations has been continuously growing in recent years; therefore, research has sought to identify factors predicting borrowing (see also Chap. 12 in this book). While Dessart and Kuylen (1986) found that institutional factors are the most highly implicated with regard to financial obligations, both socioeconomic and psychological factors (e.g., individual dispositions) are also of significance. With respect to the latter, different aspects of borrowing may be partially explained by psychological variables. In this section, we will focus on five of these aspects: (1) decisions as to whether to take out a loan or credit agreement; (2) decisions concerning the level of financial obligation to be entered into; (3) preferences for different types of loan or credit; (4) the strategies used to repay credit; and (5) the ability to pay liabilities on time.

Borrowing and Personality: The Big Five Model

Research shows that all of the Big Five personality dimensions are important in explaining people's debt-related behaviors. However, particular personality traits have different associations with various types of debt, attitudes towards borrowing, borrowing needs, and behaviors while repaying credit.

Extraversion is associated with a positive attitude towards indebtedness (Pacheco, Campara, & da Costa Jr, 2018), while introverts generally have neutral attitudes towards borrowing (Yazdanparast & Alhenawi, 2017). Extraverts' attitudes are reflected in their propensity to use debt: the higher the extraversion score, the higher the propensity to use debt (Harrison & Chudry, 2011). Examining this relationship more closely, Davey and George (2011) observed that extraverts are nearly twice as likely to have some form of debt than introverts. Moreover, extraversion not only predicts the mere fact that a person will have debts, but it is also positively predictive of the magnitude of the debt held, Brown and Taylor (2014) showing that extraversion was the best predictor of all the Big Five personality traits in this regard.

Harrison and Chudry (2011) studied a group of UK undergraduate students, asking them about current and future borrowing from different sources. They found that extraverted people were more likely to have used an overdraft facility and to have borrowed money from family members. Also, while extraversion was a significant predictor of the intention to use overdrafts in the future, there was no significant relationship between extraversion and the propensity to use student loans and credit cards. However, other studies have shown that individuals scoring high on introversion exhibit stronger intentions to use credit cards, despite having neutral attitudes towards borrowing (Yazdanparast & Alhenawi, 2017). Although no studies examining extraversion's connection with taking out housing loans currently appear to exist, empirical findings have shown that extraverts prefer housing loans with adjustable rates over fixed rates (Gambetti & Giusberti, 2017).

Extraversion also influences people's debt repayment behaviors. Davey and George (2011) observed that, compared to those scoring high in extraversion, people scoring low in extraversion were much more likely to pay off an outstanding balance on their credit card before being charged. It was also rarer for the former people to pay their balance off in the required time. Perhaps not surprisingly then, a study of 22–45-year-olds by Zainol, Daud, Nizam, Rashid, and Alias (2016) has shown extraversion to be related to debt repayment problems.

In addition to their observations on extraversion, Davey and George (2011) also found *openness to experience* to be associated with higher intentions to borrow, a relationship which is also reflected in higher levels of openness among debtors than non-debtors (Brown & Taylor, 2014). While there seems to be no work on the extent to which openness to experience can explain people's borrowing behaviors in relation to high consequence debts (e.g., mortgages), Brown and Taylor (2014) also observed that openness was highly positively correlated with the probability of having credit card debt (a low consequence debt). This relationship suggests that openness to experience promotes credit card debt.

Openness to experience also seems to be important in determining people's debt repayment strategies, Gagarina and Goroshnikova (2018) linking a higher level of openness with three strategies: (a) a semi-rational strategy (directed towards reducing the total amount of debt); (b) an aversive strategy (aimed at reducing the number of debts, but not the total amount of debt); and (c) a distributive strategy (dividing repayments between all or several debts simultaneously, without closing any of them completely). These authors also found people who tend to use a chaotic strategy (one that is burdened with mathematical and logical errors, e.g., involving the mistake of not repaying the entire loan installment or repaying a greater amount of money than the sum of the loan) to be less open than those not employing such a strategy.

Conscientiousness is strongly and negatively related to borrowing, conscientious people showing negative attitudes towards indebtedness (Pacheco et al., 2018; Yazdanparast & Alhenawi, 2017). People who do not hold unsecured debts are more conscientious than those with financial obligations, irrespective of the type of debt held (Brown & Taylor, 2014; Donnelly, Iyer, & Howell, 2012; Nyhus & Webley, 2001). Moreover, conscientiousness is inversely associated with level of unsecured debt (Brown & Taylor, 2014). Such a relationship may be explained by conscientious people's ability to manage their money with greater levels of financial self-control (Donnelly et al., 2012).

The role of conscientiousness seems to be highly important when decisions related to credit card and overdraft usage are considered. Conscientiousness is inversely related to the probability of having these types of debt (Brown & Taylor, 2014). As far as methods of repaying debts are concerned, conscientious people prefer fixed-rate over adjustable-rate mortgage loans and shorter mortgage loan durations over longer ones (Ben-Shahar & Golan, 2014). Moreover, it has been shown that more conscientious people experience fewer difficulties in repaying high consequence debts (e.g., mortgages), most likely because they are self-disciplined, organized, and deliberate (Roberts, Jackson, Fayard, Edmonds, & Meints, 2009). Surprisingly, however, Roberts et al. (2009) identified no relationship between level of conscientiousness and difficulty in repaying low consequence debts (e.g., credit card debts).

Although people with higher levels of *agreeableness* show more negative attitudes towards borrowing (Yazdanparast & Alhenawi, 2017), debtors have a higher level of agreeableness than non-debtors for all categories of debt (Ben-Shahar & Golan, 2014; Brown & Taylor, 2014). But despite their negative attitudes towards borrowing, agreeable people tend to have a high need to borrow and, as a consequence, borrow more than less agreeable individuals (Daly, Delaney, & McManus, 2010; Nyhus & Webley, 2001). This is especially true with respect to mortgage loans (Yazdanparast & Alhenawi, 2017).

As mentioned previously, people use different strategies for paying off their debts, and agreeableness seems to promote an aversive strategy focusing on reducing the number of debts instead of reducing the total amount of debt (Gagarina & Goroshnikova, 2018).

Turning to the last of the Big Five personality factors, despite the fact that *neuroticism* is associated with overspending (Mansfield, Pinto, & Parente, 2003), impulsive spending (Baumeister & Exline, 2000), and poor financial management (Brandstätter, 1996), more neurotic individuals do not exhibit favorable attitudes towards borrowing: rather, their attitude seems to be neutral (Yazdanparast & Alhenawi, 2017). Emotional instability's (i.e., neuroticism's) part in explaining indebtedness is unclear. Some studies have shown that neuroticism is a positive predictor of using debt (Ben-Shahar & Golan, 2014; Nyhus & Webley, 2001), but other studies are unsupportive of this (Ganzach & Amar, 2017). What seems to be clearer is that neuroticism is related to choosing one particular type of debt, this trait being positively linked to the probability of holding hire purchase debt[2] and an overdraft (Brown & Taylor, 2014). Further, neuroticism negatively correlates with the willingness to take out debt with a high loan-to-value ratio (the ratio of the size of a loan to the value of a purchased asset; Ben-Shahar & Golan, 2014).

The fact that more neurotic people lack self-control and tend to make impulsive decisions (Andrews, Stewart, Morris-Yates, Holt, & Henderson, 1990) could explain why higher neuroticism is associated with difficulties in repaying high consequence debts (e.g., mortgage debts) among mature adults (Ganzach & Amar, 2017) and low consequence debt problems among young people (Zainol et al., 2016).

To conclude this section, of all the Big Five traits, extraversion seems to be the most important factor to take into account when analyzing people's borrowing behavior: it is positively related to taking on debt, total amount of debt accumulated, and having debt problems. To date, studies of extraversion only seem to have involved unsecured debts (e.g., credit cards), and therefore the aforementioned observations may not generalize to other types of debts such as mortgages since the contexts surrounding the taking out of secured and unsecured loans are very different. Conscientiousness is the Big Five factor exhibiting inverse relationships with taking on debt, total amount of debt, and having debt problems. Importantly, the role of this aspect of personality is stable and consistent across the different contexts in which debt is taken on, held, and repaid. Agreeableness and neuroticism are less consistent as predictors of different aspects of borrowing behaviors. Highly agreeable people tend to have strong negative attitudes towards borrowing, but at the same time, they have a high need to borrow and borrow more than less agreeable individuals. While attitudes towards borrowing of people characterized by high neuroticism tend to be neutral, neuroticism is positively related to the probability of taking out hire purchase debt and overdrafts, although it is not related to the likelihood of taking on other types of debt. These conclusions concerning agreeableness and neuroticism suggest that different aspects of borrowing (e.g., type of debt and attitudes towards debt) need to be considered if we are to correctly understand the function of personality traits in explaining borrowing behaviors.

Borrowing and Self-Control

As we have already pointed out earlier in this chapter, *self-control* is the ability to control one's impulses, emotions, and behaviors to achieve long-term goals, while *impulsivity* denotes a tendency to take actions spontaneously and a lack of sensitiv-

[2] This type of debt is typically used to spread the cost of purchasing goods such as cars and consumer durables over a specified time period. It allows people to pay for high value goods, but the borrower does not become the owner of the goods until they have made the final payment under the agreement with the lender.

ity to the long-term consequences of one's present behaviors. In the realm of consumption-related activities, impulsivity is not simply about making unplanned purchases because it involves experiential desires (Mette, de Matos, Rohden, & Ponchio, 2019). Self-control and impulsiveness are related to spontaneous buying and even compulsive buying, although in the opposite directions. Impulsiveness promotes immediate buying, while self-control supports the postponement of purchases. Because over-consumption can result in indebtedness, self-control and impulsiveness should play significant parts in explaining people's debt-related behaviors.

Credit users are less likely to exert behavioral self-control than non-users (Nyhus & Webley, 2001). Also, consumers with high self-control are less likely to get into debt and remain in it (Kamleitner, Hoelzl, & Kirchler, 2012; Nyhus & Webley, 2001), and they have lower levels of debt than those with low self-control (Achtziger et al., 2015). Therefore it is not surprising that people who exhibit low self-control are more likely to run into debt problems and experience over-indebtedness (Achtziger et al., 2015; Anderloni, Bacchiocchi, & Vandone, 2012; Gathergood, 2012).

Impulsivity promotes decisions to take on debt, even after controlling for sociodemographic variables such as work status, net wealth, and having children (Ottaviani & Vandone, 2011). Impulsivity also predicts people's number of financial obligations, and people with higher impulsivity levels are more prone to having debt and a higher total debt balance than those characterized by lower impulsivity (Henegar et al., 2013; Limerick & Peltier, 2014; Ottaviani & Vandone, 2011; Pirog & Roberts, 2007). Having said all this, impulsivity seems to be related to specific facets of indebtedness in different ways. Impulsive users of credit cards tend to buy more on credit than those with low levels of impulsiveness (Brougham, Jacobs-Lawson, Hershey, & Trujillo, 2011; Mette et al., 2019). But, while, in line with these findings, Ottaviani and Vandone (2011) found that impulsiveness promoted taking out consumer credit, they did not identify relationships between impulsiveness and the taking out of mortgages or other housing-related loans. Thus, although impulsivity seems to be important in explaining people's behaviors with respect to unsecured debt, this is not true for secured debt. One possible explanation for this is that secured debts (e.g., mortgages) are debts with high and long-term consequences, and they therefore entail large financial and psychological risks. So, it may be that the fear of losing one's home is strong enough to balance or outweigh the influence of impulsiveness.

Impulsivity is also positively related to problematic credit use: it is a significant predictor of debt burden and credit card misuse (Limerick & Peltier, 2014; Ottaviani & Vandone, 2018; Pirog & Roberts, 2007), and in Ottaviani and Vandone's (2018) work, it mediated the financial literacy–debt burden relationship. Given such findings, it should come as no surprise that a meta-analysis of 16 studies (involving a total of 10,569 participants) conducted by Frigerio, Ottaviani, and Vandone (2018) confirmed impulsivity's positive relationships with both having debts and over-indebtedness, the effect of impulsivity being stronger for over-indebtedness (a large effect) than for debt (a medium effect).

Overall then, self-control promotes healthy borrowing behaviors (avoiding the taking out of unnecessary credit, maintaining only a low level of debt, and avoiding problems with credit use), while lack of self-control (e.g., impulsiveness) is related to problematic debt use. Self-control's role in explaining people's borrowing behaviors is prominent and consistent both at the general level of borrowing propensity and when different aspects of credit use (e.g., level of debt) and its consequences (e.g., problematic credit use) are considered. Thus, self-control seems to be central to understanding people's borrowing behaviors. However, it should be noted that all the abovementioned relationships concern unsecured debts (e.g., credit cards) but not secured debts (e.g., mortgages), and therefore future research should analyze relationships between self-control (and lack of self-control) and borrowing behaviors across different borrowing decision contexts such as differing types of debt.

Borrowing and Locus of Control

The locus of control (LOC) construct describes people's beliefs pertaining to their potential influence on the environment (Rotter, 1966). People with an internal LOC believe in their own competences and abilities and believe that they have a substantial influence over the events that happen to them. On the other hand, people with an external LOC marginalize the influence that they can have on the things that happen to them, believing that external forces determine the events in their lives (Kelley & Stack, 2000).

An external LOC promotes both positive attitudes towards the use of credit cards (Davies & Lea, 1995) and the use of credit cards to avoid thinking about how much money one is spending on consumption (Davey & George, 2011). As might be expected from these observations, an external LOC is also positively related to the level of debt people accumulate, as reflected in the total amount they owe, their credit card balance, and the number of maxed out credit cards they have (Donnelly et al., 2012; Livingstone & Lunt, 1992; Tokunaga, 1993). Such observations might lead one to suspect that people with an external LOC might be prone to over-indebtedness, and, indeed, work by Tokunaga (1993) supports such a suspicion, this author reporting that people who experience serious problems using credit cards display greater externality than successful credit card users.

While the above studies all concentrated on externality, a final finding concerning unsecured credit use that deserves mention is one showing that an internal LOC is positively correlated with revolving credit use[3] (Wang, Lu, & Malhotra, 2011). When it comes to financial decisions connected with buying a house, findings relating to LOC differ somewhat from those involving the use of unsecured credit above. Here, the work of Wang, Chen, and Wang (2008) indicated that, compared to mort-

[3] A line of credit where the customer is allowed to use borrowed funds when needed. Revolving credit does not have a fixed number of payments in contrast to installment credit.

gagors with an internal LOC, mortgagors with an external LOC chose lower-value homes so as to have smaller financial obligations. The ratio of their mortgage loan amount to their total home value was also lower, and they took out loans for a shorter term. Furthermore, people who had already bought their own house without a loan and those who planned to buy a house without applying for credit were more external than those already having a mortgage loans and those planning to obtain a mortgage.

From the studies reviewed above, it can be concluded that locus of control plays a significant part in explaining people's debt-related behaviors, but findings seem to be dependent upon the type of debt involved. Therefore, to understand the extent to which externality and internality of LOC influence the borrowing of money and people's repayments of their debt obligations, it is important for future analyses to be conducted separately for each type of debt.

This part of the chapter has reviewed the current state of knowledge about the role of the Big Five personality traits, self-control, and locus of control in explaining borrowing behaviors, and, before moving on, at this point it is appropriate to summarize a few important issues. Thus, individual characteristics are important in understanding borrowing behaviors at two points in time: (1) when a decision about taking out a loan and what the value of the loan should be is made and (2) during the period of the loan's repayment. And it should not be assumed that the characteristics of people that are relevant at one stage will also be relevant at the other stage. It should also be borne in mind that any particular characteristic does not have to be consistently related to different aspects within the same stage of borrowing. For example, a high level of agreeableness is negatively related to attitudes towards borrowing but positively related to taking a loan and the value of the debt, and an external LOC is positively related to people's levels of unsecured debts but negatively related to people's levels of secure debts. Of course, the influence of some individual dispositions (e.g., self-control) in explaining borrowing behaviors seems to be stable and consistent across both stages and different aspects of borrowing behavior, but these dispositions are in a minority. So, to fully understand how individual dispositions can explain borrowing behaviors, it is necessary to implement models such as interactional model of risk taking (Figner & Weber, 2011) that we introduced at the beginning of this chapter and analyze interplays between individual and contextual factors, considering such factors' joint influence on people's behavior.

Financial Cheating

Psychological Dispositions and Financial Cheating

People sometimes face a choice between two options when making financial decisions: being honest and gaining less (or losing more) or being dishonest and gaining more (or losing less). While the first option is usually safe, involving no risks, the second option usually brings some uncertainty.

Individual differences influence decision-makers' willingness to cheat. The initial viewpoint on wrongdoing, as presented by Becker (1968), assumed that people compare the utilities of behaving correctly and behaving incorrectly, choosing the course of action that offers the greatest utility. However, such a view can be considered too simplistic from a descriptive point of view: even if decision parameters (payoffs and probabilities) are objective, they may be perceived as subjectively different by different decision-makers, this contributing to heterogeneity in cheating propensity (Markiewicz et al., 2019; Weber et al., 2002). Additionally, Becker's model gives no place to individual differences in moral identity. Mazar, Amir, and Ariely (2008) suggested an extension to Becker's model, claiming that people trade off possible monetary gains with losses in self-esteem when deciding whether to cheat. This provides extra latitude for interindividual variability in people's approaches to lying because different people may attach different weights to moral aspects of situations (Markiewicz, Malawski, & Tyszka, under review). As noted by Kajackaite and Gneezy (2017, p. 433): "Some people may be unwilling to tell a lie, regardless of their benefit from it ('ethical type')." And as they note further:

> People who are not willing to lie could be described in our approach as having an infinite cost of lying. Other people may have a finite positive intrinsic cost of lying. These people will lie when the benefit of lying is higher than the associated cost ("finite positive cost type"); at the extreme are people with a zero cost of lying ("economic type").

In support of such reasoning, Hilbig and Thielmann (2017) showed that different clusters of people were unequally sensitive to incentive size when deciding whether or not to lie. While "corruptible individuals" easily violate norms when this pays off, "small sinners" do this only up to a certain point, and "honest individuals" do not cheat at all, regardless of the magnitude of a monetary incentive. Having said this, we do not diminish the role of situational dispositions in cheating—as gain/loss framing (Markiewicz & Czupryna, 2019; Markiewicz & Gawryluk, 2019) or being exposed to money (Markiewicz & Trzcińska, under review). Rather, we suggest that individual dispositions can augment explanations of cheating that are possible by only considering situational factors, mostly by way of interactions: some situational factors matter more for some types of decision-makers than for others (Jones & Paulhus, 2017; Kleinlogel, Dietz, & Antonakis, 2018).

People cheat to obtain different, often non-monetary, gains (time, prestige, honor, sexual partners, and pleasant experiences). This part of the chapter focuses on studies investigating decision behaviors where people face a monetary incentive and can respond dishonestly to obtain a larger payoff. Recent studies in behavioral ethics (see the meta-analyses of Abeler, Nosenzo, & Raymond, 2019; Gerlach, Teodorescu, & Hertwig, 2019) have listed incentivized cheating paradigms that meet the above-mentioned criteria. In most cases, a decision-maker (the research participant) is asked to report the result of some random device (usually a die roll or coin toss) in an environment where there is a greater incentive for dishonest reporting than for honest reporting. Such a method permits the investigation of real-life behaviors (decisions being linked to real-life consequences) rather than just reports of behavioral intentions (which are potentially influenced by self-presentation bias). The following sections review studies showing how the personality dimensions in two personality models (the HEXACO and Big Five models) may be used to predict cheating in financial contexts.

Financial Cheating and Personality: The HEXACO Model

The *Honesty–Humility* (HH) dimension of Lee and Ashton's (2004) HEXACO model consists of facets such as sincerity, fairness, modesty, and greed avoidance and should, by definition, be associated with ethical decision making. And, indeed, Hilbig and Zettler's (2015) series of six behavioral experiments (across different cheating paradigms: the dice-rolling paradigm and the coin-toss task) showed that HH is positively linked to honesty. This result was confirmed by Kleinlogel et al. (2018). It has also been shown that people low in HH are less likely to admit committing a moral transgression (e.g., cheating) when directly questioned (Hilbig, Moshagen, & Zettler, 2015).

Heck, Thielmann, Moshagen, and Hilbig (2018) accumulated and re-analyzed data from 16 previous experiments (with combined samples close to 5000 participants) and confirmed that higher levels of HH are associated with less dishonest behavior. They restricted their analysis to studies where the dependent variable was a behavioral binominal decision regarding whether to cheat in an incentivized one-shot cheating paradigm. They concluded that a "medium to large" effect held when controlling for demographic variables (gender and age) and correcting for the fact that some "wins" were true wins. As the effect applied to all facets of HH (sincerity, fairness, modesty, and greed avoidance), the observation that HH is negatively associated with dishonest behavior cannot simply be attributed to the fact that several HH scale items relate directly to cheating.

Financial Cheating and Personality: The Big Five Model

Other studies have investigated the influence of the Big Five personality traits on cheating, but caution is needed when comparing Big Five and HEXACO observations because although some factors with the same names in the two models are highly similar to each other (extraversion, conscientiousness, and openness to experience), others have less resemblance (emotionality and agreeableness).

There is sparse evidence that Big Five *agreeableness* (Hilbig & Zettler, 2015) and Big Five *conscientiousness* are independently predictive of dishonesty (Hilbig & Zettler, 2015; Horn, Nelson, & Brannick, 2004). In Hilbig and Zettler's (2015) study, lower agreeableness predicted cheating when it was the only predictor in a model, but adding the HH factor diminished this effect. Also, Heck et al. (2018) reconfirmed dishonesty's relationship with agreeableness in their accumulated sample (the higher people's agreeableness, the lower the odds of dishonesty), although they failed to show any incremental effect over and above HH.

Financial Cheating and the Dark Triad of Personality

Not surprisingly, all three dark triad traits (*narcissism*, *Machiavellianism*, and *psychopathy*) have been shown to be strongly associated with dishonesty. Jones and Paulhus (2017) found that all three dimensions predicted cheating in a coin-flipping task when there was no risk of being caught, while only psychopathy predicted cheating when detection was possible. Also, Roeser et al. (2016) observed that while Machiavellians displayed a preference for deception in a cheap talk sender-receiver game, psychopathy was linked to impulsive cheating in a matrix task. Similarly, Nathanson, Paulhus, and Williams (2006) have demonstrated the role of psychopathy in scholastic cheating.

Further to the above studies, Moshagen, Hilbig, and Zettler (2018) specified a common core of dark traits, naming this the “Dark Factor of Personality (D)” and defining it as “individual differences in the tendency to maximize one’s individual utility—disregarding, accepting, or malevolently provoking disutility for others—accompanied by beliefs that serve as justifications.” (p. 656). In one of their studies, they predicted decision behavior in an incentivized flip-a-coin task using data from dark triad questionnaire responses. Their results showed that D was the only variable able to explain cheating behavior and that the three dark traits (although correlated with cheating behavior) did not separately predict cheating behavior above and beyond D.

In summary, at a general level, there are clear relationships between dishonesty and the Honesty–Humility (HH) dimension of the HEXACO model and the dark triad traits of narcissism, Machiavellianism, and psychopathy. This said, debate is ongoing as to how much these concepts overlap with each other and the extent to which different traits can explain additional variance in dishonesty over and above others. Some researchers maintain that the dark triad is theoretically and empirically distinguishable from HH (Moshagen et al., 2018). But others question whether the dark triad traits are sufficiently distinct from the HH dimension (Muris, Merckelbach, Otgaar, & Meijer, 2017), and such suspicions can only be reinforced by the recent work of Pfattheicher, Schindler, and Nockur (2019). Using incentivized cheating paradigms (dice rolling and coin tossing), these authors demonstrated a link between HH and cheating behavior and found that HH fully accounted for positive correlations between the dark triad dimensions and cheating. Nevertheless, irrespective of how such factors are conceptualized (e.g., whether as HH or perhaps as Dark Factor of Personality (D); Moshagen et al., 2018), it is clear that a link exists between individual differences in this area and dishonesty.

As with other financial behaviors considered in this chapter, only a few studies of dishonesty have emphasized the interactivity of individual and situational factors. Thus, Kleinlogel et al. (2018) showed that while people high in HH were consistent in not cheating very much across situational primes, those low in HH were sensitive to variations in moral priming, cheating more when exposed to immoral as opposed to moral primes.

Concluding Remarks

This chapter has reviewed the evidence that individual difference factors may have a role in explaining people's financial decisions related to saving, investing, borrowing, gambling, and cheating. Despite the large mass of data considered, the reader may be puzzled as to why different individual difference factors seem to be implicated in explaining behavior relating to similar financial activities. Similarly, the influence of the same factors appears to be different for the same activities researched in different contexts. Thus, there seems to be noise in the overall corpus of data, and this may reflect the relevance of Meehl's crud factor to personality psychology (Meehl, 1990, p. 204), stating that "in the social sciences and arguably in the biological sciences, everything correlates to some extent with everything else." The current literature on financial decision making is also limited by the fact that it largely focuses on either situational or individual differences, rarely focusing on their interaction. In this connection, Bromiley and Curley (1992, p. 111) noted that:

> Numerous studies examine investment decision making, but the studies are difficult to coalesce since they vary considerably across situations and subject populations with no explanatory basis driving the variations. The studies mix professional investment advisors, serious amateur investors, the general population, and students as well as mixing hypothetical securities choice, actual holdings of investors and other investment settings.

Such sentiments, expressed with regard to studies of relationships between risk taking and personality factors, also apply to work describing personality factors' influence on financial decision making. While these words can be interpreted as an expression of powerlessness, they can also be taken as arguing in favor of interactive models combining individual difference and situational factors as joint influences on financial decisions. Thus, personality factors influence financial decisions differently in different contexts, the latter being defined broadly as different types of financial decision, different aspects of decisions, differences in external situations, differences in intrinsic motivation, etc. Such a suggestion also echoes the call of Appelt, Milch, Handgraaf, and Weber (2011, p. 252) to change research practice so that interactions, and not simply main effects, are focused upon; these authors proposed:

> four guidelines for the more productive pursuit of individual differences research within JDM (authors' addition: Judgment and Decision Making): a more systematic approach, a shift toward theoretically relevant measures, a greater emphasis on interactions, and more extensive communication of results.

Decision making researchers already accept that one situational effect can be modified by another situational effect, namely, by the context of a decision. For example, risk taking has traditionally been considered to be an individual disposition that is domain-invariant (e.g., Kahneman & Tversky, 1979), but some studies have demonstrated that the propensity to take risks may be domain-specific (Blais & Weber, 2006; Hanoch, Johnson, & Wilke, 2006; Slovic, 1972; Weber et al., 2002; Zaleskiewicz, 2001) or even specific to a particular behavior within a single domain:

both Weber et al. (2002) and Vlaev, Kusev, Stewart, Aldrovandi, and Chater (2010) have shown that people make different risky financial choices when such choices are alternatively framed as gambling decisions or investment decisions. Similarly, loss framing (Kahneman & Tversky, 1979) does not always promote risk avoidance, as the direction of the effect is probability dependent (Tversky & Kahneman, 1992) and the framing of the payoff (Thaler & Johnson, 1990). Thus, it should not be surprising that some "*whens*" (situational factors) work differently for some "*whos*" (individual difference-related factors).

To conclude, in order to fully and correctly understand the role of individual dispositions in explaining people's financial behavior, further studies should verify how situational and contextual factors modify the influence of individual factors on financial decisions. Future studies should also use both types of theoretically relevant measure as independent variables but also control for other individual difference measures used widely in the field in attempting to discover unique influences of independent variables on dependent variables.

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Chapter 8
Aging and Financial Decision Making

JoNell Strough, Jenna Wilson, and Wändi Bruine de Bruin

Introduction

With age, the complexity and frequency of financial decisions increases as individuals confront decisions about retirement savings, home mortgages, and long-term investments (Hershey, Austin, & Guitierrez, 2015). The ability to recover from bad decisions decreases with age due to physical and cognitive declines and having less time remaining in life (Agarwal, Driscoll, Gabaix, & Laibson 2009). Population increases in life expectancy (Bloom et al., 2015) are such that older adults make consequential decisions for a greater number of years compared to previous cohorts. Current cohorts face new challenges when planning for retirement due to employers shifting from defined benefit to defined contribution plans and to changes in norms about the timing of retirement (Shultz & Wang, 2011). Simultaneously, increases in the number of financial options from which to choose make decisions more difficult (Schwartz, 2004).

To date, research on age differences in decision making indicates that adults 60 years or older perform better, worse, or the same as younger people, depending on the skills involved (Bruine de Bruin, 2017; Strough, Parker, & Bruine de Bruin, 2015). Skills associated with financial decision making that show age-related differences are reviewed in the following sections. We focus on skills emphasized in our conceptual model of life-span decision making (Strough et al., 2015; Strough, Karns & Schlosnagle, 2011). We begin with skills that support cognitive deliberation and reasoning about options and consider how age-related differences in motivation influence the application of these skills. We then discuss how life experience may

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help older adults to compensate for declines in other cognitive skills. Next, we highlight evidence showing that life-span changes in emotion and motivation influence decisions. We conclude with suggestions for interventions to promote effective financial decision making and directions for future research.

Cognitive Deliberation and Age-Related Differences in Financial Decision Making

Early theories of normative decision making viewed cognitive deliberation as essential. Good decisions were seen as those that maximized the likelihood of desired future outcomes after a systematic comparison of all alternatives (Edwards, 1954; Keren & Bruine de Bruin, 2003). Skills or "mechanics" underlying cognitive deliberation include fluid abilities such as executive functioning, processing speed, and working memory (Baltes, Lindenberger & Staudinger, 2006; Salthouse, 2004).

Individuals who are more prone to violating principles of sound decision making also tend to score lower on measures of working memory, executive cognitive function, cognitive reflection, and numeracy (Bruine de Bruin, Parker, & Fischhoff, 2007; Del Missier, Mäntylä, & Bruine de Bruin, 2012; Del Missier et al., 2013, 2017; Finucane & Gullion, 2010; Hess, O'Brien, Growner, & Hafer, 2017; Parker & Fischhoff, 2005; Toplak, West, & Stanovich, 2011; Weller, Levin, Rose, & Bossard, 2012). Perhaps as a result, higher scores on tests of fluid cognitive abilities have been associated with making fewer financial mistakes and having higher credit scores, even after taking into account demographic variables (Agarwal et al., 2009; Eberhardt, Bruine de Bruin, & Strough 2018; Li, et al., 2015). Fluid cognitive abilities and numeracy have also been associated with performance on hypothetical tasks of assessing financial discount rates, inflation rates, and financial outcomes (Bruine de Bruin et al., 2010; Li, Baldassi, Johnson, & Weber, 2013; Peters et al., 2019).

Age-Related Differences in Cognitive Deliberation

Performance on tests of fluid cognition declines with age, with declines starting as early as the mid-twenties on some tasks (e.g., Park et al., 2002; Salthouse, 2012). Older adults whose cognitive ability declined more rapidly over time reported greater susceptibility to financial scams (Boyle et al., 2012) and greater difficulties in managing money (Hsu & Willis, 2013). When decisions required cognitive deliberation, older age was associated with poorer performance (Finucane, Mertz, Slovic, & Schmidt, 2005; Hess, Queen, & Patterson, 2012; Weller, Denberg & Levin, 2011). For instance, older adults were worse than younger adults at applying rules to choose hypothetical financial products, which was explained by their lower scores on standard tests of fluid cognition, including nonverbal reasoning and working memory (Bruine de Bruin, Parker, & Fischhoff, 2012; Del Missier et al., 2013; Del Missier et al., 2017; Finucane & Gullion, 2010; Rosi, Bruine de Bruin, Del Missier, Cavallini & Russo, 2019; Stewart, Yu, Wilson, Bennet, & Boyle, 2018).

Many adults in the United States have difficulty comprehending and using numbers, and older age is associated with lower numeracy (Bruine de Bruin, McNair, Taylor, Summers, & Strough, 2015; Lusardi. 2012; Peters et al., 2006). For some older adults, low numeracy is an indicator of low lifelong abilities, but for others it represents a loss compared to when they were younger (Wood, Liu, Hanoch, & Estevez-Cores, 2015). Although declines in the ability to complete calculations can be offset by using mathematical rules learned with experience (McArdle, Smith, & Willis, 2009), comprehending and applying numeric information depends on basic cognitive abilities that tend to decline with age (Del Missier et al., 2012). Low numeracy has been associated with allowing irrelevant affective factors to influence decisions (Peters et al., 2006). Older adults' lower numeracy was associated with their lesser sensitivity to the expected value of options and difficulties in applying complex decision rules to consumer decisions (Bangma, Fuermaier, Tucha, Tucha, & Koerts, 2017; Chen, Wang, Kirk, Pethtel, & Kiefners, 2014).

Older adults' lower fluid cognition and numeracy contributed to their selecting monetary lotteries with relatively lower expected values in gambles involving losses (Pachur, Mata, & Hertwig, 2017). Increasing the cognitive load of a decision by adding more options decreased older adults' performance relative to that of younger adults, whereas both older and younger adults chose the option with the greater expected value when there were only two options (Frey, Mata, & Hertwig, 2015). Similarly, age differences were accentuated for risky decisions that required learning in a new environment (Mata, Josef, Samanez-Larkin, & Hertwig, 2011).

Older adults appear to compensate for declines in their fluid abilities by structuring decision environments to reduce cognitive demands (Mata et al., 2012; Rydzewska et al., 2018). For example, older age was associated with preferring to make choices from a smaller number of options, eliminating bad options first to narrow down the choice set, and searching less information prior to making a decision (Besedes, Deck, Sarangi, & Shor, 2012; Johnson, 1990; Lui, Wood, & Hanoch, 2015; Mata & Nunes, 2010; Reed, Mikels & Lockenhoff, 2013). Relative to younger adults, older adults reported a greater tendency to satisfice or choose an option that is "good enough" instead of maximizing and searching for the very best option (Bruine de Bruin, Parker, & Strough, 2016). Older adults' satisficing strategy was associated with emotional well-being (Bruine de Bruin, et al., 2016) and had negligible consequences for decision quality (Besedes et al., 2012; Mata & Nunes, 2010; Rydzewska, von Helversen, Kossowska, Magnuski, & Sedek, 2018).

Age-Related Differences in Cognition and Motivation

Effortful thinking (measured by systolic blood pressure on difficult tasks relative to baseline) becomes physiologically more costly with age (Ennis, Hess, & Smith, 2013). Compared to those who are younger, older adults report lesser willingness to "think hard" about difficult tasks, which may undermine their performance on such tasks (Bruine de Bruin et al., 2015). It is theorized that when older adults view tasks as personally relevant, they are more motivated to deploy cognitive resources (Hess, 2014). For example, when searching information that was low in self-relevance, adults 64 and older used a satisficing strategy (requiring less cognitive effort), but used a systematic search strategy (requiring more cognitive effort) when self-relevance was high; self-relevance had less impact on the strategies used by adults 21–41 years (Hess, Queen, & Ennis, 2012). Yet, outcomes of older adults' decisions about their personal finances—a domain that is presumably high in self-relevance—suggest poor decision making. One such example is the increased prevalence of fraud and bankruptcy filings among older adults (Lichtenberg, 2016; Pottow, 2010). Older adults are often the targets of financial exploitation, and declines in cognitive skills increase their vulnerability (Wood & Lichtenberg, 2017).

Experience-Based Knowledge and Age-Related Differences in Financial Decision Making

Repeated practice and experience allows people to bypass cognitive deliberation and instead apply heuristics or "rules of thumb" to make decisions (Gigerenzer, 2008; Reyna, Chick, Corbin, & Hsia, 2014). Heuristics are efficient and often effective, but they can lead to predictable errors, even among experts (Kahneman, 1991; Tversky & Kahneman, 1974). Even so, experts are better than nonexperts at distinguishing relevant from irrelevant information and using tools that foster good decision making within specific domains (Shanteau, 2015).

Expertise comes from experience and training (Ericsson, Prietula, & Cokely, 2007). People with more training in financial principles were better at applying cost-benefit principles to financial decisions, whereas work experience in the financial domain was beneficial when individuals were required to justify their decisions (Larrick, Nisbett, & Morgan, 1993; Fennema & Perkins, 2008). Experience and training can promote financial literacy, or the understanding of financial principles about risk diversification and inflation, as well as numeracy (Lusardi & Mitchell, 2007). Having greater financial literacy is associated with planning for retirement, having higher credit scores, and better debt management (Li et al., 2013; Lusardi & Tufano, 2009, Lusardi & Mitchell, 2014).

Age-Related Differences in Experience-Based Knowledge

Older adults have more life experience than younger adults, due to having lived longer (Baltes et al., 2006). Older age is associated with reporting greater use of one's experience to make decisions (Strough, Parker, & Bruine de Bruin, 2018). In contrast to the age-related declines seen in fluid intelligence, crystallized intelligence, which is often used as a proxy for life experience, improves until around age 60 and then plateaus (Park et al., 2002; Salthouse, 2012). Older adults' crystallized intelligence helped to explain their higher credit scores and greater knowledge of finances and debt relative to younger adults (Li et al., 2013). Older adults' learned word knowledge (semantic memory), which may be a proxy for other learned knowledge, was related to their willingness to discontinue unprofitable investments and avoid the sunk-cost bias (Del Missier et al., 2013).

When making financial decisions, older adults can use their crystallized intelligence to compensate for age-related declines in fluid intelligence (Li et al., 2013, 2015). However, the gap between the two forms of intelligence becomes larger with age, which challenges the effectiveness of this compensatory process. This was seen in the U-shaped pattern across adulthood of credit mistakes being lowest in midlife (Agarwal et al., 2009). In midlife, the combination of experience and deliberative skills facilitated peak performance; younger adults had good deliberative skills but little experience, and older adults' experience was insufficient to compensate for declines in deliberative capacity (Agarwal et al., 2009). A similar pattern was seen in stock market investments where older investors had greater knowledge of the principles of sound investments than younger investors, yet were less successful in applying them due to declines in skills that support cognitive deliberation (Korniotis & Kumar, 2010). Because individual differences increase with age (Dannefer, 2003), the specific age at which experience is insufficient to compensate for cognitive declines is likely to vary considerably, with some research suggesting a sharp drop around age 70, especially among less educated older adults with lower income (Korniotis & Kumar, 2010).

When experience was measured as financial literacy, older adults outperformed younger adults (Eberhardt et al., 2018; Li et al., 2013, 2015). Yet, older adults performed worse than middle-aged adults, indicating declines in later life (Finke, Howe, & Huston, 2017; Lusardi & Mitchell, 2014). Despite these declines, confidence in financial knowledge increased with age, leading some to suggest that older adults are overconfident (Finke et al., 2017; Lusardi & Mitchell, 2014). Although financial literacy and confidence in one's ability may result from experience, literacy appears to be more important than simply having experience for making good financial decisions (Li et al., 2015).

Emotions and Age-Related Differences in Financial Decision Making

Emotional reactions are often the primary response to information and may therefore automatically guide decision making (Slovic, Finucane, Peters, & MacGregor, 2002; Zajonc, 1980). Recent perspectives on decision making suggest that emotions can facilitate evaluations of options and motivate decision makers by placing a "spotlight" on relevant information (Peters, Västfjäll, Gärling, & Slovic, 2006). Emotions that are integral to the decision at hand, such as the fear of losing money when evaluating investment options, can shape decisions (Lerner, Li, Valdesolo, & Kassam, 2015). Incidental emotions that are caused by unrelated situations, and are not directly relevant, can also inadvertently influence decisions (Loewenstein, Weber, Hsee, & Welch, 2001). For example, people are more optimistic when the sun shines, and sunshine on a given day has been shown to be positively correlated with stock market returns (Hirshleifer & Shumway, 2003).

Emotional coping, which includes releasing or accepting one's emotions, can be an adaptive response to stress (Folkman & Lazarus, 1985), including stress associated with finances. Emotional coping through releasing one's emotions aided clearer thinking (Stanton, Kirk, Cameron, & Danoff-Burg, 2000) and predicted a lower propensity to borrow during the stressful Christmas season (McNair, Summers, Bruine de Bruin, & Ranyard, 2016).

Age-Related Differences in Emotion and Motivation

Numerous studies have shown that older adults, compared to younger adults, tend to report less negative and more positive emotions (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Charles, Reynolds, & Gatz, 2001; Gross et al., 1997). Older age has also been shown to be associated with ruminating less about adverse life events (Sütterlin, Paap, Babic, Kübler, & Vögele, 2012; Torges, Stewart, & Nolen-Hoeksema, 2008). Theorists have suggested that affective processes and emotions may become more central to decisions with age as deliberative cognitive abilities decline (Peters, Hess, Vastjfall, & Aumann, 2007). The socioemotional selectivity theory posits motivational shifts with age such that older adults pursue emotionally meaningful positive experiences in the present moment due to recognizing life's finitude, whereas younger adults pursue knowledge to prepare for a seemingly limitless future (Carstensen, 2006). Such motivational shifts are thought to underlie older adults' tendency to favor positive information over negative information, also known as the positivity effect (Carstensen & Mikels, 2005; Mather & Carstensen, 2005; Reed, Chan, & Mikels, 2014). An example of this was seen in consumer choices where older adults listed more positive than negative attributes about a product compared to younger adults and had more post-choice satisfaction due to their focus on the positive features of selected options (Kim, Healey, Goldstein, Hasher, & Wiprzycka, 2008).

Older adults' ability to regulate their emotions has been suggested to explain why they report less impulsive purchasing (Bangma et al., 2017). Lesser self-reported reliance on emotions helped to explain older adults' preferences for receiving larger amounts of money up-front and smaller amounts later, a preference that maximized the current value of funds (Strough et al., 2018). Those who relied more on their emotional gut feelings tended to make better decisions about "sunk costs" or irrelevant past losses, as well as to report better financial outcomes (Bruine de Bruin et al., 2007). Older adults, relative to younger adults, were less biased by sunk costs (Strough, Mehta, McFall, & Schuller, 2008), and this was statistically accounted for by their greater avoidance of ruminative coping strategies (Bruine de Bruin, Strough, & Parker, 2014).

Dampening of negative emotions with age was seen in responses to a randomly determined loss on a gambling task, where older adults relative to younger adults reported less negative emotions and more positive emotions (Bruine de Bruin, van Putten, van Emden, & Strough, 2018). Older adults' lower reported negative emotions about financial decisions partly accounted for their better financial decisions compared to the decisions of younger adults (Eberhardt et al., 2018). Older adults also showed lower neural activation when anticipating losses compared to younger adults, but did not differ when anticipating gains (Samanez-Larkin et al., 2007). Relative to younger adults, older adults were more likely to choose the riskier option when choosing between lotteries framed as gains, and this was accounted for by their lower levels of negative affect (Pachur et al., 2017).

Induced positive feelings (vs neutral feelings) among older adults were associated with improved decision performance for learning about gains and losses from card decks (Carpenter, Peters, Västfjäll, & Isen, 2013). However, older adults' greater positive affect relative to younger adults was associated with ignoring the odds of winning and instead making choices based only on the number of chances to win (Mikels, Cheung, Cone, & Gilovich, 2013). Older adults who experienced induced high-arousing positive and negative emotions were more susceptible to fraudulent advertisements compared to those in a low arousal condition; still, younger adults exhibited the same effect with older adults reporting a greater intent to purchase irrespective of the emotion that was induced (Kircanski et al., 2018).

Interventions

Policy makers and practitioners strive to promote sound financial decisions and may develop interventions with this aim. Older adults may especially benefit from interventions that address age-related declines in deliberative capacity, while also taking into account age-related differences in experience-based knowledge, emotions, and motivation.

Nudges

Nudges structure the architecture or environment of choices to predictably steer decisions with the goal of retaining freedom of choice (Thaler & Sunstein, 2008). Nudges capitalize on the limits of attention as well as habitual thinking styles (Thaler & Sunstein, 2008). For example, giving new employees a deadline for enrolling in a retirement plan prevented procrastination, leading them to allocate a greater percentage of their salary as compared to an open-ended timeline that automatically reverted to opting out of the plan (Carroll, Choi, Laibson, Madrian, & Metrick, 2009). Other nudges capitalize on the status quo bias by setting the default to enrolment in a retirement savings plan such that opting out requires attention and action (Beshears, Choi, Laibson, & Madrian, 2009; Frydman & Camerer, 2016).

Nudges aimed at older adults could consider that older age is associated with a habitual orientation towards perceiving a more limited future with fewer opportunities, and focusing more on the present (Carstensen, 2006; Shook, Ford, Strough, Delaney & Barker, 2017; Strough, Bruine de Bruin, Parker, Lemaster, Pichayayothin, & Delaney, 2016). Older adults' orientation towards the present was apparent in their preferences to make larger payment sooner instead of later, even when deferring larger payments was preferable (Strough et al., 2018). When middle-aged and older adults' time horizons were restricted through instructions to imagine having a limited time left to live, they were more likely to act on an attractive consumer opportunity (compared to a no-instruction control group); however, instructions to imagine an expanded future lifetime were only effective among middle-aged adults (Strough, Parker & Bruine de Bruin, 2019).

Although some have argued that nudges can be relatively cheap to implement (Bernartzi et al., 2017), others have expressed concerns that nudges may infringe on personal autonomy (Barton & Grüne-Yanoff, 2015). Yet, given older adults' motivation to selectively allocate cognitive resources (Hess, 2014) and lesser reported willingness to think hard about complex problems (Bruine de Bruin et al., 2015), nudge interventions would seem to be a good fit.

Decision Aids

A common choice faced by adults in the United States as they approach retirement is the age at which to claim social security benefits. To assist with this decision, financial planners and government agencies offer decision aids in the form of web-based computer tools (e.g., Charles Schwab, 2019; Consumer Financial Protection Bureau, 2019). Yet, older adults may fail to use such tools if they have not had the opportunity to develop efficacy and positive experiences with computer technologies (Mitzner et al., 2019). Older age is associated with reporting less efficacy and comfort about using computers, although more recent birth cohorts have more positive attitudes than later cohorts (Lee et al., 2019). More generally, older age is associated with perceiving that one's ability to make decisions has worsened over time (Strough et al., 2016).

When designing computer-based or other types of decision aids for older adults, understanding their perceptions of their strengths and weaknesses, existing beliefs, and the type of information they want and need is an important first step (Strough, Bruine de Bruin & Peters, 2015). As discussed above, experts are skilled at identifying relevant information; however, their expertise may lead them to conceptualize decisions differently than a more naïve layperson and thus misjudge the type of information laypersons find most relevant (Bruine de Bruin & Bostrom, 2013). Because older adults tend to prefer and better remember information that is emotion-focused rather than information that focuses solely on facts (Fung & Carstensen, 2003; Williams & Drolet, 2005), highlighting the emotional relevance of information may be beneficial.

Substantial research has shown that the way that information is presented or "framed" can influence decisions even when the objective facts are the same (Tversky & Kahneman, 1974). For example, decisions to claim benefits at an older age were more prevalent when claiming was described as a gain versus as a loss (Brown, Kapteyn, Mattox, & Mitchell, 2013). Gain versus loss wording or "frame" would seem to be especially important when designing decision aids for older adults. Theorists posit age-related increases in motivation to avoid loss and maintain emotional well-being (Carstensen, 2006; Depping & Freund, 2011). Considerable research shows older adults are more likely to attend and remember positive information over negative information (Reed et al., 2014). However, laboratory research on risky financial decision making suggests that the extent to which older and younger adults respond differently to positive and negative frames is moderated by other factors such as the amount of money under consideration (Best & Charness, 2015). Older adults are also more motivated to put effort into decisions that are presented as personally relevant (Hess, 2014). Thus, a range of factors must be considered when tailoring decision aids to older adults.

When decisions involve numerical concepts and probabilistic information, decision aids that reduce demands on numerical skills may beneficial. Many adults in the United States have difficulty comprehending and using numbers, and older age is associated with lower numeracy (Bruine de Bruine et al., 2015; Lusardi, 2012; Peters et al., 2006). Considerable research has addressed how to make numerical information easier for people with low numeracy to understand (Trevan et al., 2013). Adding bar graphs and pictographs (also referred to as icon arrays) that show the proportion of the population with a negative outcome relative to the total at-risk population was beneficial to low-numerate individuals, especially those with skills for comprehending graphical information (Garcia-Retamero & Galesic, 2010). Adding evaluative labels to graphs—for example, labeling a numerical range on a bar chart as "poor," "fair," "good," or "excellent"—helped people to use relevant information and reduced the influence of irrelevant affect on decisions (Peters et al., 2009). Likely because few consumers know how to evaluate annual percentage rates (APRs), financial disclosures augmented with histograms showing how the APR of a credit card on offer compared to APRs in the credit card market improved consumers' estimates of APR costs relative to the market (Chin & Bruine de Bruin, 2019). This intervention also tempered consumers' evaluations of an expensive credit card, in comparison to standard disclosures that only showed the APR for the credit card on offer. Such interventions may derive their effectiveness not only by addressing low numeracy, but also by addressing lack of experience, for example, in how to interpret APRs.

Research has shown that low-numerate individuals are more likely to attend to narratives than to numerical information (Diekmann, Slovic, & Peters, 2009). Yet, it is unclear whether adding personal narratives to decision aids increases their effectiveness (Bekker et al., 2013). Older adults spontaneously apply narratives about their own and others' personal experiences to decisions (Woodhead, Lynch, & Edelstein, 2011). Thus, adding narratives to decision aids could be a way to encourage older adults to use such aids.

The ability to imagine the future is an essential component of financial decision making (Weirich et al., 2010) and this ability declines with age (Rendell et al., 2012). Decision aids shown to increase a focus on the future in other age groups could be tested with older adults. For example, younger adults who were shown age-progressed images of themselves increased saving for retirement, presumably because this increased the relevance of choices for one's future self (Hershfield, et al., 2011).

Training

One approach to promoting sound financial decisions is to train skills fundamental to such decisions. As noted earlier, financial literacy peaks in midlife with older adults performing worse than middle-aged adults, but better than young adults (Li et al., 2013; Finke et al. 2017). Beginning training in financial literacy early in life could help to delay the onset of negative consequences of cognitive declines on financial decision making by boosting relevant knowledge (Agarwal et al., 2009; Li et al., 2015). Sustained training may be necessary because educational programs that target financial literacy have only small effects on financial behavior and these effects decay rapidly over time (Fernandes, Lynch, & Netemeyer, 2014). Alternatively, "just-in-time" education could be used (Fernandes et al., 2014). For example, watching a video on risk diversification boosted financial literacy (Glinert et al., 2014). Making such videos available to individuals when they are choosing a workplace retirement plan could facilitate retirement planning.

Future Directions

Research on aging and decision making has expanded rapidly over the past 15 years (see Hess, Strough, and Lockenhoff, 2015). This larger literature has informed much of the current literature on aging and financial decision making (Bruine de Bruin, 2017). In the following section, we draw from the larger literature to discuss directions for future research on financial decision making.

Measurement Issues

To advance the field, researchers have noted the need for improved measures—for example, measures of real-world financial outcomes as opposed to performance on hypothetical tasks (Bruine de Bruin, 2017). Outcomes associated with fraud victimization and financial abuse have received increasing attention (Burnes et al., 2017; Lichtenberg, Gross, & Campbell, 2020; Pottow, 2010). The incidence of fraud is on the rise with about 6% of community-dwelling older adults encountering fraud perpetrated by strangers (Burns et al., 2017; Lichtenberg, Sugarman, Paulson, Ficker, & Rahman-Filipiak, 2016). Other real-world financial outcomes such as falling behind on mortgage payments, carrying high-interest credit card debt (e.g., Bruine de Bruin et al., 2007), or reentering the workforce due to shortfalls in retirement savings could also be investigated. Consideration of the subjective aspects of financial decisions, such as regret and satisfaction, may facilitate a greater understanding of how financial decisions relate to emotional well-being and life satisfaction.

Development and use of validated measures of decision making processes are also important for advancing the field. Research on emotion and decision making has used measures that were developed to study emotion and coping (e.g., Bruine de Bruin et al., 2014) and in some cases has tailored these measures to financial decisions (e.g., Eberhardt et al., 2018). Because research with young adults indicates that different emotions (e.g., anger, fear) have distinct consequences on decisions, identifying how specific emotions relate to older adults' decisions would also be valuable (Lerner, Li, & Weber, 2012). Theories of aging posit changes in motivation to avoid loss and pursue emotional well-being across the life span (Carstensen, 2006; Depping & Freund, 2011) and also outline differential strengths and vulnerabilities in emotional coping with age (Charles et al., 2010). These theories provide fertile ground for testing how specific emotions may differentially influence decision making across the life span.

Social Context of Financial Decisions

Much of the existing research on aging and financial decision making has investigated financial decision making as if it were a solitary, individualistic process. Yet, close interpersonal relationships are important to people of all ages (Bruine de Bruin, Parker, & Strough, 2020) and financial decision making occurs in a social context. Some research suggests that older adults prefer to delegate complex decisions to others (e.g., Finucane et al., 2005), whereas other research suggests that older adults report being more willing than younger adults to carefully and deliberately make decisions on their own (Delaney, Strough, Parker, & Bruine de Bruin, 2015). Preferences for involving others via delegation and advice seeking versus making decisions alone may depend on the decision maker's self-perceptions of their skills and abilities (Strough, Cheng, & Swenson, 2002). For instance, people may avoid seeking advice from a financial adviser due to embarrassment about their financial knowledge and status (Gerrans & Hershey, 2017).

An individual's financial well-being may be challenged by the death or incapacity of a partner when household finances depend on the cognitive abilities of the household member responsible for financial decisions (Boyle, 2013; Smith, McArdle, & Willis, 2010). Among the current cohort of older adults in the United States, men are more likely than women to assume responsibility for large financial decisions, whereas women manage day-to-day tasks such as paying bills (Kim, Gutter, & Spangler, 2017; Smith et al., 2010). Accordingly, because women, on average, live longer than men (CDC, 2013), some women may lack financial experience when confronting financial decisions in later life. Historical increases in women's labor force participation, education, and head of household status may counter this trend in future cohorts (Kim et al., 2017). Women may be well-positioned to reap support from financial advisors since they are more likely than men to report they include others when making important decisions (Delaney et al., 2015).

Maturational Change Vs Cohort Differences

Most existing knowledge of aging and financial decision making is derived from cross-sectional studies of people of different ages at a single time, confounding history-based cohort effects and maturational change (Schaie, 2012). Correlates of age differences identified in cross-sectional studies may not necessarily predict maturational stability versus change (Lindenberger et al., 2011). Emerging longitudinal findings suggest stability of individual differences in decision making competence, both when examining the transition from adolescence to adulthood (Parker, Bruine de Bruin, Fischhoff, & Weller, 2018) and over 5 years when investigating adults 60 years and older (Del Missier, Hansson, Parker, Bruine de Bruin & Mantyla, 2019). Additional longitudinal studies are needed to identify mechanisms that predict stability, improvement, decline, and the rate of change (e.g., Boyle et al., 2012). Such studies can also address how decision making changes in normal versus pathological aging such as Alzheimer's disease.

Historical events such as the "Great Recession" have different consequences for Baby Boomers versus Generation Xers versus Millennials given their proximity to retirement. Many Millennials enter adulthood carrying student loan debt. Because historical events have the greatest psychological impact on people transitioning to adulthood (Stewart & Healy, 1989), this may have lifelong consequences for their financial decision making. Cross-sequential studies are necessary to identify common patterns of change across different historical cohorts (Schaie, 2012).

Conclusion

Age-related declines in fluid cognitive abilities may challenge older adults' financial decision making when decisions are complex or require learning new information, or if older adults lack motivation to apply their cognitive skills. Although lower fluid cognitive abilities have been linked to suboptimal financial decisions, the age of onset of such detriments can be offset when people apply accurate knowledge derived from experience. Age-related increases in emotion regulation skills can be advantageous to older adults when they face decisions about irrecoverable losses or missed opportunities. Yet, the consequences of age-related increases in positive emotions vary depending on the decision at hand. Continued research is necessary to understand how to offset deficits and accentuate strengths. Such research serves as a foundation for designing interventions to promote sound financial decision making as we age.

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Chapter 9
Financial Decision Making Under Uncertainty: Psychological Coping Methods

X. T. (XiaoTian) Wang

The Uncertainty Challenge: Rational Models in an Irrational Market

Frank Knight proposed a well-accepted distinction between risk (when the probabilities of expected outcomes are known) and uncertainty (when the probabilities of expected outcomes are unknown). Knight may not have anticipated that behavioral decision making research would largely restrict its focus on risky decisions, by sticking to a reductionist optimization approach to human decision making. This approach reduces the concept of decision rationality to a small set of axioms and optimizes by deriving a single utility score for each choice option from the "weighted sum" of expected values and probabilities. The mainstream research in the fields of economics, finance, and behavioral decision making has demonstrated a persistent preference for probability-based models, to replace uncertainty with risk, so that decisions can be parsimoniously gauged by rational axioms and the principle of utility maximization (von Neumann & Morgenstern, 1944; Savage, 1954).

This persistent effort to reduce decision problems to mathematical formulations seems to have its roots in the history of science. In 1654, prompted by a question of how to score an unfinished game of chance, Blaise Pascal and Pierre de Fermat formulated probabilities for chance events. Correspondence between them established the concept of expected value and marked the beginning of mathematical studies of decision making. Following their lead, in 1738, Daniel Bernoulli laid the foundation for risk science by examining subjective value functions (see Buchanan & O'Connell, 2006; Shafer, 1990).

Another significant event in the literature of behavioral and financial decision making was the Keynes vs. Ramsey-Savage debate, following the publication of *A*

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Treatise on Probability by John Maynard Keynes in 1921. The central point of the debate concerns whether probability estimates are appropriate in modeling some financial situations where, as Keynes puts it, “we simply do not know.” Keynes believed that the financial and business environment is characterized by “radical uncertainty.” The only reasonable response to the question “what will interest rates be in 20 years’ time?” is “we simply do not know.” In contrast to this view, Ramsey (1922, 1926/2016) argued that probabilities can be derived objectively from the choices and preferences of the decision-makers, based on a small set of rational axioms.

Surprisingly, there was little development in the theories of decision making in the century and a half between Bernoulli (1738) and Keynes (1921). However, we have witnessed rapid developments and groundbreaking discoveries in many other areas of science during this period. These scientific achievements, to name a few, include the Bayesian model of probability by Thomas Bayes in 1763, John Dalton’s atomic theory in chemistry in 1805, Darwin’s theory of evolution in 1859, Mendel’s laws of inheritance in 1865, the discovery of the periodic table by Mendeleev in 1869, Karl Pearson’s statistical testing in 1892, Albert Einstein’s theory of special relativity in 1905, Walther Nernst’s third law of thermodynamics in 1906, and Thomas Morgan’s laws of genetic linkage and genetic recombination in 1911 and 1915. All these scientific developments highlight the importance of logic and rationalism and reveal the beauty of a reductionist approach to discovering simple rules in a complicated universe and deriving fundamental principles that govern numerous behaviors of diverse organisms. With such a reductionist vision, psychology has embarked on a journey of discovering a few physics-like laws of behavior, as seen in the effort of structuralism to search for the elements of thought, of behaviorism to find general principles of reinforcement and learning, and of cognitive research to reveal a small set of logic rules of reasoning and decision making.

The power of Newton’s laws in physics and the beauty of the periodic table of elements in chemistry have inspired social scientists to discover a small set of laws to concisely describe and predict complicated human behaviors. In economics and finance, the focus of work has been on identifying the axioms of rationality and principles of probability. As a result, decision rationality is defined largely by logical consistency with neoclassic standards of expected utility maximization. To be rational, *homo economicus*, *the economic man*, would have to know all of the expected consequences and their probabilities. In reality, however, this omniscience assumption is oftentimes shackled by the cognitive limitations of the decision-maker and shattered by the harsh uncertainty of the decision environment.

In the world of financial investment, not only are probabilities of future returns unknown, but market reactions to observable performance of a company are also capricious. Figure 9.1 compares the changes in revenues over 8–10 years with the corresponding changes in the market capitalizations for three companies (Wal-Mart, Exxon Mobil, and Yahoo). As Fig. 9.1 shows, the market had distinct reactions to the similarly linear increases in revenue of these three companies. Adding to this market uncertainty, the market expectations for each company, as shown in its market cap, lack consistency in reaction to a simple linear increase in revenues over

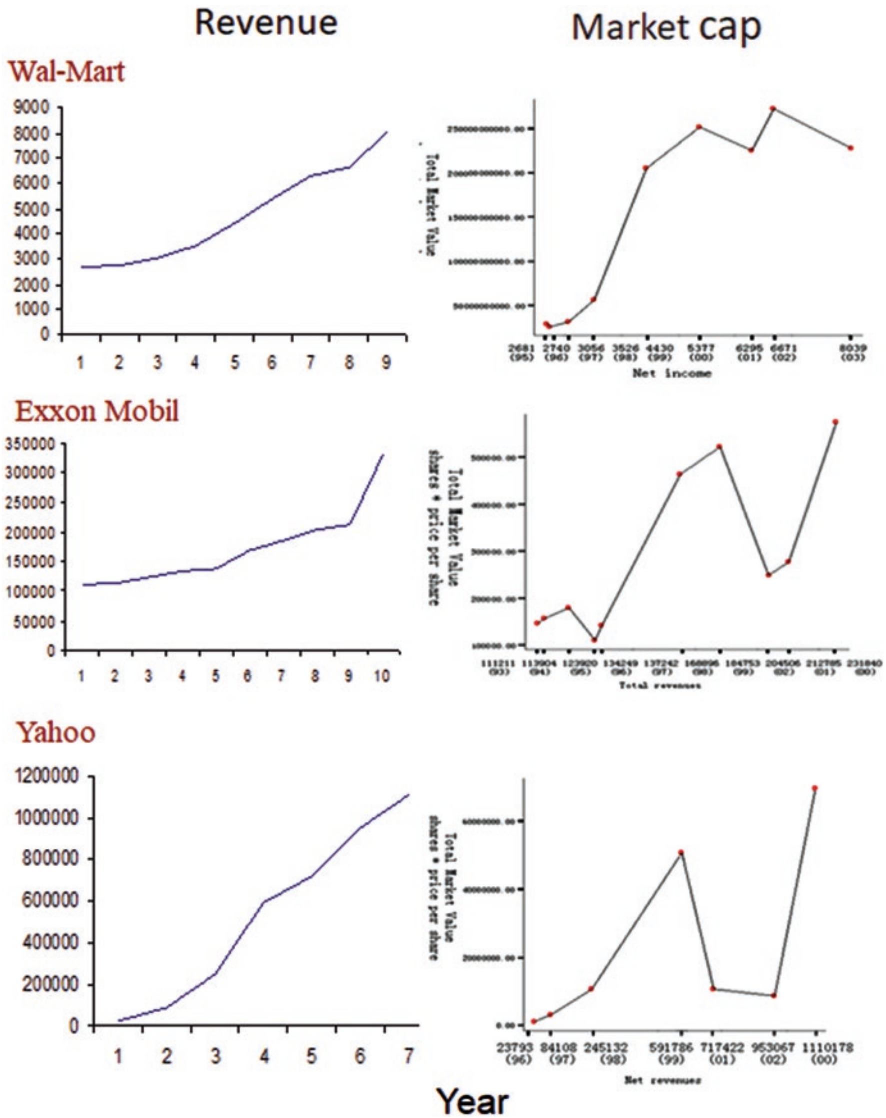

Fig. 9.1 Comparisons between the changes in annual revenue and corresponding changes in the market capitalization for three companies

time. It is difficult to rely on the historical record to predict what the market expectation will be at the next moment in time. Although a post hoc statistical fitting function may show a consistent overall correspondence between the changes in revenue and the changes in market cap, such a function is insufficient for ad hoc investment decisions under market uncertainty.

Asset pricing theories typically relate expected risk premiums to covariances between the return on an asset and some ex ante risk factors. However, it is difficult to identify and stay with a set of common risk factors since risks are confined to task environment, specific types of assets, and specific periods (Keim & Stambaugh, 1986). Using the asset-pricing model, based on the ex-ante variables, is particularly problematic under uncertainty, where the past does not have to define the present or future. Regression analysis of the market data revealed that risk premiums varied as a function of levels of uncertainty. In the bond market, and as one would reasonably predict, risk premiums are positively correlated with actual asset prices. In contrast, in the stock market of small firms with high levels of uncertainty, the risk premiums are largely negatively correlated with actual stock prices (Keim & Stambaugh, 1986).

Lessons from Russell's Turkey

The commonly accepted method of making backward inferences from choice preferences promoted by Ramsey (1922), von Neumann and Morgenstern (1944), and Savage (1954) is only possible under the assumption that the decision-maker's preferences obey the axioms of rationality, such as dominance, transitivity, independence, etc. These axioms serve as foundations for neoclassical theories of economics. However, people systematically violate these axioms when making judgments and decisions (Kahneman & Tversky, 1979, Kahneman, 2000, 2011; Tversky & Kahneman, 1992). Daniel McFadden (1999) noted that people are often rule-driven, rather than cost-benefit analyzing as neoclassic economic models suggest. When probability-based models encounter financial reality, expected utility calibrations simply do not match the "irrational" behaviors of the investors. An ultimate challenge of financial reality to finance theory is market uncertainty, characterized by events that are unprecedented, unpredicted, and unpredictable for their potential effects and a lack of knowledge, experience, and time for deliberation.

When risk models are "forced" to guide financial decisions under uncertainty, each parameter in the model brings in a certain amount of noise and complexity, which compound each other and subsequently break down the accuracy of model predictions. More important, without doing a psychological analysis of motives and respective values of the decision-maker and decision-recipient, the probability estimates of the model can be inaccurate and dangerously misleading. In the following, I will try to illustrate how probability-based calculations fail in a real world of uncertainty and exemplify possible remedies using the example of "Bertrand Russell's Turkey". In his book *The Problems of Philosophy*, Russell (1957) demonstrated how logical and probability-based inductive reasoning goes astray with an ingenious example of an inductivist turkey, reformulated below.

A smart turkey, who is capable of inductive reasoning, was captured by a farmer and brought back to his turkey farm. Although scared, the inductivist turkey did not jump to conclusions. The turkey found that, on the first morning at the turkey farm, it was fed at 9 a.m. The turkey continued its sampling and made its observations on different days of the week and under different weather conditions. Each day, it updated its Bayesian probability calculation in terms of the probability that it would be fed again. This probability continues to increase each day after it was fed in the morning. Finally, after 100 days of observation, the turkey was satisfied with its Bayesian estimation and concluded that "I will be fed tomorrow morning" and "I am always fed in the morning." That was the day before Christmas Eve. On the morning of Christmas Eve, the turkey was not fed but instead had its throat cut.

The inductivist turkey failed to distinguish between uncertainty and risk. Gerd Gigerenzer (2015) calls this failure "turkey's illusion." Gigerenzer describes the dangers of confusing uncertain and risky types of decisions. He argues that risks are limited and can be calculated only when uncertainty is low and outcomes are predictable (see also Volz & Gigerener, 2012). However, probabilities derived from a large amount of data from the past can quantify expected future happenings only in stable environments. In the world of uncertainty, outcomes take an all-or-nothing form, where uncertainty becomes certainty only after a decision results in outcomes. The decision-maker then faces new uncertainty again. Such uncertainty-certainty conversions take place repeatedly without predictable probabilities in between. An important function of human intelligence is to either reduce uncertainty to qualitative likelihood estimates or deal with it without resorting to probability estimation in situations of "radical uncertainty."

In less radical uncertain situations, the likelihood of an event cannot be pinpointed but can be reduced to categorical likelihoods. To reduce outcome uncertainty, decision agents try to estimate the ranges and categorical likelihoods of expected outcomes (e.g., likely, unlikely). Xiong (2017) provided some preliminary evidence of such categorical likelihood estimation with Chinese participants. The results of this study showed that the participants evaluated uncertain events in terms of categorical and ordinal likelihoods. Moreover, they were able to convert the verbal likelihood descriptions to corresponding probabilities on a numerical scale. The commonly used verbal descriptions of the categorical likelihoods of expected outcomes seem to have two focal points: reliable vs. unreliable. The average cardinal conversions of the "reliable" and "unreliable" outcomes on the probability scale were 37.1% and 63.2%, respectively.

Following Bertrand Russell, many researchers have questioned the ecological validity of inductive logic and probability-based models in finance and economics. However, only few had paid attention to alternative methods that might help the turkey make a better judgment. What other mental tools, besides salvation from God, could the turkey use to save its life? I propose that a psychological analysis of motives based on survival instincts, aided by simple frequency sampling, would help this intelligent turkey out of its predicament.

The turkey's failure was not due to its choice of an inductive approach. The turkey paradox shows that it is not the statistics per se that is misleading but the way it is used that is responsible for the failure of Russell's turkey. What went wrong with the inductivist turkey was its ignorance of the needs and motives of the farmer. The turkey only asked, "When do I get fed?" It never asked, "Why do I get fed?" Statistical thinking with simple frequency counts may help if used with social intelligence. Living on a turkey farm, the inductivist turkey can gather some functional information. For instance, how many fellow turkeys have been taken away? Among these turkeys, how many have ever returned to the farm? How old were these turkeys when they disappeared? With these questions in mind, the turkey might find out that most of the fellow turkeys which disappeared were taken away after being fed for about 100 days. Once being taken away, no one would return. These observations would allow the turkey to reach a different conclusion. It would not be difficult to get these kinds of information. One only needs to get a few frequency counts from natural sampling (e.g., y out of z were taken away after 100 days, x out of z never returned, etc.). This intelligent turkey thus is likely to abandon Bayesian probability updates and adopt natural frequency counts for an analysis of motives. The turkey would decide to escape from the farm before it is too late.

A problem of relying on probability calculations is that it focuses only on correlations instead of causation. Probability models deal with questions of "what and when" but not "why." However, answers to "why" questions provide more reliable predictions in an unstable and uncertain environment since psychological factors (e.g., values, motives, personality traits, dispositions, etc.) are often more stable than social and situational factors.

I derive from the above analysis two key points. First, probability calculations are only correlational and incapable of revealing the motives of decision-makers. Probability-based models of risky choice fail in the face of real-world uncertainty. Second, but more importantly, a decision agent is capable of reducing uncertainty by doing a psychological analysis of motives and values of interacting agents, aided by natural frequency sampling. Decision models should consider ecological and social rationalities. A good model of decision making is a psychologically valid model.

Under Uncertainty, Less Is More

Different views have challenged the reductionist optimization approach. In line with Keynes' idea of "radical uncertainty," Knight suggested that it is uncertainty that characterizes the business environment and enables profit opportunities to emerge. In a similar vein, Simon and Newell (1958) pointed out, "there are no known formal techniques for finding answers to most of the important top-level management problems" (p. 4) because these are "ill-structured." Simon (1956) proposed that the human mind is capable of coping with such an ill-structured environment with limited cognitive capacity. Coping with a complicated environment with limited computational capacity requires simplicity.

One way of achieving simplicity in decision making is to rely on a single reason. To illustrate how a vital decision can be firmly made under time pressure and with a very small sample, consider the example of the decision made by the vice present Dick Cheney on 9/11, 2001, when America was under attack. Two airplanes had already crashed into the Twin Towers, another one into the Pentagon. Combat air patrols were aloft. Cheney received the report that a fourth plane was "80 miles out" from Washington, D.C. At this moment, as President Bush was on Air Force One in the sky, Cheney received no instruction on how to respond to the attacks. A military aide was asking Cheney for shoot-down authority. Now Dick Cheney faced a huge decision on a morning in which every minute mattered. Cheney did not flinch, according to the 9/11 Commission Report, and immediately gave the order to shoot the fourth airplane down, telling others the president had "signed off on the concept."

Clearly, Cheney's decision was based on national security, which was prioritized in his mind above all other possible concerns. This is a case of less is more and less is more precious. When Cheney made the decision, the available information was limited and was from a small frequency sample of four airplanes with a clear understanding about the motives of the terrorists. When making such a vital decision in an unpredictably variable and urgent situation, one-reason decision making with a clear stopping rule becomes necessary. When big decisions have to be made instantly, the heuristics that rely on a single reason seem to be the art of effective leadership. Under uncertainty, probability estimates are inevitably volatile and unreliable, and these parameters are likely to increase existing uncertainty rather than reduce it. Frustrated by the normative approach to uncertainty, President Harry Truman reportedly said, "All my economists say, 'on the one hand ... but on the other.' Give me a one-handed economist!" (Boller, 1981, p. 278). President Truman's complaint calls for research on probability-free simple heuristics, such as intuition-based decision making (March, 2010; Zsambok & Klein, 2014), one-reason decision making, and even ignorance-based decision making (Gigerenzer, 2007, 2010).

A grand example of ignorance-based decision making is the free-market economy, which assumes that people, including experts and policymakers, are ignorant about how to accurately and consistently predict future needs, stimulate innovations, put forth economic policies, or estimate asset prices. This ignorance-based approach relies on the invisible hand to move the economy forward through individual self-interest and freedom of production and consumption. It is in sharp contrast to the command economy of a central planning bureaucracy, which assumes that the government can be omniscient and omnipotent in predicting, directing, and controlling the economy and market behaviors. Simplicity has been identified as a powerful strategy to succeed in the literature of business management. What separates successful companies from average companies is a "hedgehog" wisdom of using simplicity to succeed (Berlin, 1953). Organizations are more likely to succeed if they can identify the one thing that they do best. This "hedgehog strategy" is in the "DNA" of successful companies (Collins, 2001).

James March (2010) emphasizes the important role of experience and storytelling in dealing with novelty and uncertainty in organizations. "Organizations were pictured as pursuing intelligence, and intelligence was presented as having two components. The first involves the instrumental utility of adaptation to the environment. The second involves the gratuitous interpretation of the nature of things through the use of human intellect." (p. 117). From the second point of view, organizational learning does not fit with utility formulations with a distinct value structure and ranking for expected outcomes, since unique things are often equally valued in the mind of the owner. Once the value of an important thing or person reaches a psychological threshold, the decision-maker would abandon utilitarian calculations. People may refuse to rank valuable things since each of the valuable things is important in a unique way. Ranking valuable things in terms of their expected utilities is like turning friends into competing enemies of each other.

Reducing Uncertainty with Simple Heuristics and One-Reason Decision Making

Although many believed that the Keynes vs. Ramsey and Savage debate had consequently strengthened the foundation of probability-weighted utility models in neoclassic economics and finance, Keynes' idea of "radical uncertainty" has drawn an increasing amount of attention. Following the vision of Herbert Simon, researchers have been working on developing alternative and probability-independent decision tools. A major effort in this area is to take a heuristic approach to decision making under uncertainty. The satisficing heuristic proposed by Simon (1956) abandons the central idea of probability weighting optimization and utility maximization and demonstrates the advantages of using a satisfactory and sufficing stopping rule when making decisions in an uncertain and fast-changing environment. Step-by-step, fast, and frugal heuristics have been shown to match or even outperform well-known statistical benchmark models, such as multiple regression, and Bayesian algorithms, particularly when uncertainty is high and knowledge about the world is incomplete (Gigerenzer, 2015; Gigerenzer & Selten, 2001). Gigerenzer and Gaissmaier (2011) identified three building blocks of effective heuristics: (1) search rules that state where to look for information; (2) stopping rules that state when to stop searching; and (3) decision rules that govern how to choose given the available information.

Andre Haldane, Executive Director of Financial Stability of the Bank of England, observed a persistent effort to develop more and more complex models in the mainstream studies of financial investment and financial regulation in reaction to financial crises. He drew an analogy between catching a financial crisis and catching a Frisbee. Both are difficult when trying to understand them with mathematical models. Yet despite this formal and mathematical complexity, catching a Frisbee is remarkably common. Even an average dog can master the skill. What is the secret of the dog's success? The answer is to run at a speed so that the angle of gaze to the Frisbee remains constant. Humans follow the same simple rules of thumb to catch a Frisbee. The key is to keep it simple. We should not fight complexity with complexity. Complexity expands rather than confines uncertainty; it generates rather than reduces uncertainty (see Haldane & Madouros, 2012). In contrast, simple heuristics can be successful in complex, uncertain environments and can be selectively applied to different business situations (Artinger, Petersen, Gigerenzer, & Weibler, 2015).

The simplest reason for not using complex models in the real world of financial management is that collecting and processing the information necessary for complex decision making is punitively costly.

The second reason in favor of simple heuristics is that the normative decision models require probability-weighting functions and optimization, as established in expected utility theory (e.g., Neumann and Morgenstern, 1944) and its statistical analog, multiple regression models. However, probability calculation and weighting are often unnecessary in complex environments, where equal-weighting or "tallying" strategies are superior to risk-weighted alternatives (DeMiguel, Garlappi, & Uppal, 2007; Gigerenzer & Brighton, 2009). To illustrate how simple models can outperform complex models in the real world of asset management, Haldane and Madouros (2012) drew on actual financial market data of 200 entities since 1973 and constructed the maximum number of combinations of portfolios of different sizes, ranging from simple combinations of two assets to complex combinations of 100 assets per portfolio. For each of these sets of portfolios, they forecasted the risk in a Value-at-Risk (VaR) framework with estimates of asset volatilities and correlations. They used a relatively simple model (exponentially weighted covariance matrix) and a complex multivariate model to generate forecasts of VaR over the period of 2005–2012. They evaluated the models by comparing the model expected daily returns with actual returns. The results showed that for very simple portfolios of two or three assets, the performance of the simpler and complex models is similar. However, as the number of assets increases, the simpler model progressively outperforms the complex one. This result suggests that overfitting is a common problem of using complex models to make out-of-sample predictions, particularly when the portfolio is also large and thus complex. However, the routine response to financial crises by banks and regulators is to add more regulations and make existing forecasting models more complex. Contrary to this practice, simplicity, rather than complexity, may be better suited for reducing financial uncertainty and problems.

To develop alternative probability-free models, Dosi, Napoletano, Roventini, and Treibich (2019) argued that agents have to cope with a complex evolving economy characterized by deep uncertainty resulting from imperfect information, technology changes, and structural breaks. In these circumstances, the authors found that neither individual nor macroeconomic dynamics improve when agents apply normative utility calculations. In contrast, fast and frugal heuristics may be "rational" responses in complex and changing macroeconomic environments.

Dosi et al. (2019) suggested four possible reasons for why heuristics work well in complex business situations. First, heuristics can allow the decision agent to get more accurate forecasts than complex procedures because they are more robust to changes in the fundamentals of the economy. Second, the larger forecast errors of sophisticated agents are due to an insufficient number of observations employed in their estimations. Third, there may be selection pressure for heuristic-guided firms do better with a selection bias for heuristic learners than sophisticated learners. The fourth is that in complex and rapidly changing economies, more sophisticated rules contribute to greater volatility. In such environments, more information does not yield higher accuracy.

Overall, the aforementioned simple heuristics are fast because they use only part of the potentially available information in the environment, and they are frugal because they are guided by stopping rules for information search and use only a few cues or even a single piece of information for making a decision (one-reason decision making). These heuristics are also fast and frugal because they are specially designed mental tools for solving specific problems in specific task environments.

Demarcating Uncertainty with Decision Reference Points

It is ironic that on the one hand economics is defined as a study of goal-directed behaviors, but, on the other hand, normative economic models of decision making omit any reference point (e.g., the status quo, goal, or bottom line) (Wang, 2001). The use of a single value (the expected value) for each choice option is done at the cost of valuable information about risk distributions. As a result, each choice option is represented by a single value without information about how expected outcomes vary in relation to the decision reference points.

Recent developments in the field of behavioral decision making suggest that individuals in various risky choice situations use multiple reference points to guide their decision making. Based on tri-reference point (TRP) theory (Wang & Johnson, 2012), decision-makers strive to reach a goal and at the same time avoid falling below a bottom line. Prospect theory (Kahneman & Tversky, 1979) demonstrates that the carrier of subjective value is not total wealth but changes from the status quo (SQ) that separate expected outcomes into gains and losses. The TRP theory further divides the expected outcome space into four functional regions: negative outcomes are divided into failure and loss regions by the minimum requirement (MR) reference point and positive outcomes are divided into gain and success regions by the goal (G) reference point (see the upper panel of Fig. 9.2). As illustrated in Fig. 9.2, without reference points, the value of A to B, B to C, and C to D is the same. Once the reference points are in place, the psychological value of A to B is the highest since it is a "life-death" change from failure to survival. The value of C to D is a change "from good to great" and is thus higher than that of the change from B to C, which represents fluctuations around the status quo.

According to the TRP theory, reference point-dependent decisions should follow two rules of thumb: the MR priority principle and the mean-variance principle. The MR priority principle states that the relative psychological impact of the reference points obeys the order of MR > G > SQ. Empirical evidence (Wang & Johnson, 2012) supports this assumption: First, the disutility of a loss is greater than the utility of the same amount of gain (loss aversion). Second, the disutility of failure is greater than the utility of success in the same task (failure aversion). The mean-variance principle dictates risk/variance avoidance when the mean expected value of choice options is above the relevant reference point (MR or G) and risk/

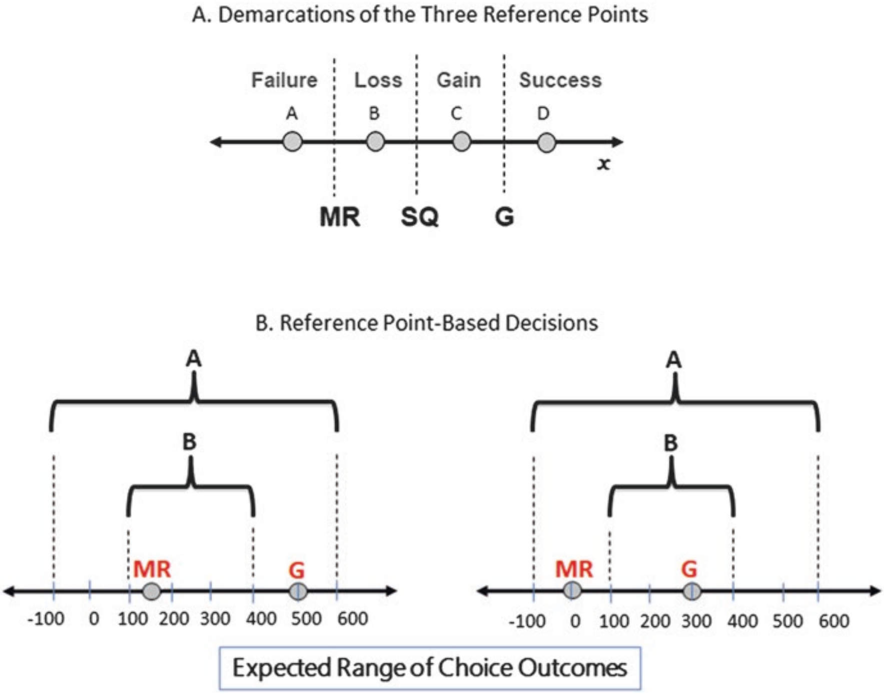

Fig. 9.2 A tri-reference point approach to decision making under outcome uncertainty

variance-seeking when the mean expected value of choice options is below the reference point.

TRP-based decision making can be independent of probability weighting and thus can be applied to choice situations for which the probabilities of expected outcomes are unknown but their distribution ranges can be estimated. Wang (2019) proposed a quintuple classification of uncertainty existing in different stages of information processing in decision making, including uncertainty in the information source, information acquisition, cognitive evaluation, choice selection, and immediate and future outcomes. People use different approaches to coping with different kinds of uncertainty. With regard to the outcome uncertainty, MR and G reference points can demarcate uncertain outcomes into functional regions and thus make it possible to compare uncertain choice options based solely on the distributions of these options without resorting to precise probability estimates.

As illustrated in panel B of Fig. 9.2, the MR priority principle and the mean-variance principle guide the choices between Option A and Option B, where Option A has a greater expected range (−100 to 600) than Option B (100–400).

Consider first the choice situation displayed on the left. Which investment option should you choose? Given that your MR = 150 and your G = 500, the low end of Option A and the low end of Option B are both below the MR and thus are functionally equivalent. You should avoid both options. If the choice is mandatory, you then only need to compare the high ends of the two options. The high end of Option A but not Option B can reach the goal G. Thus, you should choose Option A.

Consider now the choice situation displayed on the right side of panel B of Fig. 9.2. Which investment option should you choose? This time, you face the same options with different reference points (i.e., MR = 0, G = 300). Both options can reach the G at their high end and thus are functionally equal. What determines your choice would be the relationship between the low end of each option and the MR. Option B has a clear advantage since the low end of Option B is above the MR, whereas the low end of Option A falls below the MR. So, your choice should be Option B.

When applied to choices under uncertainty, the mean-variance principle of the TRP theory states that one should be variance averse when the low end of an option threatens the MR and be variance-seeking when the high end of an option reaches the G. In the case that one option spreads over both the MR and G and the other ranges within the two reference points, one should be variance averse and choose the second option to avoid any chance of functional death. This kind of baseline thinking should be an effective way of avoiding potential financial failures individually and financial crises collectively.

Implications for *Thinking, Fast and Slow* and the Dichotomy of Systems 1 and 2

Market failures have been attributed to systemic decision biases (Thaler & Sunstein, 2008) and their underlying thought processes. In his book *Thinking, Fast and Slow*, Daniel Kahneman (2011) distinguishes between two modes of thought in two systems of information processing. Based on the classifying features of Systems 1 and 2, the fast, autonomic, and intuitive System 1 is more error-prone than the slow, effortful, and deliberate System 2. However, based on the previous risk and uncertainty analysis in this chapter, System 2 may work well in risk situations but is likely to fail in the face of uncertainty. System 2 may be more fragile and error-prone, given its limited cognitive resources and small capacity. In the example of performing multiplications by System 2, errors can take place, particularly under time pressure or in multitasking situations. System 2 serves as a helper of System 1 under uncertainty situations, where new information is needed or raw information needs to be further processed.

Human memory capacity is both limited and non-verbatim (Miller, 1956; Reyna & Brainerd, 1995). These design features of human cognition determine the types of errors that humans are prone to make. In tasks with clear rules (e.g., chess games), computational human errors can be significantly reduced by artificial interference and big data techniques. Unfortunately, a set of clear-cut rules cannot define and guide most human decisions. Detecting a face from the background is easy for real human intelligence but a daunting task for artificial intelligence.

A key question from an evolutionary perspective is why *Homo sapiens* evolved to be primarily intuitive and occasionally analytical, as described by Kahneman (2011). From a design point of view, the neural programming and mechanisms of System 1 are more complex and efficient (e.g., visual pattern recognition) than the rational and rule-based System 2 (e.g., numerical calculations). Another key question concerns the environment in which human intelligence evolved. What were the likely ecological environments where System 1 and System 2 evolved? The faster System 1 should work well in a harsh and uncertain environment, which is typical in human evolutionary history. In contrast, a slow and deliberate System 2 should be useful in a more resourceful and predictable modern environment, where future-oriented decisions are often beneficial for a prolonged lifespan. In a fast-changing and unpredictable environment, System 2 can be used to gather new information for System 1 to eventually make feeling-based decisions. In other words, System 2 feeds System 1 with processed novel information. Decisions are made only after converting analytical calculations into feelings (Damasio, 1996, 1999). For instance, people decide to marry a person when they fall in love with the person. However, women tend to love those who are caring and have bright financial prospects, while men tend to love those who are physically beautiful and have great reproductive potential (Buss & Schmitt, 1993). System 1, although seemingly quick and simple, takes into consideration many factors and digests them into feelings and intuitions for effective decision making.

Although System 2 uses effortful processing, it is indecisive without System 1, particularly for making decisions under uncertainty. This argument is consistent with the idea that System 2 is a slave or subsystem of System 1. This argument is also consistent empirically with the finding that the effortful processing of System 2 often results in System 1 activation, as indicated by bodily signs of increased heart rate and dilated pupils (Kahneman, 2011). For vital decisions under uncertainty, a slow and deliberative System 2 is not assurance but a liability, unless it can work together with System 1. Once thinking activates anticipatory emotions, decisions may become intuitive, adaptive, and reliable.

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Part III
The Level of the Society

Chapter 10
Stock Markets, Market Crashes, and Market Bubbles

Sandra Andraszewicz

The Omnipresent Stock Markets Bubbles and Crashes

> One of the things that was so amazing about these experiments was that we thought that we were creating an environment that would be transparent about what the fundamental value was and that people would trade that fundamental value. Far from being based on asymmetric information, in these experiments everyone had the same information and they had complete information. In spite of this, we got the bubbles and that surprised us. At first, we thought there was something wrong with the experiments, but it turned out that they [the bubbles] replicated very easily and not only with undergraduate subjects but also with business people. (Vernon Smith[1] Nobel Prize winner in Economic Sciences in 2002)

In 1988, Vernon Smith, Gerry Suchanek, and Arlington Williams published results from a new experimental method that revolutionized the field of experimental economics. In 2002, this work was rewarded with the Nobel Prize in Economics awarded to Vernon Smith "for having established laboratory experiments as a tool in empirical analysis, especially in the study of alternative market mechanisms."[2] This pioneering method was named the "SSW," after the names of the authors, and it resulted in a new strand of research called the experimental asset markets (Smith, Suchanek, & Williams, 1988).

Why was this work so revolutionary? It was the first empirical demonstration of stock market bubble formation in a fully artificial, laboratory environment. Smith and colleagues conducted a series of experiments with students and professionals in finance, in which they asked 6–20 people to trade an asset over a number of trading

[1] The quotation comes from the Big Think interview with Vernon Smith. The interview and the transcript are available at https://bigthink.com/videos/big-think-interview-with-vernon-smith.

[2] The Nobel Prize, https://www.nobelprize.org/prizes/economic-sciences/2002/summary/ last accessed 01.11.2019

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periods, such that this asset would pay out a dividend at the end of each trading period. Due to the paid-out dividends, the rational value of the traded asset would decrease across periods. However, both naïve student participants and finance professionals were found to inflate the price of the asset with regard to its rational price. In experimental asset markets is referred to as the *fundamental value*. Participants were informed about the value of the dividends and all of them had exactly the same information. The initial set of SSW experiments followed by a large number of studies that utilized the initial design persistently resulted in a typical "bubble-and-crash" scenario (see Nuzzo & Morone, 2017; Palan, 2013; and Powell & Shestakova, 2016, for a review).

The persistent re-occurrence of market bubbles and crashes has been puzzling and fascinating not only for academics but also for practitioners. One of the first officially listed stock market bubbles is the "Dutch tulip mania." It refers to the inflation and collapse of the price of contracts for tulip bulbs. The tulip mania is one of the most often cited market bubbles in the literature (see, e.g., Sornette, Cauwels, & Smilyanov, 2018, for a review of 40 historical market bubbles), but there are many more to list, including the dot-com bubble of 1995–2000, the British property bubble in 2006, the uranium bubble in 2007, Bitcoin bubble in 2009, silver and gold bubbles in 2010, and the most pronounced—the global economic crisis in 2008–2009 that shook a number of stock markets around the world. In the face of the persistent re-occurrence of market bubbles and crashes, this raises the question of "what are the psychological mechanisms of an individual and of the aggregate market participants that constitute the underpinnings of the 'irrational exuberance'[3] present during bubbles and crashes?"

A typical answer of the "psychology of a trader" provided by both academics and finance professionals would involve a picture similar to that shown in Fig. 10.1. This figure depicts a number of strong emotional states and moods that occur at different time-points during a market bubble-and-crash cycle. It is strongly connected to what John Coates—a former Wall Street trader for Goldman Sachs and Deutsche Bank and a research fellow in applied physiology at the University of Cambridge—calls the "physiological rollercoaster." According to Coates, as a result of various market conditions, traders and investors experience certain physiological changes (i.e., hormonal changes) in their bodies, linked to strong emotions. Being aware of their bodies' physiological states could help them to anticipate their feelings and emotions and, consequently, avoid biases.

However, focusing on human emotions and behaviors during market bubbles and crashes remains in contrast to the classical theories in financial economics. The *efficient market hypothesis* (EMH) whose coinage is attributed to an American economist and the 2013 Nobel Prize winner Eugene Fama (1970) assumes that stocks are always traded at their true and fair price, because a stock price incorporates all necessary information. Therefore, EMH assumes that markets efficiently

[3] Irrational exuberance refers to market overvaluation. The phrase was coined by Alan Greenspan who was a US Federal Reserve chairman in the years 1987–2006. He used this term to refer to the dot-com bubble in the 1990s.

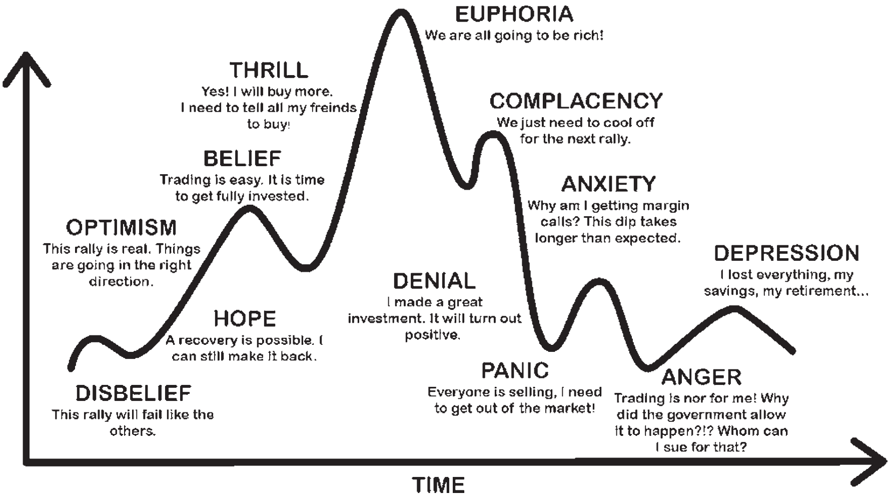

Fig. 10.1 A non-scientific diagram depicting the emotions and actions of a trader during a stock market bubble and crash. Many similar pictures can be found when Googling the term "psychology of a trader"

incorporate all information in the stock prices and this information is available to all investors. If this was the case, there would be no arbitrage opportunities[4], and no additional analysis of stocks would give an investor a competitive advantage over other investors. However, if we again refer to the quote of Vernon Smith opening this chapter, we realize that mispricing occurs even when all market participants have complete information about the stock prices and their "rational value." Observations like this have debunked the theory of perfectly rational *homo economicus* and given birth to the fields of behavioral economics and behavioral finance, which aim at explaining why people with their *bounded rationality* (Simon, 1972, 1979) do not always follow the best economic solutions to their investment choices. These fields deal mainly with the biases and cognitive limitations of an individual decision maker, which are described in more detail in Part II of this book.

Nobel Prizes were also awarded to researchers dealing with the quantitative analysis of stock markets. Harry Markowitz received this prize in 1990 together with William Sharpe and Merton Miller, for developing the Capital Asset Pricing Model (CAPM, Fama & French, 2004). This model is a portfolio optimization method based on mathematical analysis of historical stock market prices and correlations among them. The model outputs weights for assets in the portfolio to maximize expected return respective to the minimum risk level. During his interview with Jason Zweig for *The New York Times*, Markowitz openly admitted:

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[4] Arbitrage is a situation in which an investor can use the mismatch of prices by buying low and selling high. Arbitrage can happen when prices differ across markets or when markets are inefficient.

> I should have computed the historical co-variances of the asset classes and drawn an efficient frontier[5]. I visualized my grief if the stock market went way up and I wasn't in it—or if it went way down and I was completely in it. So I split my contributions 50/50 between stocks and bonds.[6]

Interestingly, the inventor of a portfolio optimization method applied a naïve diversification heuristic (i.e., the 1/N heuristic) to his own investment. This should direct our attention to the fact that every decision maker may be prone to simple biases, despite their background knowledge. What makes humans prone to particular biases and which of these biases are most present during market bubbles and crashes? Is the lack of rationality the underlying factor of irrational exuberance? How do people behave during market crashes? This chapter will provide a summary of research areas tackling these questions. First, it will explain the taxonomy of market bubbles and crashes, along with some essential financial and economic theories. Next, the chapter describes the key research devoted to the psychological aspects of experiencing extreme events, depressions, and losses. Also, it discusses the experimental techniques of investigating the behavior of stock market players, including psychometric and physiological measures. Finally, the review will refer to the field of econophysics that complements investigation of the aggregate behavior of stock market players. Therefore, this chapter will incorporate knowledge from finance, economics, psychology, biology, physics, and mathematics. The aim is to provide a broad overview of the research devoted to psychological aspects of stock markets bubbles and crashes, rather than to give an exhaustive knowledge compendium. Interested readers will be directed to the relevant literature that deals with particular aspects in more detail.

Taxonomy of Stock Markets, Bubbles, and Crashes

Stock markets are complex systems whose primary social function is the aggregation of opinions and channeling them into the most promising ventures. Investing in stock markets is characterized by decision making under uncertainty (see Chap. 9 in this book for a broader explanation). *Keynesian uncertainty* (Keynes, 1921) assumes that the possible consequences of an action are known but the actual events are unknown. It implies imperfect information and the impossibility of computing probabilities that certain events will occur. This is why forecasting, based on either past historical data and trends or vague diluted information, is a very important aspect of trading on stock markets.

Studying stock markets is rooted in complexity theory that evolved mostly due to the development of computers and computing power, which allows processing large

[5] In the Capital Asset Pricing Model, the efficient frontier is the curve that defines the maximum expected return for the possibly lowest risk level.

[6] https://www.nytimes.com/2007/09/29/business/29nocera.html?mtrref=undefined&gwh=70AE488A7619DE2C0CBE032AC752A93C&gwt=pay&assetType=REGIWALL

amounts of information in an interconnected network. Mathematically, complex systems cannot be described using a closed-form solution and are computationally irreproducible. Therefore, market crashes should be considered as extreme, unpredictable events that are beyond the normal state of affairs. Some researchers refer to market crashes as *black swans*[7]. A key feature that makes black swans unpredictable is that their probability of occurrence is impossible to compute and is beyond the *fat tail*[8] of a probability distribution of an event happening.

However, some computational methods rooted in *fractal theory* for which Benoit Mandelbrot is known have been applied to predict market bubbles and crashes (Zhang, Zhang, & Sornette, 2016). Fractal theory is based on the self-similarity of patterns; one of the commonest examples is a snowflake that is composed of arms of the same pattern, in which each arm is composed of the very same patterns, up to the nth level. What do snowflakes have to do with stock market prices? Let us imagine market conditions turning from *bullish* to *bearish*[9] exhibiting a *head-and-shoulders pattern*[10] in the last 6 months. This pattern is a composition of smaller head-and-shoulder patterns on a monthly scale, where each of these monthly patterns is a composition of the same patterns on the weekly scale, etc. Didier Sornette and colleagues have demonstrated that using this approach, called the *log-periodic power law singularity* (LPPLS; see Sornette, 2017, for an explanation of this method), can be successful in predicting irregular patterns in the stock price development. These "irregularities" are conceived in the *dragon king theory* (Sornette, 2006) that defines extreme events such as crashes as special creatures that have an exceptional impact (king) and, compared to their peers (i.e., similar market patterns), have unique origins (dragons). In 2013, Sornette established the Financial Crisis Observatory[11], a platform on which his team regularly posts reports and warnings of financial crises and crashes based on time series of about 1300 various assets

7 The black swan idea was developed by a former trader and risk analyst Nassim Taleb. The theory aims to explain the role of highly unpredictable events and psychological biases that magnify the impact of these extreme events. The name of the theory comes from ancient folklore that assumes that black swans do not exist.

8 A fat-tailed or heavy-tailed distribution is a probability distribution that exhibits a large skewness or kurtosis, assigning relatively high probability weight to events or values that are far from the mean of the distribution.

9 Bullish market patterns are conditions in which stock prices are rising or are expected to rise. The opposite situation is described as *bearish*. Based on this terminology, many stock markets and investment firms use the imagery of a bull and/or a bear.

10 Traders and investors who use price charts to classify patterns of stock price developments are called *chartists*. A head-and-shoulder pattern is characterized by two shoulders (the left one containing rising prices and the right one containing decreasing prices) and a head (a peak) in the middle. There are numerous patterns that have been classified. A curious reader is encouraged to simply Google "price chart patterns" to obtain lists and descriptions of these patterns.

11 https://er.ethz.ch/financial-crisis-observatory.html

worldwide. The main challenge is to identify the time-window in which a crash is likely to occur (Andersen & Sornette, 2005)[12].

The fractal-based approach is used to identify *endogenous crashes*—crashes that are not triggered by a particular stimulus but rather result in price disintegration characterized by smaller up-and-down patterns (Sornette, 2006; Sornette, Deschatres, Gilbert, & Ageon, 2004). In contrast, *exogenous crashes* are triggered by an external event, such as political elections, a critical piece of news, a natural disaster that could have a strong impact on the economy, etc. Recent history has witnessed a number of such crashes, for example, the crash of the Swiss Stock Market Index on the January 15, 2015, that was a reaction to the Swiss government's decision to decouple the Swiss Franc from the Euro. This decision allowed an increase in the value of the Swiss Franc in relation to other European currencies. A similar phenomenon occurred on several European markets after the results of the Brexit referendum in 2016 were announced.

A very short-lived (i.e., a few hours or one-day long) exogenous crash is called a *flash crash.* Nowadays, due to the relatively high percentage of total *trading volume*[13] on stock markets being traded by algorithms, flash crashes occur very frequently and are quickly "corrected" by the algorithms (Subrahmanyam, 2013, provides a review of the impact of algorithmic trading on market stability). Market crashes should be distinguished from depressions and crises. The two latter would refer to a prolonged period of time characterized by a bearish market or poor macroeconomic conditions, such as low GDP growth, high unemployment rate, etc.

Having defined a crash, I will also define a bubble. Mathematically, a bubble is a price pattern characterized by *faster-than-exponential* price growth (Leiss, Nax, & Sornette, 2015), where the price at time t is defined as a function of the price at time 0:

$$P_t = P_0 \left(1 + r\right)^t, \tag{10.1}$$

where r is the growth rate.

In the experimental economics terminology, a price bubble is a substantial departure of the stock price from its fundamental value, such that it is measured by either an absolute or a relative deviation (Stöckl, Huber, & Kirchler, 2010).

After this very brief introduction to the mechanisms generating and classifying market bubbles and crashes, in the two following sections, I will explain how various types of crashes and extreme events can be linked to different psychological mechanisms.

[12] Sornette used the same approach to predict outbreaks of epidemic diseases, earthquakes (Sornette, 2002), and social events (Crane & Sornette, 2008; Gisler & Sornette, 2009, 2010).

[13] Trading volume refers to the turnover of stock units on a given market or of a given company.

The Individual's Experience of Extreme Market Events

What impact do market crashes, crises, depressions, and other types of turbulent markets have on an individual decision maker? According to behavioral decision theories, negative outcomes result in a strong affect that influences the decision process (Peters & Slovic, 2000). Also, in agreement with the assumptions of *prospect theory* (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992), losses are experienced "more strongly" than gains. Would these effects also hold for decisions made in complex risky environments with higher stakes?

The seminal study that aimed at answering this question was conducted by Malmendier and Nagel (2011). In their cross-section field study using data from the Survey of Consumer Finances from 1960 to 2007, they found that *depression babies*—people who lived through a low stock market in their formative years—are less willing to take financial risks, are less likely to participate in the stock market, invest a lower fraction of their liquid assets in stocks, and are more pessimistic about future stock returns. However, these effects hold only if one personally experienced a substantial loss. In an econometric study on the Danish population, Andersen, Hanspal, and Meisner Nielsen (2019) showed that personally suffering a financial loss due to an unlucky stock investment prevents one from future investments. Liu, Tsai, Wang, and Zhu (2010) found the opposite effect for experiencing gains. They showed that traders on a Taiwanese Futures market took above-average risks in the afternoon if they had made gains in the morning.

Lejarraga, Woike, and Hertwig (2016) conducted a laboratory experiment, in which they repeatedly presented participants with historical market data of IBEX-35 in the years 1999–2009 that included a crash in January 2008. During each round, participants could see an additional piece of the price pattern and had to decide how much of their resources to allocate to a risky asset or to a risk-free asset. Eventually, they saw the complete pattern. Participants in the crash condition viewed the original index pattern, while participants in the boom condition viewed the same price pattern but flipped upside down, resulting in a boom. Participants' payment was performance-based, given the following market outcome. The results of this study indicated that experiencing a crash reduced people's risk-taking behavior, whereas experiencing a boom had the opposite effect. People's risk-taking was higher when information about the riskiness of the risky asset was presented in a descriptive way rather than directly experienced.

This evidence is in line with the findings of Imas (2016), who highlighted that only the realization of losses, by making participants own a portfolio that is decreasing in value, resulted in a consequent decrease in risk-taking. He indicated that paper losses (i.e., making participants observe a decreasing price pattern) did not have such an effect. Indeed, based on large-scale survey data, Kuchler and Zafar (2019) demonstrated that personally experiencing a lack of employment made one more pessimistic about future nationwide unemployment. They also showed that expectations about house prices are primarily based on one's recent experiences about prices rather than general trends in housing prices. Laudenbach, Malmendier, and Niessen-Ruenzi (2019) attribute this phenomenon to *emotional tagging*, which can assign weights to particular factors during belief formation.

Cohn, Engelmann, Fehr, and Marechal (2015) conducted a field study in which they primed their participants with stock market crashes. During a financial trade fair, they set up a temporary laboratory and asked finance professionals to make investment decisions after viewing an animated graph of either a market crash or a boom. Participants who were primed with the concept of a crash were less likely to take financial risks than investors who were primed with a boom. In a similar experiment, Cordes, Nolte, and Schneider (2017) also primed their participants with a concept of either a boom, a bust, or a random scenario by presenting them with price information appearing across 15 experiential rounds, followed by 15 decision rounds in which participants had to allocate their wealth between the risky and risk-free assets. They applied the same exercise in 2 treatments: (1) an observing condition, in which participants are presented with the whole price path from the 15 rounds at once, and (2) an experiencing condition, in which participants "experienced" the developing price across 15 rounds. The boom scenario resulted in the highest risky asset allocation, while the bust scenario resulted in lower risk-taking. However, this effect only held for the experience treatment, supporting the *description-experience gap*[14] in risky decisions (Hertwig & Erev, 2009).

Differences in preferential choice in the description-experience gap are usually attributed to under-sampling in decisions from experience. This is especially significant when choice options involve low-probability outcomes (such as stock market crashes). Due to the fact that decision makers do not experience enough low-probability "bad" outcomes (because they base their choices on a limited number of samples), they tend to make riskier decisions in comparison to the condition in which the same decision problem is presented descriptively (i.e., when outcomes and their exact probabilities are explicitly displayed). However, enlarging the sample size does not fully eliminate the description-experience gap, indicating a difference between experiencing particular event consequences and only being informed about the possible consequences (Hau, Pleskac, Kiefer, & Hertwig, 2008).

Another strand of research highlights the importance of sampling by experience for the purpose of enhancing the understanding of choice options. Sampling can make events either invisible or particularly salient and memorable, especially when the event is unpleasant (Redelmeier & Kahneman, 1996). "Experience has a crucial role in learning and forming judgments" (Hogarth & Soyer, 2015a, p. 1801). Several studies have shown that *simulated experience* leads to more accurate probability judgments (e.g., Hogarth & Soyer, 2015a) and statistical information communication (e.g., Hogarth & Soyer, 2015a, 2015b, 2015c). Simulated experience refers to having people experience possible outcomes of their decision through a simulation.

[14] The description-experience gap refers to the fact that people take different decisions when choice option outcomes and their corresponding probabilities are personally experienced or when they are presented in a descriptive fashion. In the experience mode, a respondent would have to sample information about the possible outcomes and the frequencies of which they can occur, before the decision maker expressed their preference for one choice option or another.

Towards this aim, Bradbury, Hens, and Zeisberger (2015) introduced a novel method of simulated experience that improves people's understanding of probabilities by asking them to view a series of possible price paths, accompanied by a histogram of the expected returns. The authors demonstrated that this simple task improves participants' understanding of outcome probabilities. Grosshans and Zeisberger (2018) experimentally demonstrated that the same returns presented as different price patterns substantially influenced customers' satisfaction from an investment and the perception of its riskiness. This could be facilitated by the fact that "by building the simulation or simply by sampling experience, decision makers actively participate in the decision making process" (Hogarth & Soyer, 2015a, p. 225).

Andraszewicz, Kaszás, Zeisberger, and Hölscher (in preparation) proposed a new experimental design in which participants experience historical market events, such as market crashes. However, a participant's experience (i.e., making a loss or a gain) would depend on his or her actions earlier in the same experiment. For example, Andraszewicz et al. (in preparation) found that participants who experience an exogenous market crash but are not invested when the price sharply drops use the crash to buy into the market to increase their profits. In contrast, participants who experience an endogenous market crash only are more profitable buying shares early, when the bullish market starts. However, participants who join the trend too late tend to underperform. While this finding may sound obvious, it is a novel laboratory demonstration of the fact that market crashes are "bad" only for some people, while others can profit from bearish markets.

Simulated experience could pose a powerful tool for improving decisions by debiasing the decision process and helping to avoid certain mistakes. This is especially important in view of the fact that lessons should be taken from historical crashes and crises (Blinder, 2015). For example, Kaufmann, Weber, and Haisley (2013) developed a risk tool to communicate risk-return ratios through a simulated experience.

The literature reviewed in this section shows that personally experiencing negative and extreme events can lead to decreased financial risk-taking. Experience clearly plays an important role in improving the understanding of probabilities, losses, and the consequences of one's decisions. However, this area of research is still in its nascent phase. The review of literature in this section may not be complete, but it presents the major research conducted on the topic related to experiencing extreme financial events.

Typical Biases on the Stock Market

There exist at least 60 different biases that can have an effect on financial decisions (see Kumar & Goyal, 2015, for a review). For example, the *group think bias* can be present when a group is making a forecast or an investment decision under uncertainty or with limited information. Due to the similar beliefs of group members, the group fails to consider the counter-arguments to their own belief, and they fall prey to limiting themselves to one idea. Other biases based on following the group rather than one's personal opinion is *herding* (discussed later in this chapter) and *confirmation bias*, when one's initial opinion is confirmed by another person's belief or information, strengthening this initial opinion by receiving only the confirmatory information and overlooking counter-information.

Another frequently occurring inclination is *home bias*, which refers to overweighting domestic companies in one's portfolio. For example, a home-biased German trader may have a relatively high number of stocks of German companies in their portfolio, even when these stocks perform worse than stocks of foreign companies. Home bias does not have to refer to one's country of origin or residence. It can also refer to the city or birthplace or any place to which a trader may feel emotionally connected (Lindblom, Mavruk, & Sjögren, 2018). Investors systematically expect higher returns. One way to measure home bias is to compute the optimal portfolio using the CAPM approach and use it as a benchmark against the trader's actual portfolio. Certain individual traits may enhance (ambiguity aversion) or decrease (openness to new experiences) the strength of home bias (Niszczota, 2014).

The *disposition effect* is probably the most extensively researched cognitive bias in behavioral finance. It refers to investors' robust and disproportionate tendency to sell well-performing (i.e., increasing in value) stocks and hold badly performing (i.e., losing value) stocks (Odean, 1998; Weber & Camerer, 1998). The disposition effect can be induced by the emotions of regret or rejoicing, while experiencing a gain or loss without real consequences or responsibility is insufficient to induce the effect (Summers & Duxbury, 2012; see also Chap. 6 in this book). Women exhibit a stronger disposition effect (Rau, 2014), while more experienced (Da Costa, Goulart, Cupertino, Macedo, & Da Silva, 2013) and more sophisticated investors (Dhar & Zhu, 2006) exhibit a weaker disposition effect. These are just a few factors influencing the disposition effect elicited from an assortment of studies devoted to it.

One of the most important biases in investment and trading is *overconfidence* or the *better-than-average effect*. Typical examples of overconfidence include findings that 80% of drivers believe their driving skills are above-average (Svenson, 1981) and 94% of academics consider themselves above-average in their field of research (Mele, 1997). Overconfidence has also been defined as "the most pervasive bias" (Shariatmadari, 2015) and one of the most robust findings in the psychology of judgment and choice (De Bondt & Thaler, 1995). There are three facets of overconfidence: *overprecision*, *overestimation*, and *overplacement* (Moore & Healy, 2008). The examples of Svenson (1981) and Mele (1997) constitute perfect examples of overplacement. Overprecision is defined as "an excessive faith in the quality of our judgment" (Moore, Tenney, & Haran, 2015, p. 4.) and is also referred to as miscalibration. Finally, overestimation occurs when individuals overestimate their "actual ability, performance level of control or chance of success" (Moore & Healy, 2008, p. 3). Sixty-four percent of empirical papers published up to 2008 examine overconfidence in the form of overestimation (Moore & Healy, 2008).

Overconfidence is especially important in financial forecasting and belief elicitation. During trading and investing in uncertain or risky ventures, people commonly refer to using their "gut feelings." In behavioral finance, it is a standard procedure to elicit and incentivize participants' belief about the future price of an asset or a trend. There are various methods of belief elicitation. Some of them refer to *point estimates* (i.e., asking a respondent to indicate the exact predicted number), while others employ the so-called roulette prior belief elicitation (Gore, 1987; Johnson et al., 2010; Morris, Oakley, & Crowe, 2014) that are based on distributing one's probability belief chips proportionally to the weights assigned to particular events. The term "roulette" comes from the initial design, in which participants received 20 roulette chips that they could freely allocate to the available events.

In economic thinking, it is essential to apply a *proper scoring rule* (Carvalho, 2016) to incentivize honest belief elicitation. A proper scoring rule is a method to calculate a participant's payoff for providing an honest opinion. For example, in the face of the inability to verify what one's honest opinion is, a person may not be motivated to share it and give either misleading responses or random responses to limit the time needed to spend on the experimental task. Therefore, rules for calculation the error between one's estimate and the actual value to be estimated have been devised to provide monetary compensation for sharing honest beliefs that minimize error. A quadratic scoring rule is a rule that takes the error to the power of two, while the linear rule takes the difference between the belief and the actual value. There is an ongoing discussion on which scoring rule is the most effective.

Incentivization has an important impact on trading and investment. The most well-known incentive problem in finance is the *agency problem* (Eisenhardt, 1989), which highlights the conflict of interests between the manager (i.e., the principal) and the employee (i.e., the agent). For example, in a situation where the agent's compensation is strongly linked to the performance of their portfolio, they may be inclined to take substantially more risk, even if this is against the interest of the employer. In real life, this problem is often viewed in, for example, the insurance sector where underwriters are incentivized by signing more insurance contracts, which, at the same time, exposes the insurance company to higher risk. In trading, the bonus structure may also generate the principal-agent problem. For example, if a bonus is paid out only to the best performing traders on the trading floor, it may induce unfair behavior on the trading floor, misconduct (i.e., *insider trading*[15]), or excessive risk-taking. Alternatively, a flat salary (i.e., not related to one's performance) may not be motivating enough to avoid losses or to generate higher gains. Therefore, a correctly designed compensation scheme should align the interests of the principal and the agent, such that the risk of decision making and information are proportionally spread. For example, Cadsby, Song, and Tapon (2007) found that pay-for-performance compensation increases a firm's earnings compared to flat salaries. However, in trading, rank-based (i.e., based on the relative performance in

[15] Insider trading implies trading stocks of a publicly traded company, based on non-publicly available information, such as information about structural changes within the company. Insider trading is illegal and, when identified, can lead to large penalties imposed on the trading agency whose employee committed insider trading.

relation to others) payment results in increased risk-taking and consequently in larger market bubbles (Palan, 2013)[16].

Incentive schemes define the decision environment that can either enhance or diminish biases. Some environments enhancing investment biases can be visual rather than monetary. For example, Weber, Siebmorgen, and Weber (2005) showed that the format for how the historical volatility of an asset is presented significantly impacts the perceived volatility of the asset. Consequently, this impacts the perceived riskiness of this asset and the willingness to invest in it. The results showed that presenting the historical returns as a continuous density distribution leads to higher subjective risk and volatility estimates than presenting the same information in the form of a bar graph. However, only perceived risk and expected returns, but not perceived volatility, played a role in predicted portfolio decisions.

Along similar lines, Huber and Huber (2019) investigated the impact of a graph scale of risk perception, return expectations, and propensity to investment in the assets presented on the graphs. They manipulated the y-axis of two types of figures: (1) historical returns displayed as bar graphs and (2) historical line price charts. When the scale of the y-axis was wide (i.e., it made the bar graph and the price chart look flatter), the perceived risk of the asset was lower. Their participants were more likely to invest in an asset when presented with a bar graph of historical returns than when presented with a historical price chart.

Making investment mistakes due to psychological biases is a much discussed topic among finance practitioners. One way to avoid certain biases is to devise an appropriate *choice architecture* that *nudges* a decision maker to less biased decisions. These two topics have been vastly researched from the perspective of individual investment decisions such as product purchases or choices of an investment plan. In stock market trading, similar research could be conducted using various new *FinTech*[17] solutions, which are currently a growing industry.

The Role of Individual Differences on the Trading Floor

Individual differences that play an important role in trading and investment include personality-related traits and biological factors. Biological factors are often representations of certain emotional and mental states such as attention, euphoria, depression, aggression, and stress. There is no single method that can investigate all of these. The research field that deals with linking investment behavior with neural and brain activity is called *neuroeconomics*, and its presentation goes beyond the scope

[16] Recent research devoted to incentive schemes and employee performance is summarized in the review by Devers, Cannella, Reilly, and Yoder (2007).

[17] FinTech stands for financial technology and refers to technologically inspired tools with application in finance. These tools include, for example, mobile payment apps, robo-advisors, financial data visualization tools, etc.

of this chapter (please refer to Chap. 1 in this book for more details). Here, I will focus on measurements that are not directly linked with brain activity.

Factors that are often utilized in behavioral investment studies are levels of hormones such as testosterone and cortisol, skin conductivity level, heart rate, body temperature, and eye-tracking (see also Chap. 3 in this book). These measures can be divided into those related to higher risk-taking (i.e., prenatal and present higher testosterone level measured either from saliva or from blood or artificially induced by the application of hormonal cream, pill, or injection) and higher stress level (heart rate, increased sweating resulting in increased galvanic conductivity, and enlarged pupils). The present section provides a summary of the findings that directly relate biological aspects to investment and trading behavior.

In their review, Coates, Gurnell, and Sarnyai (2010) conclude that hormones such as cortisol and testosterone play an important role in risk-taking and that these endocrine hormones can be predictors of economic behavior that are at play during volatile market conditions. They emphasize that the "body influences economic decisions, frequently pushing economic agents, for good or ill, away from rational choice." Coates and Herbert (2008) found that cortisol levels rise in professional traders in the City of London with increased asset volatility. Cueva et al. (2015) also found that high levels of cortisol and testosterone increase risk-taking in men role playing on SSW-type experimental asset markets, which can have an impact on market destabilization.

Prenatal testosterone is the level of testosterone to which a fetus is exposed in the mother's womb. This level of testosterone is reflected in physical body features such as the ratio of second (2D) to fourth (4D) fingers. Coates, Gurnell, and Rustichini (2009) found that second-to-fourth digit finger length ratio predicted the profitability of male high-frequency traders (i.e., the longer the second digit finger compared to the fourth digit finger, the higher the prenatal testosterone level and the more risk-taking a person is). Pubertal testosterone (i.e., the testosterone level present during puberty) reflects facial masculinity (i.e., facial dimorphism). These two features have been found to predict risk-taking activities in finance such as high-frequency trading (Coates et al., 2009) and to be negatively correlated with risk aversion (Sapienza, Zingales, & Maestripieri, 2009. Apicella et al. (2008) found a relation between facial masculinity and risk-taking. However, other studies brought more inconclusive results (i.e., Dreber et al., 2009). In view of the "nature vs. nurture" debate, it is safer to state that there is a clear relation between current levels of endocrine hormones rather than levels of these hormones present at different stages of human development.

Elevated cortisol level is not the only indicator of increased stress. Lo and Repin (2002) measured the skin conductance, blood volume pulse, heart rate, electromyographical signals, respiration, and body temperature of ten professional traders and found not only physiological reactions to high-volatility market periods but also individual differences in the baseline reaction and difference between the baseline and the stressful situation. Simple measures of bodily activity can also be used to detect biases. For example, Goulart, Da Costa Jr, Santos, Takase, and Da Silva

(2013) found that people showing greater disposition effect sweat more and have lower body temperature.

Elevated stress can be linked to attention patterns (Vedhara, Hyde, Gilchrist, Tytherleigh, & Plummer, 2000). In trading, this is especially relevant because a job of a trader often involves multitasking and integrating large amounts of information. Eye-tracking is a good tool for measuring attention. For example, Ognjanovic, Thüring, Murphy, and Hölscher (2019) asked finance novices (i.e., students not educated in finance), intermediates (i.e., finance and economics students), and professionals (i.e., active traders working in a bank) to judge which of two stocks presented on a computer screen was riskier. The presented information included the path price, an imaginary stock name, and several other metrics, excluding *volatility*[18], making the task particularly difficult due to the lack of objective measure available to participants. They found no difference in the quality of judgments between more and less financially experienced participants. However, they found that finance professionals were significantly more confident in their judgments and that they exhibited a much more focused visual search for information.

Personality skills and other cognitive abilities seem also to be linked to trading behavior (see also Chaps. 4 and 7 in this book). For example, Hefti, Heinke, and Schneider (2018) demonstrated that participants with higher cognitive analytical skills and higher *mentalizing*[19] abilities performed best on SSW experimental asset markets, followed by participants with only high analytical skills. Participants with only high mentalizing abilities performed the worst.

Several studies investigated the link between personality and trading behavior. For example, narcissists tend to select stocks with higher volatility in their portfolios, and they tend to lose more money during crises. This leads to the conclusion that narcissists invest more riskily (Foster, Reidy, Misra, & Goff, 2011). Based on a study of 200 investors from the Tehran stock market, Sadi, Asl, Rostami, Gholipour, and Gholipour (2011) found that personality traits such as openness and extraversion significantly correlated with *hindsight bias*[20] and overconfidence. Also, neuroticism positively correlates with *randomness bias*[21] and conscientiousness negatively correlates with randomness bias. Openness negatively correlates with *availability bias*[22].

Conlin et al. (2015) conducted an econometric study based on two large data repositories in Finland. They found that personality traits such as exploratory excitability—a subscale of novelty seeking and impulsiveness—positively correlate with

[18] In finance, volatility refers to the price variability across a certain period of time (i.e., monthly or weekly volatility). This measure can be conceived of as the standard deviation of the price. Volatility is the most important factor indicating riskiness of a stock.

[19] Mentalizing refers to being able to understand the emotions of others or, in simple words, "to be able to put oneself in the shoes of others."

[20] Hindsight bias refers to the feeling that a certain event was more predictable than it actually was.

[21] Randomness bias refers to seeing patterns in random data (i.e., seeing patterns that are not there).

[22] Availability bias refers to the tendency to think that the first available thought is more representative than it actually is.

stock market participation, while extravagance and sentimentality negatively correlate with stock market participation. Also, they found that subscales of personality questionnaires are better predictors than complete constructs. Similarly, Niszczota (2014) found that citizens of countries with higher levels of the personality construct "openness to experience" tend to have more diversified portfolios.

Further, higher *numeracy* and *financial literacy* are significant drivers of stock market participation (Almenberg & Dreber, 2015; Van Rooij, Lusardi, & Alessie, 2011). Numeracy refers to one's ability to process simple computations and understand basic mathematical principles (see Chap. 4 for a more elaborate discussion), while financial literacy is a concept that links financial knowledge and skills for dealing with finance concepts. Higher financial literacy is often linked to more sophisticated investment strategies (Fernandes, Lynch, & Netemeyer, 2014).

Experimental Asset Markets

As already noticed earlier in this chapter, the field of experimental asset markets originated from the seminal study by Smith et al. (1988) who created the SSW experimental design. The SSW setup is a simple market with a few people trading one asset that, every period, pays off a dividend making the value of this asset decrease over time (see Fig. 10.2). An experiment using the SSW design would usually include 5–30 repetitions of the market, each market lasting around 1–3 min. The number of players per market would vary between 6 and 20. This type of asset market can be implemented in standard computerized economic experimental tools such as zTree (Fischbacher, 2007) and oTree (Chen, Schonger, & Wickens, 2016).

The SSW design has generated a large experimental literature (see Palan, 2013, and Nuzzo and Morone, 2017, for reviews). It has been implemented in various

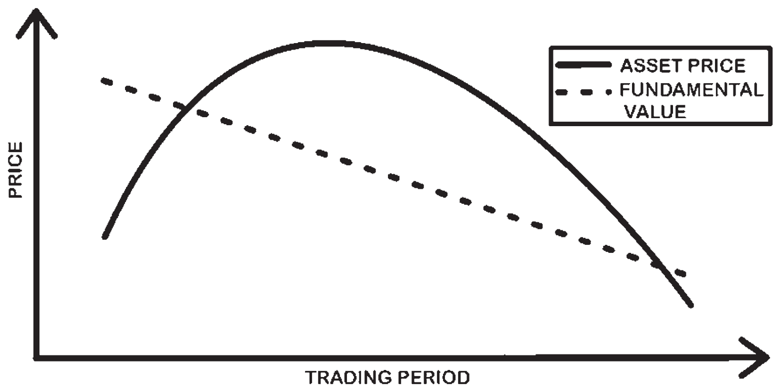

Fig. 10.2 A conceptual illustration of the market price and the fundamental price development on a typical asset market

versions, for example, as *complete and incomplete*[23] markets; as *call markets*[24], markets with single, two, or multiple traded assets, as markets incorporating various trading rules, such as inclusion of *transaction fees*[25], self-paced or time-constrained markets. Price bubbles and crashes are a robust stylized fact in this type of study, even when information about the rational price is directly provided to the participants (Powell & Shestakova, 2016). This phenomenon known as the *bubble-and-crash puzzle* has not been fully understood and "formal theoretical explanation is an area of future work" (Smith, Van Boening, & Wellford, 2000).

Palan (2013) provided a list of factors that have been found to mitigate price bubbles in an experimental setting. These factors include:

- **Experience of a trader**—a higher percentage of less experienced traders on the market results in bubble inflation. Therefore, less experienced traders are more prone to biases and higher risk-taking. Experiments with a larger number of repetitions for the same pool of participants show lower mispricing than experiments with fewer trading rounds. However, in the SSW experiments, professionals do not produce smaller bubbles than students.
- **Common expectations of rationality**—when an experimenter assures that all participants understand the value of the dividend equally well, bubbles are smaller.
- **Low cash-to-asset ratio**—the larger the amount of cash on the market, the more money can be spent on stocks, and the higher their prices become.
- **Large accrual dividend**—paying a lump sum dividend at the end of the experiment instead of at the end of each round has been shown to reduce bubbles, which makes traders focus on long-term strategies.
- **Trading teams instead of individual traders**—Charness and Sutter (2012) argue that groups are less prone to individual cognitive biases due to the feeling of membership in the group. Also, group decisions may be a way to protect oneself from one's own cognitive and information limitations (i.e., lack of self-discipline to delay gratification).
- **Lack of overconfidence**—participants with higher levels of overconfidence trade more riskily and at higher prices.
- **Existence of alternatives to trading**—according to the *active market hypothesis* (Lei, Noussair, & Plott, 2002), generating bubbles in laboratory experiments can be attributed to boredom or lack of other activities.
- **Short selling**—in the language of finance often called "shorting" or "going short," short selling means borrowing shares of an existing company through their broker and selling this borrowed stock (despite not owning them) at the

[23] A complete market is a market in which the number of securities equals the number of the states of nature.

[24] In call markets, transactions happen at predetermined time intervals, and bid (maximum price at which a buyer is willing to pay for an asset) and ask (minimum price at which a seller is willing to sell an asset) orders are aggregated and executed at specific times.

[25] A transaction (i.e., a buy or sell order) fee is paid by an investor to the broker for executing it.

current market price. After selling the borrowed stocks and cashing out, one repays the broker for the borrowed shares at the market price. Short selling is done when one speculates on stock prices declining. Short selling can reduce bubbles by lowering prices.

- **Limit price change rule**—is a rule that sets limits by which a price can change within a given contract. Such rules limit the expectations of rapid price changes and, therefore, limit mispricing.
- **Non-tournament type of compensation and comparison to the best players**—incentive structures play an important role in risk-taking during trading. Compensating traders for being at the top of the rank (i.e., receiving a bonus/payment only when one is better than others) induces the motivation to take higher risk. Sornette et al. (2019) found that the highest risk-takers are at the top or at the bottom of the rank, while medium risk-takers are in the middle of the rank receiving medium or no bonuses.

Despite the above-presented list of factors reducing mispricing, bubbles never disappear completely. Stöckl et al. (2010) found that the way the dividend payment is explained in the SSW experiments is confusing to participants. Usually, investors would enter the market with the expectation of a positive trend. However, in the SSW design, the fundamental price of a stock is decreasing during the trading period.

Irrational mispricing has also been reported in designs other than the SSW. Some authors introduced changes to the SSW design to measure mispricing depending on these design changes. For example, Bostian and Holt (2009); Holt, Porzio, and Song (2017); and Smith, Lohrenz, King, Montague, and Camerer (2014) used *double auction markets*[26] implemented in Vecon Lab[27], which allow for various dividend-generating mechanisms, payoff schemes, transaction costs, taxes, etc. Bostian and Holt (2009) introduced another change by conducting their study online, with a number of students enrolled in a finance class that could participate in the experiment at a designated time from any place they wanted, as long as they had access to the Internet. In all three studies, the dividend was paid out to the stock holders at the end of the trading period, and there were one or two assets available for trading. The major change to the SSW design was related to the various structures of dividends and fundamental values, including flat fundamental values, random dividends, etc. In the SSW-like design with multiple short trading periods with a single asset or assets with a complete number of states with known probabilities, Plott and Sunder (1988) implemented dividends that were dependent on the state of events at the end of the trading period.

Other experimental markets included the study by Palfrey and Wang (2012) who implemented a computerized laboratory experiment with a series of 11 experimental sessions with 6 markets attended by 10–12 players each. Each trading period lasted 50 s. They investigated pricing of markets with a single security, complete

[26] In a double auction market, buyers and sellers submit their orders simultaneously to an auctioneer or a trading platform.

[27] http://veconlab.econ.virginia.edu/da/da.php

markets with six securities, and markets that allowed short selling, given good or bad public information determined either with a toss of a fair coin or a roll of a fair die. The success of each security would depend on the public information. They reported over-pricing in single and complete markets with no news or with the same amount of good and bad news, while removing short-selling partially reduced mispricing but did not eliminate it. Ball and Holt (1998) conducted a non-computerized classroom market game with 5–6 students per trading team, allowing for minute-long trading, incentivizing students with real money at small stakes. They reported that asset prices exceeded their fundamental values.

Other studies focused on investigating the trading dynamics in different classes of markets. For example, a review by Friesen and Gangadharan (2013) outlines how experimental environmental markets—markets on which one trades tickets/permits for pollution limits or use of natural resources (i.e., fishing quota)—are used to investigate the impact of regulation on the individual behavior of traders in this complex trading environment. Depending on the set of trading rules, speculative bubbles occur. For example, allowing for permit banking, which refers to treating permits for the use of environmental resources as assets that can be bought, held, or leased. Alternatively, bubbles can be diminished, for example, when "permanent transfers are allowed only after traders have had some experience with temporary lease transfers" (Friesen & Gangadharan, 2013, p. 521).

Another category of studies uses *pari-mutuel betting games*, where market players can purchase tickets for a particular state of an event such that tickets are purchased at fixed prices (see Noussair and Tucker (2013), for a discussion on this type of markets). An example of a pari-mutuel betting market is a betting market for horse races, where the event can have multiple states (i.e., a given horse can end up in place 1, 2, 3, etc.). *Herding*[28] is a commonly observed behavior in this type of market, but eliciting bettors' beliefs directs their attention more to the probability of each state. These designs, however, are not applicable for studying asset markets.

Real financial markets are a particular form of *prediction markets*, in which prices are used to predict future events (Manski, 2006). Prediction markets grew in popularity from the early 1990s and "are defined as markets that are designed and run for the primary purpose of mining and aggregating information scattered among traders and subsequently using this information in the form of market values in order to make predictions about specific future events" (Tziralis & Tatsiopoulos, 2007, p. 75). In prediction markets, the possible outcomes are known, while the underlying probability structure of the outcomes is unknown and cannot be precisely estimated. Therefore, the participants of prediction markets make "educated guesses," while the market prices emerging from aggregated traders' beliefs should reflect the probability of future outcomes (Berg & Rietz, 2003; Manski, 2006). In financial markets, traders aggregate their beliefs concerning the future performance of firms, leading to prices that can be interpreted as predictions of the firm value.

[28] Herding usually refers to "following the crowd rather than one's own opinion," where in this case herding would mean "betting in disagreement with one's private signal but in favor of the consensus based on prior bets" (Noussair & Tucker, 2013, p. 8).

This is in line with the efficient market hypothesis, according to which the present price is equal to the discounted expectation of all future prices. In other words, the present price should be informed by all possible future scenarios that could impact the value of the firm.

One of the mechanisms underlying the predictive performance of prediction markets is the *wisdom of crowds* (Mannes, 2009; Ray, 2006; Surowiecki, 2005)—a phenomenon in which weak existing information diluted among many individuals may emerge above the large noise by aggregation in the group. Another mechanism is that experts, and even insiders who have special private information, may reveal their knowledge by trading (Chesney, Crameri, & Mancini, 2015). The main difference between prediction markets and the SSW and similar markets is that in prediction markets, the price of an asset should depend on the general belief of the market players about the future state of events, while in the SSW markets, the future market asset prices are determined a priori and known.

Prediction markets have been used to successfully predict political elections (Berg, Forsythe, Nelson, & Rietz, 2008; Forsythe, Nelson, Neumann, & Wright, 1992; Forsythe, Rietz, & Ross, 1999; Hansen, Schmidt, & Strobel, 2004), outbreaks of infectious diseases (Polgreen, Nelson, & Neumann, 2007; Tung, Chou, & Lin, 2015), sports outcomes (Kain & Logan, 2014), new bestselling products (Cowgill, Wolfers, & Zitzewitz, 2009; Elberse & Eliashberg, 2003; Ho & Chen, 2007), and the replicability of scientific results (Dreber et al., 2015), just to list a few examples. While the majority of prediction markets were conducted online, some have also been implemented in a laboratory (i.e., Haely, Linardi, Lowery, & Ledyard, 2010). The two most widely researched prediction markets are the Iowa Electronic Market used for predicting election results and Hollywood Stock Market that predicts the success (i.e., size of the box office) for new movies and movie stars. Deck and Porter (2013) provide a comprehensive review of the use of prediction markets in the laboratory and field studies.

Prediction markets have also been used to predict the time of the occurrence of events. For example, Othman and Sandholm (2013) conducted a large prediction-market study involving 210 participants (169 having placed at least 1 order) who, for 11 months, traded 365 securities corresponding to 365 days (possible states) on which the Gates Hillman Center would open, where the definition of the building opening was a vague term (i.e., it was not defined what occupancy would determine the opening). They used monetary prizes that were randomly allocated based on the number of tickets each participant collected, while participants traded with artificial money. The price distribution over the 365 possible states could also be interpreted as the probability distribution of each event coming true. A characteristic feature of this design was the automatized market-makers that were increasing liquidity on the market.

Artificial markets are used primarily to investigate the coordination, interaction, and aggregation of the actions of many players, rather than to focus on individual decisions. The same function fulfills the field of econophysics, in particular the agent-based modeling approach described in the following section.

Econophysics: What Social Scientists Could Learn from Physicists or the Other Way Round?

In contrast to experimental methods that focus on investigating the coordination behavior of human traders, the domain of agent-based modeling (ABM) attempts to simulate large groups of economic agents endowed with different strategies and cognitive biases to investigate the emergent market regimes' results from the collective behavior of these agents. ABM methodology has been used to explain the formation of bubbles and crashes (Samanidou, Zschischang, Stauffer, & Lux, 2007; Sornette, 2014; Sornette & Cauwels, 2014). ABM models describe psychological effects such as the illusion of control (Satinover & Sornette, 2007a, 2007b, 2009), rational and noise traders (Kaizoji, Leiss, Saichev, & Sornette, 2015), information cascades (Bikhchandani, Hirshleifer, & Welch, 1992), and many more that can shape the market. Agent-based-models are often rooted in the theory stemming from physics—the Ising model. In simple terms, this model defines in which one of two possible states (+1 or −1) the agent can be. In physics, these states refer to atomic spins and the propagation of the state among atomic neighbors. In economic simulations, this model constitutes the baseline for modeling effects such as *information cascades*[29]. Physical models can also be useful to simulate trading strategies (Kaizoji et al., 2015) and bubble formation (Harras & Sornette, 2011).

Huang (2015) utilized the Ising model to make the first attempt to link the experimental market approach with the ABM approach. He conducted an experiment, aligning it with an agent-based simulation that resulted in converging results. However, econophysics and experimental economics still evolve in parallel. The point of this section was not to give an exhaustive description of econophysics, but rather to draw the reader's attention to the methodologies that could complement each other.

Concluding Remarks

This chapter provided an overview of the research conducted to investigate the inefficiencies and anomalies of stock markets. Humans are prone to various types of psychological biases, such as the disposition effect or the overconfidence bias, that can depend on either the decision environment, the presentation of particular choice options, or one's individual traits. Investigating the influence of individual traits on investing behavior poses a number of challenges. For example, measuring one's physiological reaction to losses would require constant monitoring of one's

[29] Information cascade is a process of propagation of information from one person to multiple people. This phenomenon is often present in stock markets when pieces of news propagate and impact individual investment decisions.

physiological (i.e., hormonal or skin conductivity) changes. It may not be feasible to regularly collect saliva samples of traders busy doing their job or to regularly measure their skin conductivity using high-precision electrodes. However, new technologies, such as the usage of sensors built into smartphones for stress detection, could open new research possibilities.

The main challenge in linking personality or other self-reported measures with trading behavior is the fact that every self-report measure is biased by social desirability. On the other hand, for the elicitation of risk preferences, self-reported questionnaire-like measures have proven to be the most stable and most successful in predicting one's actual risky behaviors (see Frey, Pedroni, Mata, Rieskamp, and Hertwig, 2017, and Pedroni et al., 2017, for a more elaborated discussion).

Despite the abovementioned challenges, it has been shown that the key biological factors related to trading behavior and bubble generation are testosterone and cortisol levels. Personality seems to play an important role in being prone to particular psychological biases as well as to risky investment decisions. Numeracy, financial literacy, and analytical skills are key determinants of stock market participation and performance. Therefore, a summary of current research in this domain would point out that a successful investor has good financial knowledge, mathematical skills, and high social skills that allow her to successfully predict the behavior of other market participants, is able to suppress immediate emotions, and can feel her bodily responses to stress and strong emotions. It is not yet clear which personality traits would make a better investor.

However, exploring such research questions in the future would be possible due to the development of empirical methods in economics, inspired by psychological insights. Methods such as experimental asset markets revolutionized economic studies by creating a new sub-field—experimental economics. While most economic studies are conducted in the laboratory, it is necessary to mention the work of John List who not only pioneered field studies in experimental economics but also created classification and statistical methods that help to deal with the noise variables often present in unstructured environments.

Independent of the type of study (laboratory or field), psychology plays an important role in how stock markets function. This is the reason why regulation in finance more often accounts for human cognitive limitation and focuses on customer protection. For example, according to the rule of suitability included in Article 19(4) of the Markets in Financial Instruments Directive (MiFID) issued by the European Commission and the US-based regulation defined by the Financial Industry Regulatory Authority (FINRA), a financial institution offering investment advice and products is obliged to present risk and return information about an offered asset in a transparent way. However, as Huber and Huber (2019) showed, this regulation is underspecified leaving too much space for interpretation and manipulation of the perceived riskiness of an asset. Therefore, current regulation leaves a lot of room for improvement from the side of behavioral science in the context of trading and investment.

The alternative future scenario is that our investments will be fully controlled by algorithms (i.e., *algorithmic trading*[30]) or we could completely rely on *robo-advisors*[31]. Nowadays, these two aspects are very hot topics in the FinTech industry. It would be very interesting to investigate the psychological traits, skills, and abilities of the people who program these algorithms and those that choose to make use of them. This field of research is evolving together with the available technology.

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[30] Algorithmic trading refers to the situation in which an algorithm with predefined trading strategies implements transactions that optimize its strategy.

[31] Robo-advisors refer to algorithms that make investment suggestions based on a predefined investment optimization strategy and supplied historical market data.

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Chapter 11
Cognitive Processes Underlying Impaired Decision Making in Gambling Disorder

Damien Brevers, Claus Vögele, and Joël Billieux

From Harmonious to Obsessive Gambling Passion

High involvement in gambling does not necessarily lead to negative consequences or to a linear increase in the number of disordered gambling symptoms (e.g., Kardefelt-Winther et al., 2017; Oikonomidis, Palomäki, & Laakasuo, 2019; see also Box 11.1 for the list of diagnostic criteria pertaining to the Gambling Disorder classification of the *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edition; DSM-5; APA, 2013). It is important to distinguish harmonious gambling passion (i.e., a strong inclination to engage in gambling willingly and with a sense of volition) from obsessive gambling passion (i.e., an uncontrollable urge to engage in gambling, which interferes with daily life functioning; Rousseau, Vallerand, Ratelle, Mageau, & Provencher, 2002; Vallerand et al., 2003). More specifically, when individuals develop a harmonious passion toward gambling, they are able to maintain a fine balance (e.g., in time and degree of investment) with other daily life activities. By contrast, obsessive gambling passion is characterized by an internal pressure, which forces the individual to engage in gambling. While harmonious gambling passion generally leads to positive psychological and social and perhaps even financial outcomes, obsessive passion has been shown to lead to negative psychological and physical consequences (Rousseau et al., 2002; Vallerand et al., 2003).

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These two types of passion are generally assessed with "The Gambling Passion Scale" (Vallerand et al., 2003). The questionnaire comprises five items reflecting harmonious gambling passion (e.g., "Gambling allows me to live memorable experiences") and five items indexing obsessive gambling passion (e.g., "I couldn't live without gambling"). Using on this instrument, previous results suggest that individuals with gambling disorder tend to perceive themselves as being merely driven by an obsessive rather than a harmonious passion, as compared to recreational gamblers (Back, Lee, & Stinchfield, 2011; Morvannou, Dufour, Brunelle, Berbiche, & Roy, 2018). Past research also highlighted that harmonious gambling passion is associated with motivations of excitement and challenge (Lee, Back, Hodgins, & Lee, 2013; Lee, Chung, & Bernhard, 2014), as well as with stress reduction and positive affect (Lee et al., 2013, 2014; Mageau, Carpentier, & Vallerand, 2011; Ratelle, Vallerand, Mageau, Rousseau, & Provencher, 2004; Rousseau et al., 2002; Vallerand et al., 2003). In contrast, obsessive gambling passion is merely associated with financial motives (Lee et al., 2013, 2014) and those related to anxiety and guilt reduction (Lee et al., 2013, 2014; Mageau et al., 2011; Ratelle et al., 2004; Rousseau et al., 2002; Vallerand et al., 2003).

In the following sections, we will review the research on neurocognitive markers of gambling disorder to provide a framework to understand why some individuals continue to gamble despite negative consequences.

Box 11.1: DSM-5 Criteria for Gambling Disorder

A. Persistent and recurrent problematic gambling behavior leading to clinically significant impairment or distress, as indicated by the individual exhibiting four (or more) of the following in a 12-month period:

(a) Needs to gamble with increasing amounts of money in order to achieve the desired excitement
(b) Is restless or irritable when attempting to cut down or stop gambling
(c) Has made repeated unsuccessful efforts to control, cut back, or stop gambling
(d) Is often preoccupied with gambling (e.g., having persistent thoughts of reliving past gambling experiences, handicapping or planning the next venture, thinking of ways to get money with which to gamble)
(e) Often gambles when feeling distressed (e.g., helpless, guilty, anxious, depressed)
(f) After losing money gambling, often returns another day to get even ("chasing" one's losses)
(g) Lies to conceal the extent of involvement with gambling
(h) Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of gambling
(i) Relies on others to provide money to relieve desperate financial situations caused by gambling

B. The gambling behavior is not better explained by a manic episode.

Box 11.1 (continued)

Specify if:

Episodic: Meeting diagnostic criteria at more than one time point, with symptoms subsiding between periods of gambling disorder for at least several months

Persistent: Experiencing continuous symptoms, to meet diagnostic criteria for multiple years

Specify if:

In early remission: After full criteria for gambling disorder were previously met, none of the criteria for gambling disorder have been met for at least 3 months but for less than 12 months.

In sustained remission: After full criteria for gambling disorder were previously met, none of the criteria for gambling disorder have been met during a period of 12 months or longer.

Specify current severity:

Mild: 4–5 criteria met
Moderate: 6–7 criteria met
Severe: 8–9 criteria met

Gambling Disorder and Decision Making

One core aspect of gambling disorder is the continuation or escalation of gambling behaviors despite negative consequences at financial, work, and family levels (see also Box 11.1: criterion *h* of the DSM-V). Accordingly, numerous studies have examined the association between gambling disorder and situations of decision making that feature probabilistic monetary gains and losses (for a review, see Achab, Karila, & Khazaal, 2014; Brevers & Noël, 2013; Brevers, Bechara, Cleeremans, & Noël, 2013; Clark et al., 2013; and van Holst, van den Brink, Veltman, & Goudriaan, 2010). Among this vast literature, mainly two standardized experimental tasks have been used to model real-life decision making in problem gamblers: the « Card Playing Task » and the « Iowa Gambling Task ». These studies investigated subclinical individuals as well as individuals with severe gambling disorder (collectively referred to here as problem gamblers), being either active or abstinent gamblers, and usually compared to case controls involving non-gambler healthy controls.

For each trial of the Card Playing Task (Newman, Patterson, & Kosson, 1987; see Box 11.2 for a graphical description), participants can play a card or choose to quit the task. If the participant accepts to play, the card flips and shows a gain or a loss (0.5 euros). If the participant stops playing, the game ends, and he/she receives the cumulated monetary amount earned in previous trials. The key aspect of the task is that the ratio of wins to losses changes every ten trials (from the first to the tenth trial, the ratio of wins to losses = 9/1; from the eleventh to twentieth trial, the ratio of wins to losses = 8/2; and so on). Prior to playing the task, participants receive no information regarding the dynamic patterns of win-to-loss ratios.

Studies using the Card Playing Task have shown that, as compared to non-gambler healthy participants, problem gamblers keep playing despite experiencing mounting monetary losses (Brevers, Cleermans, Goudriaan, et al., 2012; Corr & Thompson, 2014; Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2005; for a review see also van Timmeren, Daams, van Holst, & Goudriaan, 2018). These findings model a central feature of gaming disorder, i.e., being less able to withdraw from gambling despite encountering financial losses.

A similar pattern of disadvantageous decision making has been shown with the Iowa Gambling Task (Bechara, Damasio, Damasio, & Anderson, 1994; see also Box 11.2 for a graphical description of the task). Every trial of this task consists of selecting one card from four possible decks (100 trials in total). Each deck is associated with a specific probabilistic ratio of monetary gains and losses. Specifically, two decks are considered as advantageous and two decks as disadvantageous. The advantageous decks feature frequent but small gains, as well as infrequent and small losses. In contrast, the disadvantageous decks feature high and frequent gains, as well as infrequent but high losses. Developing a choice preference for the advantageous decks, therefore, allows participants to complete the task with a monetary gain. Alternatively, if the participant more frequently choses the disadvantageous decks, this results in larger monetary loss and indexes poor decision making.

As in the Card Playing Task, participants do not receive any explicit information about the win/loss ratio associated with each deck of the Iowa Gambling Task (they only know that there are 100 trials). Hence, throughout the task, participants have to progressively learn to direct their choice toward the advantageous decks, as they are more profitable in the long run. In other words, participants need to compute their choices based on their previous experiences of wins and losses associated with each deck, that is, to anticipate the short-term and long-term outcomes of their forthcoming choices (i.e., short-term high wins but long-term high losses with the disadvantageous decks; Bechara et al., 1994; Bechara, Damasio, Tranel, & Damasio, 1997).

Healthy participants learn to choose the advantageous decks usually during the second half the task (i.e., trials 61–100), i.e., when participants start to acquire the explicit knowledge of the win/loss ratios pertaining to each deck (Dunn, Dalgleish, & Lawrence, 2006). In contrast, problem gamblers seem to fail at orienting their choices toward the advantageous decks (for a review, see Brevers, Bechara, et al., 2013).

One key finding from studies using the Card Playing Task and the Iowa Gambling Task is the reported positive association between problem gambling severity and poor performance on these two tasks (Brevers, Cleeremans, Goudriaan, et al., 2012; Ciccarelli, Griffiths, Nigro, & Cosenza, 2017; Nigro, Ciccarelli, & Cosenza, 2018). In other words, the more severe the problem gambling is, the more diminished is the ability to take advantageous monetary decisions. This finding implies that inflexible and disadvantageous patterns of monetary decision making linearly increase with gambling disorder severity.

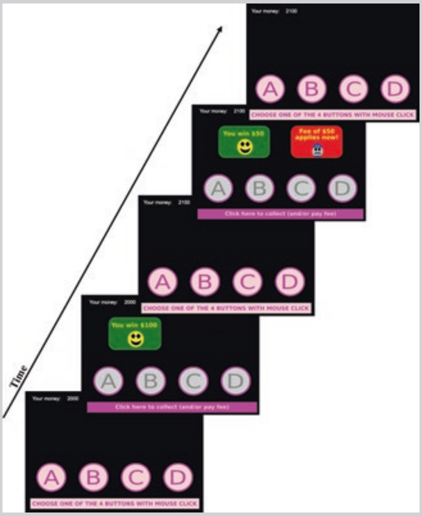
In parallel to these studies, another line of research has shown that gambling-disordered individuals exhibit disadvantageous choices under situations of decision making "under risk" (for a review, see Brevers & Noël, 2013; Brevers, Bechara, et al., 2013; Clark et al., 2013; Spurrier & Blaszczynski, 2014; and van Holst et al., 2010). Decision making under risk refers to situations in which the person receives explicit information about the probabilities and values of gains and losses associated with each specific choice option (see Box 11.2 for an example of a task modeling decision making under risk: the "Cups Task"; Levin, Weller, Pederson, & Harshman, 2007). For instance, a recent case-control brain imaging study by Fujimoto and collaborators (Fujimoto et al., 2017) found that problem gamblers experience more difficulties in switching from high-risk to low-risk monetary choices than non-gamblers. At the brain imaging level, this inability to avoid high-risk choices is associated with decreased activation of the dorsolateral prefrontal cortex (Fujimoto et al., (2017), a cerebral region playing a pivotal role in motor response inhibition and mental flexibility (e.g., Buckley et al., 2009; Rushworth, Noonan, Boorman, Walton, & Behrens, 2011). In the next section, we will discuss the importance of motor response inhibition and mental flexibility processes in decision making.

Box 11.2: Graphical Description of Decision Making Tasks

Card Playing Task (Newman et al., 1987). In each trial, participants can play a card or choose to quit the task. Number cards result in a loss of 50 eurocents. Face cards result in winning 50 eurocents. The task consists of 10 blocks of 10 cards. In each block of cards, the ratio of wins to losses changes; the number of cards increases with one loss card in each block and decreases with one win card; in the first block, the ratio of wins to losses is 9 to 1, in the second block 8 to 2, and so on. The dependent measure is the number of cards played, which indexes persistent gambling despite losses (i.e., poor decision making).

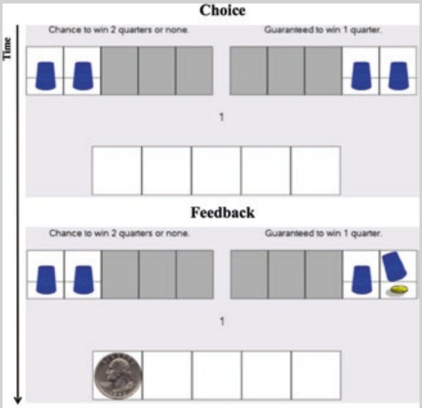
Box 11.2 (continued)

Iowa Gambling Task (Bechara et al., 1994). Each trial consists of a deck selection and a monetary feedback (net win or loss). The net outcome of choosing from either deck A or deck B is a loss of five times the average per ten cards (disadvantageous decks), and the net outcome of choosing from either decks C or D is a gain of five times the average per ten cards (advantageous decks). The total number of trials is set at 100 card selections. The dependent measure is the number of cards picked from the advantageous decks in each stage of 20 cards.



Cups Task (Levin et al., 2007). For each trial, the participant is required to choose between a risky and a safe option. The safe option is either to win or to lose €1 for sure, whereas the risky option in the Gain domain may lead to a larger win (€2, €3, or €5) with a certain probability (0.20, 0.33, or 0.50) or could lead to no win. After each choice, the participant receives a monetary feedback, allowing them to experience the consequence of the risky or safe choice. The task includes 27 trials, counterbalanced in order across participants. There are three trials for each combination of probability and outcome magnitude. The dependent measure is the number of risky choices at each expected-value (EV) level (see table).

Box 11.1 (continued)



	P	€
Risk advantageous EV	0.33	5
	0.50	3
Risk equal EV	0.20	5
	0.33	3
	0.50	2
Risk disadvantageous EV	0.20	3
	0.33	2

Impaired Cognitive Processes in Gambling Disorder

Motor Response Inhibition

Motor response inhibition (or prepotent/dominant response inhibition) refers to the ability to stop a planned or ongoing motor action when it interferes with updated goal-driven behaviors (Aron, 2011; Aron, Robbins, & Poldrack, 2014; Baddeley, 1996; Logan, 1985, 1994; Verbruggen & Logan, 2009a, 2009b). This process is especially important when the individual is embedded into signal detection contexts that require rapid adaptation to stop a motor response that has been initiated but has become inappropriate or unwanted (Aron, 2011; Barkley, 1997; Verbruggen & Logan, 2009a, 2009b). Motor response inhibition abilities may be measured with the "go/no-go task" (e.g., Benikos, Johnstone, & Roodenrys, 2013; Jodo & Kayama, 1992) and the "stop-signal task" (Logan & Cowan, 1984).

During the go/no-go task, participants are requested to press a computer key as soon as one category of stimuli appears on the screen ("go" stimulus; e.g., a triangle) or to not respond when another type of stimuli appears on the screen ("no-go" stimulus; e.g., a square). Motor response inhibition reflects the ability not to respond behaviorally (i.e., button press) when confronted with a no-go stimulus. In the go/no-go task, motor response inhibition can be manipulated in two ways: (a) by reducing the frequency of no-go stimuli, which will increase the difficulty to withdraw the button press response during no-go trials (Aron et al., 2014), or (b) by keeping the same level of go and no-go trials ratio but asking the participants to respond to go stimuli as fast as possible (Benikos et al., 2013).

In the stop-signal task (see Box 11.3 for a graphical description), participants are asked to categorize as fast as possible stimuli that appear successively on the computer screen. Intermittently, a « stop-signal » (typically a red sign or a beep sound) occurs during the onset of a stimuli. In this type of trial (i.e., stop-signal trial), participants are required to withdraw their motor response. Hence, during the stop-signal task, participants must constantly oscillate between the initiation and the interruption of a motor response (Verbruggen & Logan, 2009a, 2009b).

The stop-signal task assesses different aspects of motor response inhibition, as compared to the go/no-go task. Specifically, in the stop-signal task, the go cue always precedes the stop-signal, whereas in the go/no-go task, the stop-signal is presented unexpectedly in place of the go signals. Thus, the stop-signal paradigm permits the measurement of the inhibition of an already initiated action (i.e., action cancellation of a fast go response) and the go/no-go task the inhibition of a response before its execution (i.e., action restraint of a fast go response; Bari & Robbins, 2013; Barkley, 1997; Eagle, Bari, & Robbins, 2008; Schachar et al., 2007; Verbruggen & Logan, 2017; Wright, Lipszyc, Dupuis, Thayapararajah, & Schachar, 2014). Another important difference between these paradigms is that the go/no-go task only offers general measures of motor response inhibition, whereas the stop-signal task allows the measurement of both latency and efficacy of response inhibition by computing the stop-signal reaction time latency (SSRT; Aron, 2011; Bari & Robbins, 2013; Verbruggen & Logan, 2009a, Verbruggen & Logan, 2017; Zandbelt, van Buuren, Kahn, & Vink, 2011).

Several meta-analyses suggest that individuals with gambling disorder show lower motor response ability than non-gamblers, as assessed by the stop-signal task (Chowdhury, Livesey, Blaszczynski, & Harris, 2017; Smith, Mattick, Jamadar, & Iredale, 2014). These differences are less pronounced when motor response inhibition is assessed with the go/no-go task (Chowdhury et al., 2017; Smith et al., 2014). Therefore, the evidence suggests that gambling disorder is characterized by stronger impairment in action cancellation (as estimated with the stop-signal task) than in action restraint (as estimated with the go/no-go task) of a fast motor response (Chowdhury et al., 2017; Smith et al., 2014). Moreover, it has been shown that deficits in motor response inhibition during the stop-signal task (a) increase with the severity of gambling disorder (Brevers, Cleermans, Verbruggen, et al., 2012; Odlaug, Chamberlain, Kim, Schreiber, & Grant, 2011); (b) promote persistent playing despite losses in laboratory gambling (Devos, Clark, Maurage, Kazimierczuk, & Billieux, 2015); and (c) predict episodes of relapses in gamblers who aim at remaining abstinent from gambling (Goudriaan, Oosterlaan, De Beurs, & Van Den Brink, 2008).

Importantly, the stop-signal task also permits the measurement of reactive (as indexed by the stop-signal reaction time, SSRT) and proactive (the level of adjustment or slowdown in responding as the probability of encountering a stop event increases) motor response inhibition (Aron, 2011; Bari & Robbins, 2013; Verbruggen & Logan, 2009a, 2017; Zandbelt et al., 2011). These two components refer to distinct temporal dynamic modes of motor response inhibition (Aron, 2011; Braver, 2012; Braver, Paxton, Locke, & Barch, 2009). Reactive inhibition is a late correction process, triggered by external signals (e.g., braking when something or somebody suddenly crosses the street), and results in the cancelling of ongoing motor action (Aron, 2011; Braver, 2012; Braver et al., 2009). Proactive inhibition contrasts with the reactive mode in that it is used to strategically restrain actions in preparation for stopping (e.g., slowing down while cycling under bad weather conditions; Aron, 2011; Braver, 2012; Braver et al., 2009). More specifically, proactive response inhibition triggers early selection processes during which goal-relevant information is actively monitored to enhance the efficiency of motor response inhibition (Aron, 2011; Duckworth, Gendler, & Gross, 2016; Duckworth, White, Matteuci, Shearer, & Gross, 2016; Fujita, 2011; Galla & Duckworth, 2015). Under proactive control, the stopping mode is preactivated by preparing to stop, which makes stopping easier when it is needed (Aron, 2011; Chikazoe et al., 2009; Jahfari, Stinear, Claffey, Verbruggen, & Aron, 2010).

Proactive inhibition plays a key role in refraining from behavioral tendencies and seems a more ecologically valid model of daily life motor control than reactive inhibition. This view is supported by Verbruggen, Adams, and Chambers (2012), who demonstrated that proactive inhibitory control has a direct impact on monetary risk-taking in the context of gambling. They presented participants with six free-choice options in every trial of a gambling task. Each option was associated with a certain amount of gain; however, participants were informed that the higher the amount, the less probable a win. In some blocks (i.e., stop condition), in addition to gambling choice, participants were instructed to stop the planned manual choice response when an occasional visual stop-signal occurred. Verbruggen et al., (2012) showed that participants reduced risky gambling in the stop condition, as compared to the condition featuring only free choices (i.e., non-stop condition). These results suggest that a stop condition successfully induces a proactive motor responding mode, that is, a general state of cautiousness that enhances cognitive control and optimizes decision making. In other words, the preparation to cancel a motor response involves proactive adjustments resulting in more cautiousness when executing (prepotent) motor responses (Aron, 2011; Jahfari et al., 2010; Liddle et al., 2009; Verbruggen & Logan, 2009a). Crucially, such a proactive mode can increase the level of cognitive control during the elaboration of gambling choices. This pattern should diminish the motivational attractiveness of risky options featuring high but uncertain rewards (Verbruggen et al., 2012).

The results by Verbruggen et al., (2012) support the existence of a "control transfer" occurring between cognitive domains that might open new avenues for reducing impairments in pathological gamblers' decision making. This assumption has been tested by Steven and collaborators (Stevens et al., 2015) who investigated gamblers with various degrees of symptom severity. The results indicate that low symptom severity is associated with decreased monetary risk-taking during blocks featuring the stop condition, as compared to blocks featuring only free choices. By contrast, gamblers with more severe symptoms failed to display differential patterns of monetary risk-taking between the “stop” and “no-stop” blocks. These findings are important as they suggest that situational factors—which have been shown to modulate dynamic monetary risk-taking—do not impact monetary risk-taking in individuals with a high risk for problem gambling. These results further suggest that individuals with more severe levels of gambling disorder symptoms engage in inflexible or compulsive patterns of gambling behaviors (see also Brevers & Noel, 2015, and van Timmeren et al., 2018).

Cognitive Flexibility

Cognitive flexibility (or mental flexibility) refers to the ability to shift between different modes of action (or cognitive operations; e.g., to switch or “shift” thinking from the color of an object to its shape; Collette, Hogge, Salmon, & Van der Linden, 2006; for a review, see Dajani & Uddin, 2015).

Over the last decade, a series of studies have shown that individuals with gambling disorder exhibit lowered cognitive flexibility during tasks involving monetary reward. This has been shown with the « Probabilistic Reversal Learning Task » (e.g., Franken, van Strien, Nijs, & Muris, 2008; see Box 11.3 for a graphical description). In each trial of this task, two types of visual stimuli are displayed on a computer screen. Participants are instructed to select one of the two stimuli by pressing a computer key and then receive either a monetary gain or loss. Selecting one stimulus is initially associated with a higher probability of losses (i.e., loss/gain percentage = 75%/25%), while selecting the other is initially associated with a higher likelihood of gains (i.e., gain/loss percentage = 75%/25%). This gain/loss dynamic is reversed during the task. This means that participants must learn to reverse their response mode for previously (but no longer) advantageous stimuli. More specifically, based on the previously displayed reinforcement schedule, participants have to monitor the meaning of the different feedbacks and thus determine when a correct choice is non-rewarded or when the negative feedback signals the need for behavioral adaptation.

Using this Probabilistic Reversal Learning Task, previous research has shown that treatment-seeking gamblers were less able to dynamically adjust their behavior (i.e., they tended to display rigid and perseverating behavior) in comparison to healthy (non-gambler) controls (de Ruiter et al., 2009; Vanes et al., 2014). More specifically, gambling disorder patients present with a specific difficulty to disengage from the stimuli formerly (but no more) associated with monetary gains. This kind of studies offers additional evidence that gambling disorder is characterized by a reduced capacity to dynamically shift between different modes of action.

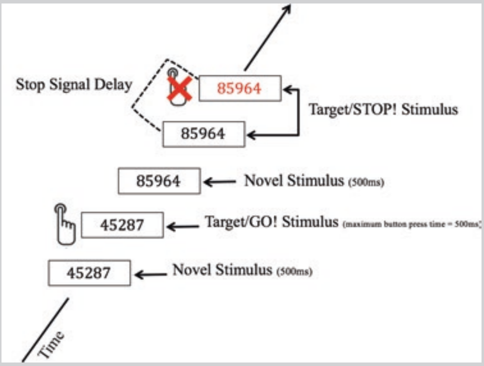
Remarkably, this reduced cognitive flexibility is less marked when tasks not involving actual monetary reinforcement are used. For instance, Boog et al., (2014) observed in a case-control study that problem gamblers undergoing psychological treatment exhibited decreased performance on the Probabilistic Reversal Learning

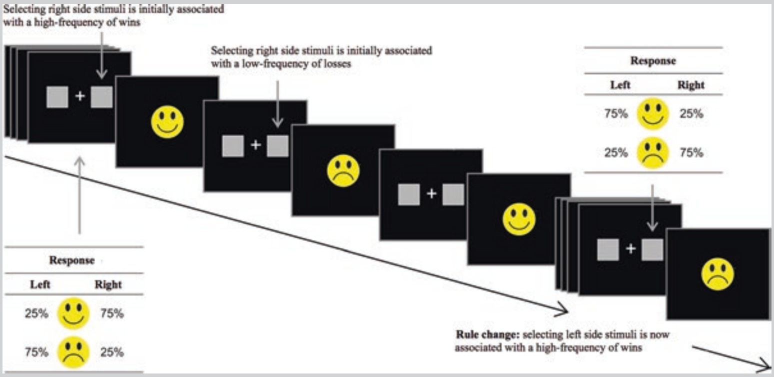
Task, but not during a cognitive flexibility task that involves informative feedback (i.e., correct response versus incorrect response; i.e., the “Wisconsin Card Sorting Test”; Heaton, 1981). These findings suggest that gambling disorder is not associated with a fundamental (or core) impairment in cognitive flexibility. Nevertheless, there are inconsistencies in the findings obtained by testing cognitive flexibility without using real monetary reinforcements, with some reporting cognitive flexibility impairments (Blum, Leppink, & Grant 2017; Grant, Chamberlain, Odlaug, Potenza, & Kim, 2010, Grant, Odlaug, Chamberlain, & Schreiber, 2012; Rugle & Melamed, 1993; Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2006; Forbush et al., 2008; Leppink, Redden, Chamberlain, & Grant, 2016, Leppink, Blum, Chamberlain, & Grant, 2016; Marazziti et al., 2008; Odlaug et al., 2011; Vanes et al., 2014), while others failed to identify deficits in cognitive flexibility in gambling-disordered individuals (Achab et al., 2014; Boog et al., 2014; Brand et al., 2005; Cavedini, Riboldi, Keller, D’Annucci, & Bellodi, 2002; Kapsomenakis, Simos, Konstantakopoulos, & Kasselimis, 2018; Ledgerwood et al., 2012; van Timmeren et al., 2018). Nevertheless, these mixed findings have been documented in heterogeneous samples of problem gamblers (in terms of symptom severity and/or gambling preferences), and these differences could account at least for some of these inconsistencies. Further studies are thus needed to confirm that gambling disorder is characterized by reduced cognitive flexibility abilities only during experimental tasks featuring monetary rewards.

Box 11.3: Graphical Description of Motor Response Inhibition and Cognitive Flexibility Tasks

Stop-signal task (figure adapted from Dougherty et al., 2003). Participants are presented with a consecutive series of five-digit numbers on a computer screen. On each trial, novel stimulus (new, previously unseen set of five numbers) is presented for 500 ms, after which a target stimulus (a set of numbers always identical to the immediately preceding novel stimulus; in black font) appears for 500 ms. Each trial is separated by a 1500 ms interval. Participants are instructed to refrain from responding to the novel stimuli and to press the response button as fast as possible when presented with the black target (go) stimulus. However, on some trials, the black target (go) stimulus turned red (i.e., a “stop” signal), which indicated that participants had to withhold their response to the target stimulus as well. During the task, stop-signal delay (SSD; the interval between the target stimulus onset and the presentation of the stop-signal) is continuously adjusted according to a tracking procedure: if a stop response is successful, then stopping is made more difficult in the next stop-trial by increasing SSD by 25 ms. The process is reversed when a stop response failed. Reactive motor response inhibition is indexed by the stop-signal reaction time (SSRT), a measure of the latency of the inhibition process. The SSRT can be obtained through the integration method (Verbruggen & Logan, 2009b), which involves subtracting the mean SSD from nth RT (with n equal to the number of RTs in the RT distribution) multiplied by the overall probability failed stop-signal response.

Box 11.3 (continued)





Probabilistic Reversal Learning Task (Franken et al., 2008; figure adapted from Vilà-Balló et al., 2017). The task is divided into blocks of trials (e.g., 60 blocks in pseudorandom order with 16–24 trials each). In every trial, participants have to select one of the two gray squares by pressing the right or left keyboard button. A feedback stimulus indicating a win (happy face) or loss (sad face) appears after the response. Participants are informed that the probability of winning remains constant during some trials, but after an unspecified period, the probability reverses. In each trial, participants have to choose the stimulus leading to the reward outcome. When reversed reward contingencies (rule reversal) occur (e.g., between the 16th and 24th trials of each block of trials), participants have to switch their selection to the new rewarded alternative. The responses with the highest probability of winning are considered a correct choice, and responses with the lowest probability of losing are considered as failures (response perseveration). The accuracy rate is calculated as the sum of correct responses divided by the total number of responses.

Reactivity to Monetary Gains and Losses

The reactivity to feedback of monetary gains and losses in gambling disorder has been examined using functional brain imaging and psychophysiological techniques (e.g., heart rate reactivity and skin conductance responses). Most of these studies suggest that problem gamblers as well as frequent gamblers (i.e., individuals who present some symptoms of problem gambling but without meeting the criteria for gambling disorder) exhibit hypo-reactivity to monetary gains and losses, as compared with non-gamblers (for reviews, see Figee et al., 2016, and Moccia et al., 2017).

These studies mostly used cognitive flexibility tasks during the phase of feedback processing (i.e., when participants receive a monetary gain or loss). More specifically, de Ruiter and collaborators (de Ruiter et al., 2009) observed that individuals with a gambling disorder showed hypo-sensitivity to monetary feedback for gains and losses during the probabilistic reversal learning task. This phenomenon has been suggested to reflect a decrease of brain activation in the ventrolateral prefrontal cortex, which is a key brain region for pondering choices based on previous outcomes (e.g., Bechara, 2005). Comparable findings have been obtained during the feedback phases of other decision making tasks (Balodis et al., 2012; Brevers, He, Xue, & Bechara, 2017; Power, Goodyear, & Crockford, 2012; Reuter et al., 2005; Tanabe et al., 2007). For instance, Brevers et al., (2017) observed that frequent gamblers, as compared to non-gambler participants, exhibited decreased brain activity when experiencing monetary gains or losses during a task assessing decision making under risk.

Interestingly, van Holst, Veltman, Büchel, van den Brink, and Goudriaan, (2012) report an opposite pattern of brain activation when treatment-seeking problem gamblers anticipate potential monetary gains or losses. More specifically, these studies showed that problem gamblers exhibit higher activation than non-gamblers within the brain reward pathways (e.g., dorsal and ventral striatum, orbitofrontal cortex) when waiting for receiving monetary feedback. One important feature of the experimental tasks used in this functional brain imaging study is that the monetary reward was probabilistic (i.e., explicit win/loss ratio followed by a random draw), which reflects real-life gambling contexts (e.g., Hellberg, Russell, & Robinson, 2019).

Overall, these findings suggest that problem gamblers with various degrees of symptom severity (from mild to severe) tend to attribute high incentive salience toward cues signaling the occurrence of gambling-related rewards, but develop a pattern of tolerance when experiencing monetary gains and losses (i.e., the individual needs to gamble with increasing amounts of money in order to achieve the desired excitement; see also Blanco, Moreyra, Nunes, Sáiz-Ruiz, & Ibáñez, 2001, and Grant & Potenza, 2006). These patterns correspond well with those commonly observed in substance use and in eating disorders (e.g., Shaffer et al., 2004).

Hypersensitivity Toward Gambling-Related Stimuli

Throughout the development of gambling habits, associative pathways are established through classical conditioning, gradually strengthening the learning history of temporal or spatial coactivation between environmental stimuli and gambling-related experiences (Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008; Hofmann, Friese, & Strack, 2009). The repeated pairing of environmental stimuli with gambling leads these stimuli to acquire increased affective and motivational salience and to capture attention (Field, Munafò, & Franken, 2009; Field et al., 2016; Robinson, Fischer, Ahuja, Lesser, & Maniates, 2016). When the gambler encounters a gambling-related stimulus (videos, pictures, words, or sounds), the "gambling cluster" may be reactivated, which would automatically trigger a corresponding impulse, consisting of a positive, fast, and intense incentive value attributed to gambling and a corresponding behavioral approach schema (Elton-Marshall, Leatherdale, & Turner, 2016; Hofmann et al., 2009; Stacy & Wiers, 2010). As a result, these hyperactive motivational salience processes tend to bias or literally "hijack" cognitive control resources typically needed for optimally weighting the pros and cons of forthcoming choices or actions, such as when one has to resist or overcome short-term rewarding gambling behavior (Verdejo-García & Bechara, 2009; Brevers & Noël, 2013; Noël, Brevers, & Bechara, 2013; Noël et al., 2013).

Converging evidence for the notion of increased sensitivity toward gambling-related cues comes from three different but inter-related results showing that gambling-related cues (a) catch gamblers' attention (i.e., attentional bias), (b) trigger positive memory associations (i.e., implicit associations), and (c) promote increased neural cue reactivity.

Attentional Bias

Gambling-related stimuli (e.g., pictures of the casino environment, slot machines, poker chips) or words (e.g., « casino », « poker », « roulette ») catch gamblers' attention, at both early (i.e., attentional engagement; Cisler & Koster, 2010) and later (attentional maintenance and disengagement; Cisler & Koster, 2010) phases of attentional processing (for a review, see Brevers & Noël, 2013; Brevers, Bechara, et al., 2013; and Hønsi, Mentzoni, Molde, & Pallesen, 2013). For instance, Brevers, Cleermans, Bechara et al., (2011) used an eye-tracking procedure during a change-detection task involving gambling-related or neutral pictures (see Box 11.4 for a graphical description). Problem gamblers were faster than non-gamblers in detecting a change of gambling-related stimuli (e.g., a picture of scratch game replaced by a picture of card games) than a change in non-gambling-related stimuli (e.g., a picture of a handkerchief replaced by a metro ticket). In the same study, problem gamblers directed their initial eye movements more frequently toward gambling-related than non-gambling stimuli, exhibited more gaze fixation counts on gambling stimuli, and spent more time looking at gambling-related than neutral stimuli. In another study, Brevers, Cleermans, Tibboel, et al., (2011) examined whether attentional bias toward gambling-related stimuli can be shown at the level of attentional encoding (i.e., an early stage of attentional processes occurring prior the initiation of the first eye movement; < 100 ms; e.g., Crabb & Dark, 1999), using an attentional blink paradigm (see Box 11.4 for a graphical description of the task). The attentional blink effect refers to the observation that the second of two-masked targets (T1 and T2), which appears in a rapid serial visual presentation (RSVP) stream of distractors, is usually poorly identified when it is presented within a short time interval after T1 (i.e., within several hundred milliseconds; Raymond, Shapiro, & Arnell, 1992). Using this paradigm, Brevers, Cleeremans, Tibboel, et al., (2011) observed that, in problem gamblers, gambling-related cues were less affected than neutral cues by the attentional blink effect. By contrast, non-gamblers showed similar attentional blink effects for neutral and gambling words. Taken together, these results suggest that problem gamblers exhibit attentional bias toward gambling-related cues at the level of attentional encoding (Brevers, Cleeremans, Tibboel, et al., 2011), attentional engagement (i.e., first eye movement; Brevers, Cleeremans, Bechara, et al., 2011), and attentional maintenance (i.e., fixation length and fixation count) (Brevers, Cleeremans, Bechara, et al., 2011).

These results are in line with findings by Ciccarelli, Nigro, Griffiths, Cosenza, and D'Olimpio (2016), who found that problem gamblers showed higher attentional engagement toward gambling-related stimuli during a stimulus detection task, as compared to a group of non-problem frequent gamblers and a group of treatment-seeking problem gamblers. Ciccarelli et al., (2016) also observed that after completing the stimulus detection task, problem gamblers reported a greater desire to gamble, as compared to non-problem frequent gamblers and gamblers in treatment for gambling disorder. Another important finding from Ciccarelli et al., (2016) is that gamblers receiving treatment showed a pattern of attentional avoidance when the gambling stimuli were presented for a longer time (i.e., attentional maintenance processes). This result further supports the notion that levels of hedonic/incentive cognitive association and motor approach tendencies (e.g., inhibitory control toward gambling cues in problem gamblers who are motivated to stop gambling; Brevers, Bechara, Kilts, et al., 2018; van Holst et al., 2012) are lower in individuals who are motivated to quit, as compared to active gamblers (for comparable findings in substance use and food use, see Meule, Lukito, Vögele, & Kübler, 2011; Morie et al., 2014; and Price, Lee, & Higgs, 2016). These findings can be explained by the fact that quitting-motivated individuals are susceptible to develop an active avoidance strategy toward cues to support their abstinence/moderation goals (e.g., Jasinska, Stein, Kaiser, Naumer, & Yalachkov, 2014; Vollstädt-Klein, Loeber, von der Goltz, Mann, & Kiefer, 2009).

Implicit Associations

Several studies have also examined whether active problem gamblers (i.e., not motivated to quit gambling) develop implicit associations toward gambling (Brevers, Cleermans, Hermant, et al., 2013; Flórez et al., 2016; Yi & Kanetkar, 2010), i.e., spontaneous and fast associations between gambling-related stimuli (words or pictures) and positive words (e.g., pleasure, freedom, leisure, joy, friend). These associations are indexed as "implicit" because they occur at an early phase of information processing, which are largely independent of conscious awareness (Greenwald & Banaji, 1995; Stacy & Wiers, 2010). The « Implicit Association Task » (IAT; Greenwald, McGhee, & Schwartz, 1998) is the most frequently used laboratory paradigm to assess implicit associations. In a typical IAT, stimuli belonging to one of four possible categories are presented one by one on a computer screen. In each trial, participants categorize (as fast as they can) the presented stimulus by pressing one of two keys. The assumption underlying the IAT effect is that behavioral responses will be quicker (lower reaction time) when associated categories are assigned to the same response button. For example, when classifying names of flowers or insects (i.e., target stimuli) and positive or negative words (i.e., attribute stimuli), people are typically faster when flowers and positive words are assigned to one key and insects and negative words to the second key (as flowers are generally considered as positive concepts), as compared with the condition in which insects and positive words are assigned to one key and flowers and negative words to the other key (as insects are generally considered as negative concepts).

Flòrez and collaborators (Flórez et al., 2016) used a standard IAT design (with gambling versus non-gambling pictures as targets and positive versus negative words as attributes) to examine implicit associations in problem gamblers. These authors found that problem gamblers held more positive (or less negative) implicit associations toward gambling, as compared to non-gambler controls. More specifically, problem gamblers were faster at categorizing gambling pictures when assigned to the same response key as positive words, but not when gambling pictures were assigned to the same response key as negative words. In another study, using a single-target bipolar IAT (i.e., this task contrasts positive vs. negative words as attribute stimuli, but only encompasses gambling pictures as target stimuli; Wigboldus, Holland, & van Knippenberg, 2004), Yi and Kanetkar (2010) found that problem gamblers held more positive (or less negative) implicit associations toward gambling than did both non-problem gamblers and non-gamblers. Hence, these findings suggest that the pattern of positive (or less negative) implicit associations is specific for problematic gamblers.

Comparable results were reported by Brevers and collaborators (2013) in that problem gamblers showed higher positive implicit associations toward gambling, as compared to non-gamblers. One remarkable aspect of this study was the use of a positive and negative unipolar version of the IAT (see Houben & Wiers, 2008): while the single-target bipolar IAT contrasts two attribute categories with each other (e.g., positive vs. negative), unipolar IATs contrast the same attribute categories with neutral categories (e.g., positive vs. neutral and negative vs. neutral). Therefore, this adaptation of the IAT design makes it possible to consider both positive and negative implicit associations. Capitalizing on this adapted IAT, Brevers, Cleeremans, et al., (2013) found that, despite experiencing deleterious consequences related to their gambling habits, active problem gamblers maintain positive, but not negative, implicit associations toward gambling stimuli.

Neural Cue Reactivity

Neural reactivity to addiction-related cues, as assessed with functional magnetic resonance imaging, has been identified as a key hallmark of gambling disorder (for a review, see Brevers, Sescousse, Maurage, & Billieux, 2019, and Starcke, Antons, Trotzke, & Brand, 2018). A wide range of experimental paradigms has been used to examine the neural correlates of gambling cue reactivity. A central feature of these tasks is that they expose participants to gambling-related cues, depicting real-life gambling-related situations through auditory and/or visual stimulations (Balodis et al., 2012; Brevers et al., 2017; Crockford, Goodyear, Edwards, Quickfall, & el-Guebaly, 2005; Kober et al., 2016; Limbrick-Oldfield et al., 2017; Potenza, Kosten, & Rounsaville, 2001; Potenza, 2008; van Holst et al., 2012). These gambling cues are usually matched with neutral cues (Balodis et al., 2012; Brevers et al., 2017; Goudriaan, de Ruiter, van den Brink, Oosterlaan, & Veltman, 2010; Limbrick-Oldfield et al., 2017; Potenza, 2008) or with other types of motivationally salient or emotionally laden cues (Balodis et al., 2012; Kober et al., 2016; Limbrick-Oldfield et al., 2017; Potenza et al., 2001; Potenza, 2008; Sescousse, Barbalat, Domenech, & Dreher, 2013; van Holst et al., 2012).

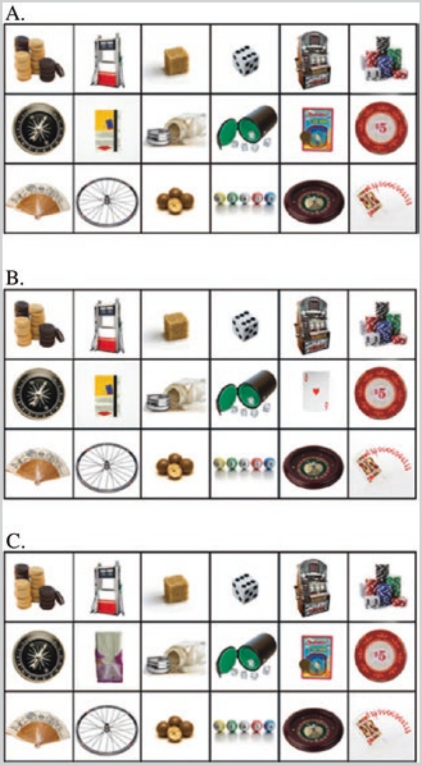
Altogether, the results from these functional brain imaging studies show that gambling-related cues trigger neural activation within a large and distributed brain system involving the ventral and dorsal striatum, amygdala, hippocampus, insula, anterior cingulate cortex, orbitofrontal cortex, and dorsolateral prefrontal cortex, as well as sensory, visual, and motor cortices (for a review, see Brevers et al., 2019). Another important finding resulting from the fMRI literature on gambling cue reactivity is the observed association of the intensity of brain activation triggered by gambling stimuli with symptom severity in problem gamblers (Sescousse et al., 2013), as well as with the intensity of gambling craving (task-induced craving change, Limbrick-Oldfield et al., 2017; post-task craving scores, Goudriaan et al., 2010; gambling craving rating scores obtained after the viewing of gambling video, Balodis et al., 2012).

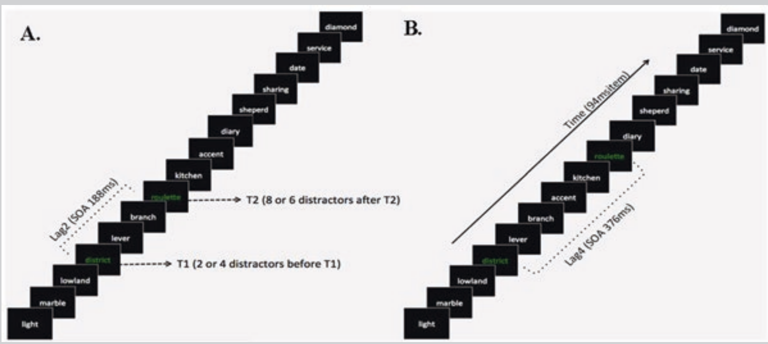
Box 11.4: Graphical Description of Attentional Bias Tasks
The flicker paradigm (Rensink, O'Regan, & Clark, 1997; Simons & Rensink, 2005). The figure is taken from Brevers, Cleeremans, Tibboel, et al., (2011) and depicts a gambling-related change. ***Panel A***. The original stimuli (with

(continued)

Box 11.4 (continued)

gambling stimuli on the right and neutral stimuli on the left). ***Panel B.*** The gambling-related change. ***Panel C***. The original stimuli. The original stimulus (OS) scene is presented for 250 ms, followed by the mask (M) for 80 ms and then the changed stimulus (CS) for 250 ms. The OS-M-CS-M series is continuously presented until change detection. The number of repetitions required for the change to be detected thus constitutes the main dependent variable in this paradigm.





Box 11.4 (continued)

Attentional blink paradigm (Raymond et al., 1992; the figure is adapted from Brevers, Cleeremans, Tibboel, et al., 2011). Each trial starts with the presentation of a red fixation cross, which remains on the screen for 1000 ms. This is followed by the rapid serial visual presentation (RSVP) stream, consisting of 13 distractor words in white and 2 target words (T1 and T2) in green. All stimuli are presented consecutively for 94 ms, against a black background. Participants are instructed to monitor the stream and to report the green words. At the end of each trial, participants are prompted to type in their responses and are asked to guess when appropriate. Participants are requested to spell the words correctly and to input the words in the correct order (T1 first and then T2). There is no response time limit. The first target word (T1) is always a neutral word. The second target word (T2) is either a neutral or a gambling-related word (random selection). T1 can appear at the third or fifth position in the stream, and T2 can appear 2 (***Panel A***) or 4 (***Panel B***) lags after T1, reflecting stimulus onset asynchronies (SOA) of 188 and 376 ms, respectively. There are 4 presentations of each of these 2 types of T2, 1 for each of the 2 lags and each of the 2 T1 positions, resulting in 72 experimental trials. The percentage of accurate T2 responses for each experimental condition (Lag2 versus Lag4; neutral versus gambling words) is the dependent measure. Only trials with the correct T1 identification are taken into account (T1/T2-correct).

Self-Control Mechanisms Involved in Gambling Harm Reduction

As previously mentioned in this chapter, there is evidence for lower levels of hedonic/incentive cognitive association and attentional bias, as well as higher patterns of motor response inhibition toward addiction-related stimuli in quitting-motivated individuals than active problem users (e.g., erotica, food, alcohol, drugs, tobacco, or gambling; Breiner, Stritzke, & Lang, 1999; Brevers, Bechara, et al., 2018; Ciccarelli et al., 2016; Lawrence, Verbruggen, Morrison, Adams, & Chambers, 2015; Meule et al., 2011; Morie et al., 2014; Noël et al., 2006; Price et al., 2016; Smith-Hoerter, Stasiewicz, & Bradizza, 2004; Tibboel et al., 2015; Townshend & Duka, 2007; van Holst et al., 2012; Vollstädt-Klein et al., 2009). Nevertheless, the substance use and behavioral addiction literature also demonstrates that these patterns of cognitive and motor avoidance are lowered when quitting-motivated individuals experience a strong need or desire to consume a substance (i.e., a "craving"; see Jasinska et al., 2014; Jones, Christiansen, Nederkoorn, Houben, & Field, 2013; and Morris & Voon, 2016). In addition, several studies have found that maintaining an active avoidance strategy toward addiction-related stimuli increases, rather than decreases, relapse rates in abstaining alcohol-dependent patients in the long run (Field, Di Lemma, Christiansen, & Dickson, 2017; Spruyt et al., 2013). These findings are important as they suggest that more elaborated coping strategies, in contrast to ad hoc attentional and motor avoidance strategies, are required for effectively preventing relapse in quitting-motivated individuals.

This view is in line with recent self-control models (Duckworth, Gendler, & Gross, 2016, Duckworth et al., 2016; Duckworth, Milkman, & Laibson, 2018; Fujita, 2011). Self-control has often been referred to as a process that enables reactive inhibition of maladaptive impulses (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Tangney, Baumeister, & Boone, 2004). For instance, Baumeister's influential *strength model* posits that self-control restraint relies on a limited resource, similar to a muscle (Baumeister et al., 1998; Baumeister, Tice, & Vohs, 2018). According to this model, engaging in self-control quickly consumes one's limited resources or energy leaving the individual in a state of "ego depletion." Consequently, when individuals engage in an effortful activity at Time 1 (e.g., such as avoiding to face addiction-related stimuli), their ability to exert self-control temporarily diminishes, and consequently performance on a different task at Time 2 typically deteriorates (e.g., higher financial risk-taking while gambling; e.g., Brevers, Herremans et al., 2018; for a meta-analysis, see Hagger, Wood, Stiff, & Chatzisarantis, 2010). More recent conceptualizations of self-control call this view into question and advance that self-regulation can take the form of proactively choosing or changing situations in ways that weakens undesirable impulses (Galla and Duckworth 2015, Duckworth, Gendler, & Gross, 2016, Duckworth et al. 2016, Duckworth et al., 2018; Fujita, 2011). For example, Duckworth's *process model* of self-control posits that intervening earlier in the cycle of short-term and pleasure-oriented impulse generation, i.e., when impulses are still developing, is more effective than intervening later (Galla and Duckworth 2015, Duckworth, Gendler, & Gross, 2016, Duckworth et al., 2016, Duckworth et al., 2018). In support of this model, Galla and Duckworth (2015) showed that high school students manage daily life self-control challenges (e.g., interpersonal conflicts, academic work, eat healthily) more efficiently when using situational self-control strategies (e.g., situation selection, situation modification) rather than cognitive ones (attentional deployment, cognitive change, response modulation). In addition, students rated situational strategies as more effective than cognitive strategies to resist temptation and achieve long-term goals (Galla and Duckworth (2015)).

In the context of gambling, previous studies have shown that quitting-motivated gamblers employ up to seven strategies to keep control over their gambling habits, with a higher number of employed strategies in problem gamblers (Drawson, Tanner, Mushquash, Mushquash, & Mazmanian, 2017; Moore, Thomas, Kyrios, & Bates, 2012; Rodda et al., 2017). The most frequent strategies include the following: applying to a voluntary self-exclusion (VSE) program, avoiding to enter a place/event or meeting a person that signal an opportunity to gamble, asking family/friends or applying to a company for financial management, to replacing gambling with another pleasurable activity, and getting rid of a credit card (Drawson et al., 2017; Moore et al., 2012; Rodda et al., 2017). Interestingly, one common aspect of these strategies is that they prevent the individual to have direct access to gambling, which is consistent with the situational self-control strategies described in Duckworth's process model of self-control.

Among these strategies, the most commonly used by quitting-motivated gamblers is applying to VSE program. VSE is one of the most established forms of player protection in the gambling industry (e.g., Gainsbury, 2014; Ladouceur, Jacques, Giroux, Ferland, & Leblond, 2000; Nelson, Kleschinsky, LaBrie, Kaplan, & Shaffer, 2010), and they allow gamblers to voluntarily ban themselves from entering casinos (real and online), gaming arcades (real and online), or betting offices (real and online) for an unlimited period of time. There is evidence that VSE is not only efficient in diminishing gambling behaviors but also in increasing well-being and perceived control over gambling in recently abstinent gamblers (Ladouceur, Sylvain, & Gosselin, 2007; Ly, 2010). Nevertheless, a large majority of individuals (88% in Cohen, McCormick, & Corrado, 2011) who applied to VSE program go back to gambling when their self-expulsion period ends (e.g., after 12 months) or gamble in illegal venues or in neighboring countries during the VSE period (e.g., Billieux et al., 2016; Hayer & Meyer, 2011; Ladouceur et al., 2007; Nelson et al., 2010; Tremblay, Boutin, & Ladouceur, 2008). To a broader extent, these findings suggest that situational (or proactive) strategies strengthen self-control abilities but remain insufficient to sustain permanent change.

The exploration of processes involved in long-term behavioral change has been the subject of research conducted by Reith and Dobbie (Reith & Dobbie, 2011, 2012, 2013; see also Reith, 2018). These authors conducted qualitative studies in which narratives of individuals who achieved to maintain a state of abstinence from gambling were analyzed. According to these studies, one recurrent aspect in the trajectories of recovery is the renewed interest in activities in line with the individual's life values, which allows him/her to recover a sense of agency and meaning in life. In others words, behavioral change should not only focus on replacing gambling with another pleasurable activity, i.e., merely revolving around shifting from a gambling self-identity (i.e., a "gambling self" that has become problematic, with many becoming unable to fulfill roles associated with their non-addict selves and even coming to lose the sense of who they were; Reith & Dobbie, 2012), but developing a self-identity that is reshaped in harmonious and appropriate ways. This view echoes the transdiagnostic approach of maladaptive and excessive behaviors (e.g., Billieux et al., 2015; Philippot, Bouvard, Baeyens, & Dethier, 2019; Rogier & Velotti, 2018; Wéry, Schimmenti, Karila, & Billieux, 2019). This framework posits that a processed-based holistic case conceptualization is required to identify specific psychological processes that can be targeted with empirically based psychological interventions (Dudley, Kuyken, & Padesky, 2011; Kinderman & Tai, 2008; Virués-Ortega & Haynes, 2005). A processed-based case conceptualization contrasts with the symptom-based approach, which merely results in standardized interventions that focus exclusively on the dysfunctional behaviors per se, such as the previously described cognitive (or reactive) and situational (or proactive) self-control strategies. A symptom-based approach may help the individual to resolve a self-control dilemma in the short or mid-term (e.g., avoid gambling to safe money; to focus on work/study), while a process-based approach should be more efficient in helping the individual to maintain recovery from gambling problems. Hence, symptom and process-based interventions should be combined to target short-term and long-term behavioral changes from addictive behaviors.

Crucially, adopting such a dynamic treatment approach is relevant in relation to the rapid proliferation of online sports betting opportunities (e.g., Hing, Russell, & Browne, 2017; Hing, Russell, Lamont, & Vitartas, 2017; Russell, Hing, Browne, & Rawat, 2018). One key aspect of sports betting is that it binds gambling to watching sport, that is, a popular, enjoyable, and valorized activity. Moreover, in contrast to other types of gambling activities, sports betting is not perceived as negative in our society (Lopez-Gonzalez et al., 2018). In this context, combining symptom-based and process-based approaches, thereby exploiting their complementarity, would help to implement clinically relevant interventions in individuals who aim at controlling or stopping their sports betting behavior. For instance, one challenge for these quitting-motivated sports bettors (especially those who are also sports fans) would be to watch a sports events but without betting on it (e.g., Johansen, Helland, Wennesland, Henden, & Brendryen, 2019). A symptom-based intervention should help the individual to develop self-control strategies while facing salient sports betting stimuli (such as when perceiving in-play betting advertising that encourage sports bettors to place bets during the game; Russell et al., 2018), while a process-based approach should help the quitting-motivated sports bettors to restore an interest in sports events watching per se, that is, without betting on it (shifting from a "gambling self" to a self-identity that is reshaped in harmonious and appropriate ways; Reith & Dobbie, 2012).

Concluding Remarks

In this chapter, we have described the findings from studies demonstrating that the stubborn persistence of gambling habits in problem gamblers might be explained by increased motivational responses coupled with reduced efficiency of impulse control processes. These patterns correspond well with those commonly observed in substance use disorder (for a review, see Field et al., 2016; Figee et al., 2016; and Smith et al., 2014), suggesting that gambling disorder shares common mechanisms with substance use disorders. Gambling disorder, as the first behavioral (i.e., non-chemical) addiction (APA, 2013), offers a valid model for studying the neurophysiological mechanisms underlying addictive behaviors without the confounding effect of drugs on the central nervous system (Dolan & Dayan, 2013; el-Guebaly, Mudry, Zohar, Tavares, & Potenza, 2012; Everitt & Robbins, 2005; Figee et al., 2016; Graybiel, 2008; Potenza, 2008; van Holst et al., 2010; Voon et al., 2015).

The examination of neurocognitive processes involved in gambling disorder is all the more crucial as online sports betting has never been so readily available and easy to engage in (e.g., Brevers et al., 2019). With easy access from a computer, tablet, or phone, it is possible to gamble on every sport event, at every moment, i.e., before or during a game in play (i.e., live sports betting), while simultaneously using different platforms. Hence, since practically every sporting event is available to bet on, merely viewing cues related to sport events (e.g., advertisements) has the potential to drastically increase gambling behaviors (Shaffer et al., 2004; Hing, Russell,

& Browne, 2017; Hing, Russell, Lamont, & Vitartas, 2017). Furthermore, nowadays, most video game products include elements of gambling (e.g., Loot Boxes), which further promote the ubiquity of gambling, especially in vulnerable individuals such as children and adolescents (King et al., 2019). In other words, this all-time gambling availability is likely to be a key environmental factor in triggering the need for or the temptation to gamble (Brevers et al., 2019; Shaffer et al., 2004) and raises important public health concerns (Stein et al., 2018). Research is thus desperately needed to assess the impact of this new gambling offer on public health (especially in young adults; Nyemcsok et al., 2018; Pitt, Thomas, Bestman, Stoneham, & Daube 2016, Pitt, Thomas, Bestman, Daube, & Derevensky 2017a, 2017b; Thomas et al., 2018) and to develop and validate psychological interventions capitalizing on the combined use of symptom- and process-based approaches.

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Chapter 12
The Psychological Perspective on the Antecedents and Consequences of Consumer Borrowing

Tommy Gärling and Rob Ranyard

Introduction

Consumer borrowing refers to credit not secured on property, usually either fixed loans repaid in fixed instalments or revolving credit such as credit cards, variable up to a credit limit and flexible repayments at or above an agreed minimum. Consumer credit is a major financial market worldwide. For example, across the 28 EU countries, it increased from around 800 to 900 billion Euro between 2013 and 2017, with widely varying annual percentage rates (APR) of interest (EBA, 2019). The market is a positive driver of economic growth that benefits consumers by allowing them to make purchases at times they otherwise could not afford. Over-indebtedness due to accumulated payment demands causing unsustainable financial stress is still a potential risk with negative consequences for the borrowers (Brown, Taylor, & Wheatley Price, 2005). That people overborrow and default is also a potential cause of instability of the economy (Elliot & Lindblom, 2019). Another issue at the societal level is the role of consumer credit for an ever-increasing consumption in affluent countries. It is generally believed that a reduction of consumption is needed to abate climate change and other threats to the planet (Thøgersen, 2014). Borrowing to fund purchases of consumer products may counteract this by contributing to unsustainable consumption levels (Cohen, 2007).

In this chapter we focus on consumers' use of credit to fund purchases and the factors associated with decisions to borrow. We also consider its consequences, particularly negative ones such as over-indebtedness. The scale and purpose of borrowing varies with age and income level. It tends to increase across early adulthood and

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to fall from the mid-40s (SCHUFA, 2010). Younger adults are increasingly taking easily accessible unsecured credit, for example, borrowing online to fund instant consumption (Autio, Wilska, Kaartinen, & Lähteenmaa, 2009). With respect to income level, more affluent households tend to borrow to fund major purchases such as cars and houses (Katona, 1975), while poorer households may borrow to make ends meet (Berthoud & Kempson, 1992). For a substantial minority of households, consumer credit repayments contribute significantly to their over-indebtedness. In some cases households fall into a debt trap, for example, from taking unsecured loans at high interest rates that force them to use new loans to cover repayments. One in six participants in a recent UK survey reported that they were likely to find meeting monthly bills a heavy burden or had missed at least two payments in the last 2 months (Money Advice Service, 2017).

In the following sections, we draw on in-depth analyses of consumer credit use by Kamleitner, Hoeltz, and Kirchler (2012) and Kamleitner and Kirchler (2007). They conceptualize credit use as a process starting with a need or desire to purchase an unaffordable consumer product, borrowing money to make the purchase, and ending with repaying the borrowed money. Each of these stages is influenced by situation and person characteristics, social practices, and decisions made by the borrowers. Figure 12.1 identifies five elements of the borrowing process that are our primary

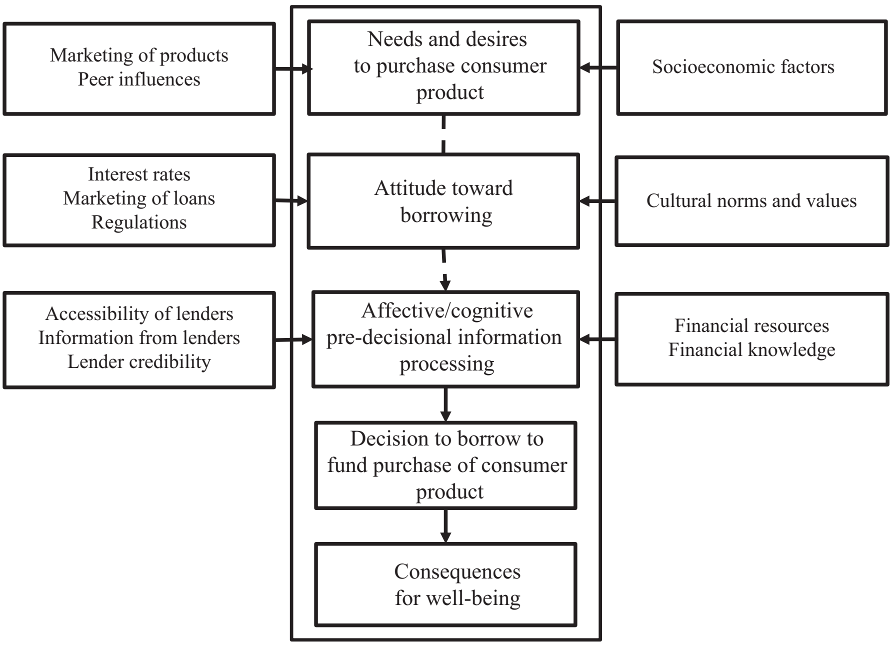

Fig. 12.1 Factors influencing the psychological components of the credit choice process. (Solid arrows represent direct effects; the broken arrow indicates that the direct effect is moderated by the variable in the box)

foci. In the first three sections following, we review research on the antecedent psychological components of the borrowing process: consumption needs and desires, attitudes towards borrowing, and affective-cognitive pre-decisional information processing and decision making. Our conceptualization of the borrowing decision process taps into the perspective of dual process theories (Kahneman, 2011; Stanovich & West, 2000) of judgement and decision making. Thus, decisions to borrow are partly effortless, fast, automatic, emotionally charged cognitive processes, partly effortful, slow, deliberate, and cold-headed. The former, referred to as "System 1" mode of thinking, is more likely to be activated if the borrowers experience either proximal stressors, including feelings of scarcity, that heighten the need for consumption or temptations that heighten the desire to consume. In such circumstances, borrowers may decide on the basis of simplifying heuristics (e.g. Kahneman & Frederick, 2005; Shah & Oppenheimer, 2008). The latter mode of "System 2" thinking may override the former mode in contexts where temporal and cognitive resources support a more reflective approach to borrowing decisions.

We then complete the chapter by considering the consequences of decisions to borrow for well-being, in particular interactions between repayment obligations and satisfaction with consumption, and psychological concomitants of over-indebtedness.

Antecedents of Borrowing Decisions

Consumption Desires and Borrowing

In the conceptual framework (Fig. 12.1), needs and desires to purchase consumer products are distal antecedents of borrowing decisions. The distinction between needs and desires is however difficult to make because over time initially desired products frequently become needed and what some people desire may be what other people need. An approximate distinction is that needs are aroused because old consumer products are worn out or because of changes in socio-economic factors (child birth, marriage or divorce, demotion or losing job, disease), whereas desires are evoked by increases in wealth, peer influences, and the availability and marketing of new products or new models of old products. In the following, we primarily focus on desired consumption.

It is frequently recognized that people have difficulty deferring desired consumption (Labroo & Pocheptsova, 2017). In general, people judge the value of immediate consumption of a desired consumer product to exceed the value of its consumption at some time later (Frederick, Loewenstein, & O'Donoghue, 2002; Read, McDonald, & He, 2018). This phenomenon, referred to as present-biased temporal discounting, has been identified as a major determinant of borrowing, which makes immediate consumption feasible at a deferred cost (Webley & Nyhus, 2008). The fact that borrowing defers painful payments strengthens the benefit of borrowing.

Thaler and Shefrin (1981; Shefrin & Thaler, 1988) proposed a behavioural alternative to the life-cycle hypothesis (Modigliani, 1966) positing that consumption is influenced by an internal conflict between a doer and a planner. The planner is assumed to be far-sighted and strive towards maximizing lifelong utility, while the coexisting doer is assumed to be myopic and impatient, striving towards maximizing immediate pleasure. Resolving the conflict between immediate and deferred consumption requires self-control. Allocation of assets to "mental accounts" (i.e. income, savings, future income) is a general self-control mechanism implying that the marginal propensity of spending is highest from the income account, next highest from the savings account, and referred to as debt aversion, lowest from the future income account.

Hoch and Loewenstein (1991) noted that unplanned purchases of consumer products are occasionally spurred by momentarily desires that create an inner conflict with long-term consumption goals. Proximity in time (present-biased temporal discounting) is one factor accounting for the sudden increases in desires, but other proximity factors (e.g. physical proximity in a store) also do this. The implication is according to Hoch and Loewenstein (1991) that normal preferences are temporarily changed by factors reducing self-control (see also Berns, Laibson, & Loewenstein, 2007). Different techniques may be used by people to regain self-control. A proposed two-factor model distinguishes between techniques that strengthen willpower or reduce desire.

In an empirical study by Karlsson (2003), the two-factor model was corroborated by means of explorative and confirmatory factor analyses of questionnaire results from a population-based Swedish sample. The different self-control techniques are described in Table 12.1. Unwillingness to take economic risk and willingness to reduce consumption in economic downturns were positively correlated with reported frequency of both strengthening-willpower and desire-reduction techniques. A better economy and being older increased strengthening-willpower and

Table 12.1 Descriptions of consumer self-control techniques (Karlsson, 2003)

Desire-reducing techniques
Avoidance: Avoid places in which impulse buying is tempting
Distraction: Try to think of something else if tempted to buy
Substitution: Give myself a smaller but immediate reward to resist a larger desire
Strengthening-willpower techniques
Precommitment: Leave checkbook and credit cards at home, and only bring a small amount of money when going shopping
Economic cost assessment: Assure that I buy things that are worth the price and not cheaper somewhere else
Time binding: Think of the positive aspects with deferring to buy
Bundling of costs: Think of how much it is going to cost a year for things I purchase often
Regret and guilt: Anticipate if I will feel regret or guilt
Deliberate: Think twice before I buy
Budgeting: Budget and book expenses

decreased desire-reduction techniques, presumably because it was considered important to spend financial resources soundly. Perhaps reflecting different purchasing patterns, women more frequently used desire-reduction and men more frequently strengthening-willpower techniques.

Loewenstein (1996) argued that transient involuntary losses of self-control sometimes are caused by high-intensity visceral factors including drive states (e.g., hunger, thirst, sexual desire), craving, and emotions. A corollary is the hot-cold empathy gap referring to that people underestimate the influence of high-intensity visceral factors, failing to anticipate either in a cold state how they will be influenced in a hot state or in the hot state failing to recognize influences of this state. Both types of empathy gaps may influence purchases of desired consumer products (Cohen, Pham, & Andrade, 2008). Van Boven, Loewenstein, Dunning, and Nordgren (2013) reviewed research identifying different types of influences of hot states. One influence is increases in both sustained and selective attention, a second heightened involvement, a third biased interpretations of ambiguous information, and a fourth evoked approach and withdrawal behaviour.

Traditionally, self-control has been considered to be a dispositional trait (Labroo & Pocheptsova, 2017). This is reflected in credit research showing that trait measures of impulsivity (Ottaviani & Vandone, 2011), present orientation (Meier & Sprenger, 2010), and delay of gratification (Norvilitis, 2014) are related to debt levels. Switching from a focus on such personal causes to situational causes of self-control is the essence of a recent theoretical account of the role of present-biased temporal discounting in explanations of borrowing. This theoretical account has been proposed to explain irrational economic behaviours as resulting "simply from having less" (Shah, Mullainathan, & Shafir, 2012, p. 682). Studies show that feelings of resource scarcity alter how information is processed (Mani, Mullainathan, Shafir, & Zhao, 2013; Shah et al., 2012; Shah, Shafir, & Mullainathan, 2015; Shah, Zhao, Mullainathan, & Shafir, 2018). In the context of purchases of consumer products, people would feel a financial deficit if desiring to purchase an unaffordable product. A financial deficit has the consequence that attention is focused on means of reducing the deficit (Shah et al., 2012). Metaphorically, "tunnel vision" is created such that matters falling inside of the tunnel receive attention, while matters falling outside are neglected. If facing financial barriers to purchases, people may eliminate the financial deficit by borrowing to fund immediate consumption, neglecting the costs of future repayments.

A more elaborated self-regulatory model of how people respond to resource scarcity was proposed by Cannon, Goldsmith, and Roux (2018). They noted that resources of many kinds have in common that they are quantitative, offer utility, and are consumable. Scarcity is defined as a discrepancy between the level of the resource (e.g. current financial assets) and a higher desirable level (e.g. the price of a desired consumer product). Objective or subjective assessments of financial resources (e.g. income, assets) are frequently used as a proxy of scarcity. Cannon et al. also listed several experimental techniques to activate feelings of scarcity (referred to as a scarcity mindset by Shah et al., 2012). In their model, a distinction is furthermore made between a focus on the goal of reducing the scarcity and, if unable to do this, a focus on regaining personal control. The former results in high self-regulation aimed at reducing the scarcity. The alternative focus instead results in low self-regulation by switching between various attempts to regain personal control. Which focus will dominate depends on whether scarcity reduction is perceived to be possible to attain. An aggressive marketing of consumer loans by lenders may favour perceptions that resources can be attained by borrowing and thus strengthens the focus on scarcity reduction.

Instalment payments that retailers offer in stores or online presumably increase the likelihood of borrowing to fund purchases of desired consumer products. Gärling, Michaelsen, and Gamble (2019) conducted an online experiment in which a heterogonous sample of Swedish young adults participated. The young adults were asked in one condition to think of a desired consumer product (predominantly electronic gadgets) in a price range barely affordable. The likelihood of borrowing was marginally higher in this condition than in another condition in which the young adults were asked to think of a consumer product in the same price range that they expected would need to be replaced in the near future. The weak effect was explained as resulting from the influence of the young adults' negative attitudes towards borrowing.

A payday loan[1] is another credit form that may increase borrowing. Referring to the "triple scarcity" effect, Cook and Sadeghein (2018) argued that insufficient liquidity, limited lending possibilities, and personal loss consequences are necessary conditions for a scarcity mindset to be evoked and to result in overborrowing. In a scenario experiment, adult participants were asked how much they would borrow to cover an expense if liquidity was absent and they had no other lending possibilities than a payday loan. The expense was in different conditions late instalment payments for the currently owned car (anticipated loss of repossession of the car) or paying for leasing a new model (anticipated gain). The anticipated loss more frequently than the anticipated gain resulted in borrowing a larger amount than required to cover the expense. Overborrowing was higher for those who had previously taken payday loans than those who had not.

In this section we focused on purchases of desired consumer products when different factors (such as temporal and physical proximity, intense emotional-visceral states, or financial deficits) reduce self-control. We conclude that purchasing a desired consumer product that is unaffordable is difficult to defer if self-control is reduced. Some factors (e.g. financial deficit) in such cases influence affective/cognitive pre-decisional information processing such that increased loan costs and repayments associated with borrowing for the purchase are neglected.[2] Yet, purchasing

[1] An unsecured high-interest loan which the borrower is obliged to repay on the day of the next paycheck.

[2] Hamilton, Mittal, Shah, Thompson, and Griskevicius (2018) reviewed research showing that although people suffer from negative consequences of financial constraints, after an initial negative reaction, they are frequently able to cope by removing or at least managing the constraints and eventually to adapt by changing their spending. They argue that it is essential therefore to consider the time course of effects of financial constraints.

the desired consumer product by borrowing money is not feasible if there are no lenders. Another possibility would then be to save money to a future purchase or decide to not purchase it by eradicating the desire for the consumer product. Deferring or inhibiting the purchase may also be chosen if the attitude towards borrowing is negative. In the next section, we review studies of attitude towards borrowing that moderates the influence of desire on decisions to borrow to fund purchases of consumer products.

Attitude Towards Borrowing

Attitude towards borrowing is a psychological factor that in previous research has been associated with debt (Ranyard, McHugh, & McNair, 2018). In social psychology, attitude originally referred to a disposition to behave in a certain way towards an object (Allport, 1935). The narrower definition of attitude adopted in current social-psychological research (for recent reviews, see Albarracin & Johnson, 2019; Albarracin & Shavitt, 2018) is that provided by Eagly and Chaiken (1993, p. 1): "Attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor". The particular entity or "attitude object" may be everything a person discriminates perceptually or holds in mind. Corollaries include that an attitude is less influenced by situational factors than preferences although less stable than personality traits (Ajzen, 1987) and that the evaluation has several antecedents such as affective (feelings about the attitude object as measured by, e.g. feeling ratings or physiological indicators) and cognitive (beliefs about the attitude object as measured by, e.g. likelihood ratings) as well as consequences (e.g. behavioural approach-avoidance tendencies measured by observations or self-reports) (Eagly & Chaiken, 1993).

In the dominant Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975, 2010) and its successor the Theory of Planned Behaviour (TPB) (Ajzen, 1991, 2012), an attitude is a summation of favourable or unfavourable evaluations of salient properties of the attitude object multiplied by their perceived likelihood. Changes in salience, evaluations, or perceived likelihood would therefore change the attitude. Adapting TRA or TPB in a study of attitudes towards borrowing (see, e.g. Sotiropoulos & d'Astous, 2013; Xiao, Tang, Serido, & Shim, 2011), salient beliefs about borrowing are first identified, and then evaluations and perceived likelihood measured, multiplied, and summed to an attitude score (Fishbein & Ajzen, 1975, 2010). An alternative method is to obtain direct evaluative ratings of borrowing (Krosnick, Judd, & Wittenbrink, 2019).

The review by Kamleitner et al. (2012) documents that studies in several countries show that favourable attitudes increase and unfavourable attitudes decrease credit use. Although some of this research has investigated determinants of attitude towards borrowing (in Fig. 12.1 we identify culture norms and values, interest rates, availability and marketing of loans, and regulations), in most studies, the question raised is how attitudes towards borrowing are related to borrowing decisions. In the following, we selectively review these studies. Since borrowing is more difficult to assess, its consequence debt is commonly used as a proxy (Pattarin & Cosma, 2012).

In one of the earliest studies of the relationship between attitudes and borrowing, Livingstone and Lunt (1992; see also Lunt & Livingstone, 1992) attempted to understand what makes some people borrow more than others. To this end, they examined how sociodemographic, economic, and psychological factors operate. The psychological factors included social knowledge, locus of control, attitudes, and values. In order to measure attitudes in their heterogeneous sample, eight statements were presented in a questionnaire predominantly consisting of other questions. In a discriminant analysis, the attitude statements (e.g. "Better to borrow to buy what you want now", "Debt is wrong and should be avoided") to some degree accounted for the difference between indebted and not indebted participants.

Also in the early 1990s, Lea, Webley, and Levine (1995) reported research comparing consumers with or without outstanding debts to a supplier of water and sewerages. Attitudes were measured with a 12-item scale composed of pro-debt and con-debt statements. On average, participants did not have favourable attitudes towards debt, but debtors had less unfavourable attitudes. In another early study, Davies and Lea (1995) investigated which factors explain UK university students' indebtedness and whether these factors are the same as those in the general population. The scale used earlier by Lea et al., to measure attitudes was developed into the "Attitudes to Debt Scale" consisting of seven pro-debt statements (e.g. "Debt is an integral part of today's lifestyle") and seven con-debt statements (e.g. "Once you are in debt, it is very difficult to get out"). The university students' attitudes measured with this scale were on average slightly favourable and more favourable than in the general population. A positive relationship was furthermore observed between more favourable attitudes towards debt and higher expenditures for luxury consumption of clothing and entertainment.

The "Attitudes to Debt Scale" scale has been used in several subsequent studies (e.g. Boddington & Kemp, 1999; Norvilitis & Mao, 2013; Norvilitis et al., 2006; Zhang & Kemp, 2009) demonstrating correlations with debt. In these studies the reliability of the scale has, however, not been satisfactory. A reason may be that the scale does not measure a single "tolerance of debt" dimension, as Davies and Lea (1995) posited. By means of explanatory and confirmatory factor analysis of attitude responses obtained from three New Zealand student samples, Haultain, Kemp, and Chernyshenko (2010) found two uncorrelated factors, one labelled "fear of debt" and the other "debt utility". Being relatively fearless of debt and believing borrowing to be useful in attaining important goals appeared to be behaviourally relevant attitude dimensions. Along similar lines, Harrison, Agnew, and Serido (2015) analysed attitude responses from UK, US, and New Zealand university student samples. An exploratory factor analysis of agreement ratings of newly constructed statements yielded four factors labelled "anxiety", "utility-for-lifestyle", "utility-for-investment", and "awareness". Whereas the first two factors are similar to "fear of debt" and "debt utility" in Haultain et al. (2010), "utility-for-investment" is narrowly related to student loans. "Awareness" that was correlated with the other factors appears to be a self-report measure of financial knowledge. It may be asked whether the different dimensions have different relationships to borrowing. For instance, additional studies could investigate the possibility that "debt utility" is positively related and "fear of debt" negatively related to borrowing.

An attitude may be general and not specific (Albarracin & Shavitt, 2018). A general attitude would have a low correlation with specific behaviours (Ajzen, Fishbein, Lohmann, & Albarracín, 2019). The empirically verified principles of compatibility and aggregation were introduced by Fishbein and Ajzen (1975, 2010). According to the principle of compatibility, a measure of attitude towards borrowing would be weakly correlated with a measure of borrowing, unless compatible with respect to target, action, context, and time. Even though, a measure of a general attitude towards borrowing may therefore fail to correlate with different types of loans (e.g. loan from family or friends, credit card, instalment payment to store). According to the aggregation principle, it would correlate with the average frequency of using several types of loans. Individuals with a positive general attitude are for various reasons not likely to use all the types, but they are more likely than individuals with a negative general attitude to use at least some of them. Gamble, Gärling, and Michaelsen (2019) showed that when their measures targeted the same types of loan, attitude towards borrowing correlated positively with both likelihood of borrowing in the online experiment referred to in the preceding section (Gärling et al., 2019) and self-reports of frequency of previous borrowing. A measure of general attitude towards borrowing correlated positively with the frequency of previous borrowing aggregated for different loan types. Chien and DeVaney (2001) reported that an index of attitude towards borrowing money for purchasing consumer goods and services (e.g. a vacation trip) had a higher correlation with outstanding credit card balances than a general attitude, whereas a general attitude had a higher correlation with instalment debts. A general attitude may be more relevant for payments by instalments than credit cards, since it involves larger sums that evoke a higher involvement and in-depth processing of information.

A correlation between attitude towards borrowing and actual borrowing does not prove causality. A favourable attitude towards borrowing may cause increases in debt (borrowing), or increasing debt may cause an unfavourable attitude. Webley and Nyhus (2001) conducted a longitudinal study by tracking debtors and non-debtors over time. A cross-lagged analysis suggested that less unfavourable attitudes towards debt were a consequence of indebtedness. Davies and Lea (1995) compared different cohorts of university students in a quasi-longitudinal design. The results showed that debt increased with years at the university but more steeply in the first years, while attitude towards debt changed less steeply. Paradoxically, however, they found that as debt accrued, attitudes became more favourable. The students in the study belonged to prosperous socio-economic groups accustomed to a higher living standard. Borrowing provided an opportunity to sustain their previous living standard while studying at the university. Probably, therefore, their attitudes became more favourable over time. In line with this reasoning, Callender and Jackson (2005) found the opposite relationship for undergraduate students from lower socio-economic groups who were negative towards debt because it would jeopardize their continued higher education.

In the conceptual framework presented earlier in this chapter (Fig. 12.1), it is assumed that attitude towards borrowing is a determinant of decisions to borrow. However, although attitudes towards borrowing have been found to correlate with debt (borrowing), it has not been conclusively shown that attitude is a cause of borrowing. In fact, the results described above are more consistent with the reverse causality that debt causes changes in attitudes. Another issue is that attitude towards borrowing has not frequently been connected to borrowing decisions as proposed in Fig. 12.1. Dabholkar (1994) early raised the general question of whether choices between alternatives are made based on aggregated attitudes towards each alternative (alternative-wise processing) or the evaluations of the properties associated with the attitude (attribute-wise processing). In an empirical study of binary choices, the results supported the latter, but for a choice between more than two alternatives, the former seems more plausible.[3] However, Sotiropoulos and d'Astous (2013) noted that for understanding borrowing decisions, the role of reason-based attitudes may be questioned if borrowing decisions are impulsive. In a similar vein, Gärling et al. (2019) proposed that a negative attitude towards borrowing may act as a heuristic (Pratkanis, 1989) that suppresses any further pre-decisional processing of loan information. A positive attitude would instead allow the pre-decisional processing to continue. Future research should investigate the issues of whether attitude towards borrowing causally affect borrowing decisions and how it does this. In our next section, the focus is on how borrowing decisions are made.

Borrowing Decisions

So far, we considered factors that influence consumers' decisions to borrow to fund a purchase rather than delay consumption. This fundamental decision to borrow interacts with pre-decision evaluations and choice of the specific credit options available from different lenders of different types – secured or unsecured, revolving or fixed instalment. Previous research has investigated the extent of information search and the way information disclosure by lenders influences the decision process. In contexts in which System 1 processing is triggered, information search may be minimal, and simplifying decision rules or heuristics may be used. Where conditions are conducive to System 2 processing on the other hand, information search may be more extensive, and more effortful decision strategies utilized involving several attributes of credit options. However, in this case consumers may still choose credit on the basis of simplifying decision rules, if the complexity of credit products is such that they are not fully understood or the cognitive effort for deliberative choice is too onerous.

[3] Dabholkar (1994) also tested whether the choices were based on intentions (a linear additive function of attitude and subjective norm) as suggested by Fishbein and Ajzen (1980). This test yielded a worse fit.

Although an obvious first step towards making economically sound borrowing decisions is to thoroughly search for information about the alternatives available, it has been found that people often do not do this. Chang and Hanna (1992) reported that only 20% of borrowers had tried to get any information about multiple lenders or credit terms and those that had done so tended to be younger and represent higher levels of education. Similarly, Fan and Chatterjee (2017) found that only 25% of a US survey's participants reported that they had compared credit cards before choosing one, and the probability of doing so was inversely related to financial knowledge.

Other research suggests that consumers may be more inclined to compare credit options if search costs are lower. Ranyard, Hinkley, Williamson, and McHugh (2006) presented participants with realistic scenarios in which they could seek information from an interviewer about credit options for consumer durable purchase. They found that many participants sought information about monthly repayment, total cost, and annual percentage rate of interest (APR) of credit options. In this context, then, where information was readily available, these participants were prepared to search for information relevant to borrowing decisions. Consistent with this, the Financial Conduct Authority (2016) reported increases in active information search and switching of lenders in the UK credit card market which may be due to the increasing availability of comparison websites which reduce information search costs.

How do borrowers evaluate credit options and decide which to accept? Simple intertemporal choices, such as receiving $100 today versus $110 next month, have been extensively researched, leading to theoretical advances beyond discounted utility theory (Frederick et al., 2002; Read et al., 2018). However, such theories do not readily generalize to more complex instalment credit options. Ranyard and Craig (1995) proposed an alternative, dual mental account theory in which instalment credit is cognitively represented in terms of either a total or a recurrent budget period account. In the total account, all future repayments are integrated and treated as a total current cost, without temporal discounting. In this case, then, the total cost including interest and loan amount, or the charge for credit in cash terms, is the salient aspects of cost. Although these indicators of cost are limited because they are absolute measures that do not take into account the duration of the loan, they are easy to understand and represent mentally in a total account. On the other hand, in the recurrent budget period account, each future repayment is integrated into its corresponding future budget period, seen as similar to the current budget period, again without discounting. In this representation, the most important aspect of cost is the repayment amount, with the loan duration, or number of budget periods in which the repayment is required, also being important. Ranyard and Craig's in-depth interviews with borrowers suggested that the evaluation of instalment credit in terms of total and budget period accounts facilitates thinking about relatively complex credit products and to some extent determines borrowing decisions.

As well as the cost of credit in the cash terms just mentioned, the annual percentage rate of interest (APR), often described as the true cost of credit, is important information for borrows. The disclosure of the APR by lenders is nowadays a legal requirement internationally. On the positive side, it is a widely accepted comparison standard based on a designated time period that is easy to use with a simple "take the best APR" approach (see below). On the negative side, however, APR is a complex statistic that can be misunderstood. One misunderstanding identified is that the APR indicates the percent of the amount borrowed that would be charged in interest regardless of loan duration (Ranyard & Craig, 1995). Another is that it indicates the percent charged yearly of the initial, not the average, amount borrowed (McHugh, Ranyard, & Lewis, 2011).

For fixed credit options, APR, loan duration, total cost, and monthly repayment information should be available at the point of borrowing. In the study mentioned earlier, Ranyard et al. (2006) presented consumers with hypothetical credit choice scenarios in which APRs were given and other relevant information could be requested. Decision strategies were classified as comparative or non-comparative, and many of the (more frequent) comparative ones were based on APR only; participants simply said they would "take the best APR". Other participants' strategies compared total cost, monthly repayments, and loan duration, consistent with the alternative mental accounts described above. Follow-up experiments systematically varying total cost and APR information confirmed that APR was a major determinant of credit choice but also found that its effect was moderated by total cost information (McHugh et al., 2011). Two further studies have reported effects of total cost information on fixed credit choice, the first in hypothetical scenarios and the second with actual loan offers. First, in two within-group experiments, Lunn, Bohacek, and Rybicki (2016) found that relative to a baseline choice condition in which APR and loan duration information was presented, substantially more participants chose a longer loan term when monthly repayment was also given, while substantially fewer chose it when total cost information was given. They also found that two nudges mitigated these effects to some extent: the provision of a warning of high cost for APRs above 15% and the provision of a full information table, for example, loans, including the total cost. Second, in a field experiment, Bertrand and Morse (2011) found that the provision of information on the total cost of high-cost, rollover payday loans reduced the take-up by 11%. In their review of the above research, Lunn, McGowan, and Howard (2018) note that most relevant evidence is based on hypothetical scenarios, and therefore, more field studies are needed to clarify the most effective information disclosures to support borrowers using fixed instalment credit.

With flexible credit such as store and credit cards, repayments are not fixed at the point of initial borrowing; the level of repayment at or above the minimum must be decided repeatedly after borrowing, usually monthly. An economically sound repayment strategy that borrowers adopt is to choose the highest repayment level that is affordable within recurrent budget period constraints in order to reduce total cost and loan duration (Ranyard et al., 2006). Consistent with this, McHugh and Ranyard (2012) found that participants' credit card repayments in a scenario study were correlated with disposable income. This study also found that disclosing the long-term consequences of repaying a credit card balance, that is, the total cost and loan duration at different repayment levels, led to significantly higher repayments compared to a control group not receiving this information.

Two items of information on credit card statements, credit limits and the required minimum repayment, have been found to affect spending and borrowing in unintended ways. On the former, it has been found that borrowers can interpret credit limits as a signal for their future income and also that higher credit limits encourage spending (Gross & Souleles, 2002; Soman & Cheema, 2002). This leads to the suggestion that lenders should set credit limits with reference to its affordability for a reasonable loan duration.

On minimum repayment information, research has shown that its mere presence acts as an anchor for repayment decisions. In a scenario experiment, Stewart (2009) found that when it was present, more people chose to repay only the minimum and those who repaid more tended to repay less than those in a control group (see also Navarro-Martinez, Salisbury, Lemon, Matthews, & Harris, 2011). Furthermore, evidence from mass transaction data shows that changing minimum repayments alters borrowers' repayment levels more than expected from economic considerations (Keys & Wang, 2019). This leads to the suggestion that regulations for a minimum repayment level above 2% should be considered (with an APR of 14%, repaying monthly at a 2% of balance takes about 19 years). If, however, the level of minimum repayment was set too high, this could contribute to borrowers' financial stress.

Information disclosures that may counteract the minimum repayment anchoring effect have been investigated in several scenario experiments. First, Salisbury (2014) found that informing people of the repayment necessary to repay in 3 years, as required by the US CARD Act of 2010, increased the proportion of credit card users repaying at that level. This was confirmed by Agarwal, Chomsisengphet, Mahoney, and Stroebel (2014) analysis of mass transaction data, although no aggregate increase in repayments was observed. In fact, although Salisbury found that the proportion repaying more than the minimum increased when 3-year repayment information was given, Hershfield and Roese (2015) showed that a significant number of users repaid less than they would have paid if it had not been present. Nevertheless, McHugh and Ranyard (2016) found that providing total cost and loan duration information for anchors higher than 3-year repayment amounts increased the proportion of users repaying at or above such higher levels. This was tested further in an online between-groups experiment by the Behavioural Insights Team (Team, 2018) comparing a standard statement information control with alternative additional information: (a) an analogue slider with minimum repayment information at one end and the balance at the other, thereby making the lowest and highest anchor salient; (b) the slider position moved to give information on an anchor higher than the minimum; and (c) a slider showing minimum repayment information that also made time to repay the loan salient. In all three conditions, mean repayments were significantly higher than the control, and significantly fewer chose the minimum. Although promising, the effectiveness of different information disclosures to that required by the US CARD Act of 2010 in counteracting the minimum repayment anchor effect has yet to be tested in the field.

The complexity of consumer borrowing decisions is increased when consumers acquire multiple credit cards, when sellers introduce introductory offers with variations in initial interest rates and penalty charges, or when payday loans allow debt rollover with interest charges compounded. Faced with this, research has shown that borrowers tend to make less economically sound choices. For example, multiple credit card holders tend to pay off smaller balances first, thus reducing the overall number of outstanding debts, rather than prioritizing the one with the highest rate of interest (Amar, Ariely, Ayal, Cryder, & Rick, 2011). In addition to the Bertrand and Morse's (2011) study mentioned above, there have been several studies of the effectiveness of nudges towards better credit decisions in the face of complex credit products. The Behavioural Insights Team conducted an incentivized experiment of consumer understanding of credit cards with different balance transfer offers. They found that the provision of "key facts", including total cost, improved participant understanding of which was the better option (Team, 2018). The provision of less key information, four items rather than six, was more effective. While some disclosures may be generally effective, such as presenting the total cost or the cost of credit in money terms, the effectiveness of others may depend on the borrower's level of numeracy, or level of financial literacy, defined as the ability to use financial knowledge and information effectively. Both have been found to be associated with the quality of borrowing decisions and level of debt (Team, 2018; Lusardi & Tufano, 2015; Gathergood, 2012). Disclosures involving detailed quantitative information, such as tables of cost and time to repay, may be more effective for the more numerate borrower, while simple qualitative messages, such as reminders that any repayment can be made between the minimum and the full balance, may be more effective for others.

Irrespectively of how borrowing decisions are made, they have outcomes that influence short-term and long-term well-being consequences (see Fig. 12.1). In the next section, we turn to these consequences.

Consequences of Borrowing for Well-Being

Satisfaction with Consumption

In economics, the dominant objective indicator of well-being is material wealth (Perlman & Marietta, 2005). A positive relation between material wealth and lifelong utility depends on that markets offer needed and desired products that citizens can purchase. Would borrowing to fund immediate desired consumption maximize lifelong utility? According to the life-cycle hypothesis (Modigliani, 1966), it would increase lifelong utility if consumption is distributed evenly across the life cycle by borrowing to consume at early ages when incomes are lower and repaying at older ages when incomes are higher. However, as noted in previous sections (see also

Labroo & Pocheptsova, 2017), even though borrowing to acquire desired consumer products raises utility at the time of the purchase,[4] it is frequently in conflict with lifelong utility.

In recognizing that people are less economically rational, we note that (a) the conventional utility construct in economics (utility inferred from observed choices) does not fully correspond to experienced satisfaction with material consumption (Kahneman & Sugden, 2005; Kahneman, Wakker, & Sarin, 1997); (b) satisfaction derived from material consumption decreases over time (Frederick & Loewenstein, 1999; Wilson & Gilbert, 2008); and (c) satisfaction with material consumption is not the only factor associated with well-being (Diener & Seligman, 2004). In this section we next address the question of how borrowing to fund purchases of desired consumer products is related to satisfaction with the purchased products. Thereafter, we focus on negative influences on well-being of borrowing such as reduced future consumption or in prolongation possible over-indebtedness.

An answer to the first question is suggested by Prelec and Loewenstein (1998) who propose that pain of paying undermines satisfaction derived from consumption. If payment is made at the time of purchase, people experience an immediate pain of paying. Consumption that has already been paid for (e.g. a pre-paid vacation trip), on the other hand, may be enjoyed as if it were free. Deferring payments by borrowing to a purchase would likewise relieve people from the immediate pain of paying. But do loan repayments influence satisfaction with the purchased product? Prelec and Loewenstein (1998) proposed that it depends on the "mental coupling" between satisfaction derived from consumption and the pain of repayment. Satisfaction would be reduced if mentally coupled with (bringing to mind) the pain each time loan repayment is made. A factor influencing coupling is the payment method; specific instalment or cash payments are coupled with the purchased product, whereas paying a monthly bill for an outstanding credit card balance may not be. Coupling is also proposed to work in the other direction by buffering the pain of payment. Therefore, loan repayments would be particularly painful if not finished before the consumer product is worn out. If loan repayments remain the same over time, decreasing enjoyment with the consumer product would buffer the pain of paying less (Frederick & Loewenstein, 1999; Wilson & Gilbert, 2008).

In a review, Kamleitner and Hoelzl (2009) noted that there are only few studies that have empirically investigated coupling of benefits and costs in the context of borrowing to fund purchases of consumer products. An exception is Kamleitner and Kirchler (2006) who conducted interviews with a sample of people who were about to, or had already, made a purchase with a personal bank loan. They found that

[4] Dunn, Gilbert, and Wilson (2011) noted several deviations from utility maximization, also at the time of purchase, such as foregoing the pleasure of anticipating the consumption of the product. Anticipating consumption may be higher than remembering or sometimes even actually consuming. Another deviation is falsely believing that consumption has a stronger emotional impact in the present than the same consumption has in the future. They additionally noted that forecasting pleasure from consuming a purchased product is inaccurate because it focuses on positive and neglects negative aspects.

participants often reported coupling the loan repayment with the purchased product, thereby buffering the impact of the cost. On the other hand, they seldom reported coupling the purchased product with the loan repayment, thus decoupling them to protect the enjoyment of the product. However, these asymmetric effects varied with context (e.g. were stronger for furniture than vehicle purchases) and diminished towards the end of the loan period. Kamleitner, Hoelzl, and Kirchler (2010) surveyed two groups similar in average age and income, one group having consumer loans and the other group mortgages. Both groups were asked whether thinking about the purchase for which they used the loan made them think about the loan (benefit-to-cost coupling) and whether thinking about the loan made them think about the product they purchased for the borrowed money (cost-to-benefit coupling). They were also asked to report the degree of pleasure derived from consuming the product as well as the degree to which the loan repayment was a burden. The survey was followed by an online scenario experiment in which another sample of participants was asked to imagine repaying a loan to the purchase of their currently owned automobile. Benefit-to-cost versus cost-to-benefit coupling was varied by directing participants' attention to the loan burden (a possible increase in interest rate) or the benefit of the automobile (the pleasure of a driving trip). The results of both studies were consistent in showing that the repayment burden (pain of paying) was increased proportional to the degree to which thoughts about benefits brought to mind thoughts of costs. No buffering effect of enjoying the product was detected. Similar findings were reported by Hoelzl, Pollai, and Kamleitner (2009) in a survey of mortgage users. In addition, these authors found that participants remembered loan burden to have been higher in the past and expected it to be lower in the future despite that measures at different points in time showed no differences.

Overborrowing for purchases of desired consumer products may limit both needed and desired future consumption. It may also make borrowers accustomed to a material lifestyle entailing an unaffordable level of expenses. In investigating how people adjust their expenses to a lower income, Van Raaij and Eilander (1983) identified several tactics, including buying the same products at lower prices in cheaper stores or on sale, buying smaller quantities, or deferring replacement purchases of expensive durables. Changing the material lifestyle was a tactic chosen last. It may include selling the automobile, selling the owned home, or cancelling vacation trips abroad. These are painful choices for people, because they show to themselves and others that they are affected by an adverse financial development. If overborrowing consequences are comparable to the consequences of income reductions, one may expect that strong motives are evoked to take new loans. Both hedonic adaptation and rising aspiration levels (Frederick & Loewenstein, 1999; Wilson & Gilbert, 2008) additionally increase the desire to consume and, thus, the likelihood to take new loans. However, some people succeed in enjoying positive changes longer (Lyubomirsky, Sheldon, & Schkade, 2005). Others may perhaps be taught the skills these people possess. Renting at lower prices than buying is another practice that would bolster well-being at the same time as it may reduce overspending with borrowed money.

Borrowing may alleviate people from pain of the immediate payment but not, as studies show, from the burden of repayment which frequently appears to be neglected at the time of purchase. Consumption desires due to hedonic adaptation, and rising aspiration levels also tend to lead to additional borrowing suggesting that borrowers are at risk of over-indebtedness.

Psychological Concomitants of Debt and Over-Indebtedness

As noted above, borrowing to fund consumption improves well-being in the short term since immediate needs are met and desires fulfilled. However, consumer borrowing can contribute to over-indebtedness, often in conjunction with low income or disruptions to economic stability such as redundancy or illness (Berthoud & Kempson, 1992). More generally, there is consistent evidence from panel and national representative surveys that consumer debt is associated with detriments to well-being such as depression, anxiety, and ill-health. Although psychological detriment is not an inevitable consequence of consumer borrowing, indebted individuals tend on aggregate to score lower on relevant measures than those without debt. A comprehensive literature search by Richardson, Elliot, and Roberts (2013) identified 52 studies of the relationship between personal unsecured debt and mental and physical health. Their meta-analysis identified consistent associations between unsecured debt and prevalence of both depression and mental ill-health. For example, Bridges and Disney's (2010) analysis of the UK Families and Children's Survey found that significantly more participants currently in debt were depressed compared to those who were not currently experiencing such difficulties. Similarly, Brown et al. (2005) reported an association between unsecured debt and depressive symptoms in British Household Survey Panel respondents.

Not surprisingly, over-indebtedness is associated with greater detriment to well-being. Drentea (2000) found that two measures of problem debt, the likelihood of default and debt-to-income ratio, were both associated with the number of days participants felt anxious recently, while Gathergood (2012) found that debt "being a heavy burden" was associated with poorer reported mental health. Several studies have found that the association between debt and psychological detriment was mainly accounted for by the subjective experience of debt rather than objective measures. Bridges and Disney (2010), for example, found that the association between debt and depression was mainly accounted for in this way, and Butterworth, Fairweather, Anstey, and Windsor (2006) found that feelings of hopelessness, worthlessness, and demoralisation partially mediated this link.

Richardson et al. (2013) observed that most research linking debt to psychological detriment is cross-sectional in design and could not address questions of direction of causality. In some cases indebtedness, mediated by perceptions of a heavy burden, may be a major cause of psychological detriment, but in other cases, serious life events such as bereavement or job loss may be a common cause of both. Some longitudinal studies have shed some light on this issue, such as Webley and Nyhus's

(2001), referred to in a previous section, who found that several psychological and behavioural responses are consequences of indebtedness: having a less unfavourable attitude to debt, tending to prefer spending immediately, shorter planning horizons, and certain money management practices. In a field test of an intervention to support over-indebted people, O'Neill, Sorhaindo, Xiao, and Garman (2005) found that those who reduced their debt reported better health outcomes.

Over-indebtedness evokes the conditions of scarcity that contributes to inattention and impairs information processing necessary to take actions to recover economic control (e.g. Cannon et al., 2018; Shah et al., 2012). This is compounded by tendencies of those experiencing depression or anxiety of denial and avoidance of threatening information. Shapiro and Burchell (2012) found that higher financial anxiety was associated with avoiding financial information or taking longer to process it. The Money Advice Service (2017) reported that only a minority of seriously indebted UK participants had sought support, while a French survey found that many over-indebted people waited several months before seeking help (Banque de France, 2014).

Concluding Remarks

The decision to borrow has been characterized as a conflict between immediate wants and needs and long-term life satisfaction. Research shows that self-control to defer consumption is reduced, and the propensity to borrow increase, by contextual factors such as proximity, emotional state, and feelings of scarcity. Various techniques of self-control can help people to resist the temptation to borrow when it would be against their long-term interests. Similarly, if people consider borrowing to reduce feelings of scarcity, certain interventions could help them to regain control of their situation. Both of these potential means of reducing overspending and over-indebtedness are promising areas for further enquiry.

Although borrowing and debt are correlated with attitudes, it has not been proven that the latter determines the former. This is to some extent because of evidence that attitude towards debt can become less negative following debt experience. Therefore, research is still needed to clarify the antecedent role of attitudes in borrowing decisions and subsequent behaviour, such as whether a negative attitude may act as a heuristic for a fast decision to not borrow. In addition, more recent research has identified distinguishable components of attitude, such as "fear of debt" and "debt utility", whose role warrants further investigation.

Borrowers often choose the first credit option that becomes available without first obtaining full information on it or on any alternatives. Lowering search costs via comparison websites may alleviate this tendency, and further research is needed on how best to disclose information on such websites. More generally, how credit information disclosure can best support the consumer is an important ongoing issue for field research in the complex and changing market for credit. For fixed instalment credit, APR and credit cost in cash terms are key disclosures for the consumer.

For revolving credit, however, disclosure of the cash cost of credit and of loan duration has had limited success in counteracting minimum repayment biases. For both credit types, field studies are still needed to identify whether simple qualitative messages or, alternatively, tables of numerical information are more useful for borrowers at different financial capability levels.

Financial education in childhood and beyond that includes in-depth coverage of borrowing and debt can nurture the knowledge and skills required for sound financial decision making. However, while this may be necessary, research seems to show it is not sufficient. Effective ways to broaden the curriculum, for example, to foster resilience, could be developed and evaluated.

Psychological detriments such as depression and anxiety may be either a consequence of debt or, alternatively, both may be caused by prior life events. In either case, such psychological issues can make it difficult for over-indebted people to deal effectively with their financial problems. Further research is needed to develop and evaluate debt management interventions that include broader psychological support for those who might benefit from it.

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Chapter 13
Tax Compliance: Research Methods and Decision Processes

Andre Julian Hartmann, Martin Mueller, and Erich Kirchler

Introduction

Most countries levy duties and taxes to finance public goods and services. Taxes also serve to regulate individuals' behaviors and market dynamics. Unwanted behaviors of citizens and businesses (e.g., smoking and consumption of unhealthy food) are taxed, whereas desired behaviors (e.g., carbon emission versus environmentally friendly production) are promoted (Bristow, Wardman, Zanni, & Chintakayala, 2010; Haavio & Kotakorpi, 2011). Moreover, progressive taxation aims to correct excessive differences in income and wealth, which seems to positively affect national happiness (Oishi, Schimmack, & Diener, 2012).

Citizens value the provision of public goods and services (e.g., healthcare system, education, infrastructure, national security, and defense). Nevertheless, they complain about levies and are reluctant to pay taxes (Kirchler, 1997). Thus, it is questionable whether tax compliance would be high if the government would not enforce it.

Which strategies are most effective in ensuring tax honesty? For decades, researchers in social sciences, especially in economics, have addressed tax compliance decisions and investigated strategies to deter evasion. Traditionally, research focuses on individual taxpayers who face a decision under uncertainty when filing their income tax. If they follow the law by paying their full share, they can be certain to keep their net income, independent of future audits. However, when they pay less than the amount due, the outcome depends on whether they are audited or not: if audited and punished, they face a loss; if not audited, they remain with more than the net income. Consequently, the decision to act honestly or to cheat depends

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predominantly on the following factors: audit probability, audit efficiency, and the severity of fines.

Economic theory assumes that individuals maximize their profits through rational decision processes. However, taxpayers who act only in their selfish interest and maximize their personal utility harm the community. If the majority or all individuals free ride, they will act not only to the disadvantage of other taxpayers but also eventually to the disadvantage of themselves. The tension between individual benefit maximization and collective interests gives rise to a social contribution dilemma (Dawes, 1980). According to the social dilemma perspective, taxpayers consider not only audit probability and fines but also the behavior of other taxpayers. Assuming that others cheat on taxes is likely to fuel individual dishonesty as well.

The assumption that taxpayers are rational utility maximizers in risky decisions and social dilemma situations leads to the theoretical premise that the income level, tax rate, and especially audit probability and fine rate, as well as the contributions of other taxpayers, impact individual tax compliance. Research both in the laboratory and in the field lends support for the relevance of these variables. However, they explain only part of the tax behavior. Sometimes the observed effects are opposite to the theoretical predictions. Economic psychology and behavioral economics reveal several “anomalies” (i.e., effects going into the opposite direction as theoretically predicted). For instance, the “bomb crater effect,” the “echo effect,” mental accounting strategies, and the impact of windfall gains on tax behavior contradict neoclassical assumptions. Moreover, psychological research provides evidence for the importance of factors, such as the understanding of the tax law, attitudes toward taxes and tax morale, personal and social norms, and perception of distributive and procedural justice since the late 1970s. Moreover, the quality of the relationship between citizens and the state authorities also affects willingness to cooperate.

Feld and Frey (2007) referred to an implicit psychological contract between citizens and authorities that implies duties and rights for each party. Tax authorities can violate the psychological contract and undermine taxpayers’ willingness to pay in two ways: through frequent checks or heavy penalties that do not appear legitimate or credible or by the lack of retributive fairness considerations that can adversely affect subsequent compliance with tax regulations. The “slippery slope framework” (Kirchler, Hoelzl, & Wahl, 2008) integrates empirical findings from economics (e.g., audits and fine rates) and social psychology (e.g., social norms and fairness considerations) into a coherent frame explaining individual tax compliance behavior. The framework comprises two dimensions: power of authorities and taxpayers’ trust in the authorities that determine the interaction climate between the taxpayers and the authorities. Power refers to the authorities’ capacity to audit taxpayers, to detect evasion, and to punish evaders. Trust refers to taxpayers’ belief that the authorities are trustworthy and act in the interest of the commons. Trust builds on competence, benevolence, and integrity (Mayer, Davis, & Schoorman, 1995) and is positively related to fair procedures (Tyler, Goff, & MacCoun, 2015). Trust and perceptions of power result also from communication about the use of tax money, the perceived behavior of other taxpayers, and the appropriateness of audits and fines (Alm, Jackson, & McKee, 2009). According to the slippery slope framework, high perceptions of tax authorities' power lead to enforced compliance, whereas perceptions of trust lead to voluntary motivation to comply.

In this chapter, we provide a review of the research on tax compliance decisions. We address traditional approaches to study compliance decisions and anomalies as well as the psychological determinants of compliance. Since different research methods reveal different results, we describe the arsenal of research methods and their strengths and weaknesses. We also pay specific attention to results from information processing techniques in tax compliance research, which are typically applied in laboratory experiments. The results suggest that the irrational behavior observed in experimental settings arises because the participants do not always search for the provided information on audit probability and fines but consider other aspects relevant. This chapter is structured into four sections. In the first section, we provide an overview of rational and behavioral economic models of tax behavior and describe the selected anomalies. Further, we present sociopsychological insights and the "slippery slope framework." Section "Tax compliance: theoretical models and determinants of compliance" gives an overview of the research methods applied in the field of tax research. The strengths and weaknesses of various methods and convergence of results from different methods are discussed. In section "Methods in tax research", we address new methodological approaches that aim to understand the underlying cognitive processes of tax decisions. The most popular process tracing techniques and insights in economic decision making are presented. Finally, we conclude our chapter with practical implications for policymakers and researchers in the field.

Tax Compliance: Theoretical Models and Determinants of Compliance

Rational Choice Model

Based on the economic model of criminal activity (Becker, 1968), Allingham and Sandmo (1972) and Srinivasan (1973) developed seminal models of tax decisions. When filing taxes, taxpayers face a decision under uncertainty as they do not know whether they will be subject to a tax audit. The resulting decision problem is assumed to be solved according to the expected utility theory (von Neumann & Morgenstern, 1947). Allingham and Sandmo (1972) and Srinivasan (1973) assumed that taxpayers are motivated to maximize their expected utility by rationally considering the value and probability of decision outcomes. On the one hand, taxpayers can declare the total gross income (i.e., pay the tax due). Alternatively, they can conceal some of their income or unauthorized expenditures (i.e., pay less than the tax due). If taxpayers pay the tax due, then they have chosen the sure option. They get to keep their net income independently of future audits. If taxpayers cheat on taxes, then they will be faced with uncertainty: in case of no audit, their income will

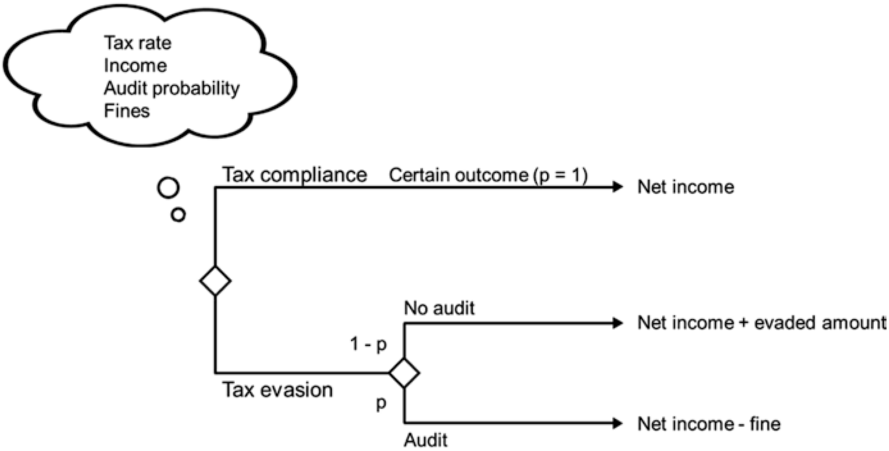

Fig. 13.1 Tax compliance decision tree according to the parameters of the model of Allingham and Sandmo (1972) and Srinivasan (1973). The audit probability is indicated by p

be higher than the net income; in case of an audit, they will have to not only reimburse the tax due but also pay a fine, which eventually results in less than the net income.

According to Allingham and Sandmo (1972) and Srinivasan (1973), taxpayers consider four central parameters in their model of tax compliance: income, tax rate, audit probability, and fine rate. They compare the value of the sure option with the expected value of the uncertain options. Figure 13.1 shows the decision tree under these assumptions. In a nutshell, taxpayers pay the tax due depending on the economic consequences of detection probability and punishment (Alm, 2012). If deterrence resulting from a high audit probability and harsh fines, in case of detected evasion, is high, tax compliance is high too.

The assumptions of the traditional economic model have been empirically tested in a myriad of empirical studies. Survey studies, laboratory and field experiments, and analyses of aggregate data yielded evidence that audit probability and fines positively affect tax compliance. However, the effects vary in size and are generally weak (Andreoni, Erard, & Feinstein, 1998; Fischer, Wartick, & Mark, 1992; for an overview, see Kirchler, Muehlbacher, Kastlunger, & Wahl, 2010). Moreover, the standard economic model vastly overpredicts tax evasion. The generally small audit probability in most countries (ranging from below 1% to 3%; e.g., the Internal Revenue Service (IRS) audited 0.84% of individual filers in 2015; Internal Revenue Service, 2016) and rather low fines in case of evasion (0.5–2 times the evaded amount) hardly explain the high compliance rates, observed in many countries (Alm, Kirchler, & Muehlbacher, 2012; Alm, McClelland, & Schulze, 1992).

Rational choice models assume that people know all alternatives of a decision, weigh the alternatives, and choose the alternative that yields the highest prospect. However, this seems to be highly unrealistic. First, in reality, not all alternatives are always known to taxpayers. Second, people are limited in their cognitive abilities and are, thus, unlikely to calculate the exact expected values when filing their tax return (e.g., Simon, 1956). Third, even when explicit information about the expected value of each alternative is provided, this does not seem to lead to more rational choices (Colbert, Murray, & Nieschwietz, 2009; Li, 2003; Lichtenstein, Slovic, & Zink, 1969). Lastly, many observations of taxpayer behavior in real-life situations challenge assumptions and predictions of the standard model of tax evasion.

Rationality and Anomalies

Deviations from the standard model suggest that behavior is shaped by more variables than the audit probability and fine rate. Before describing additional determinants of behavior, we will address some anomalies that underline the need to extend the theoretical perspective on taxpaying.

Bomb Crater Effect

During bombardments in World War I, soldiers hid in the craters of recent explosions. They assumed that it would be very unlikely that the same crater gets hit again. This behavior is eponymous for a comparable effect objected during tax decisions: the bomb crater effect (Mittone, 2006). This effect describes the phenomenon that participants in repeated rounds tax experiments tend to evade more taxes immediately after an audit. Two different psychological explanations have been postulated to explain this deviation from the standard model: misperception of chance and loss repair (Kastlunger, Kirchler, Mittone, & Pitters, 2009; Maciejovsky, Kirchler, & Schwarzenberger, 2007). Misperception of chance describes individuals' tendency to overestimate the probability of an event to occur if it has not happened in a while and to underestimate it if it happened recently (Maciejovsky et al., 2007). Thus, taxpayers might underestimate the chance of an audit to occur in two consecutive rounds. The second possible explanation states that participants who were caught evading and were fined are likely to experience a loss that they will try to repair in future rounds.

Several laboratory experiments tried to disentangle these two different explanations (Kastlunger et al., 2009; Maciejovsky et al., 2007). However, none of them was able to fully explain the mechanism, and it still remains unclear what really drives the phenomenon. Maciejovsky et al. (2007) found in a laboratory study that taxpayers underestimate the probability of two audits occurring after one another; thus, they were less compliant in subsequent rounds and even more so if they had to pay a fine for cheating in the previous round. Similarly, Kastlunger et al. (2009) concluded that misperception of chance might be the main driver of this effect. The bomb crater effect was confirmed in the field by Bergman and Nevarez (2006), who analyzed Argentinian and Chilean value-added tax (VAT) data from individual tax returns between 1997 and 2000. Overall, audits had no effect on the compliance rates. However, taxpayers who were found evading their VAT duties were less compliant after the audit compared to non-audited taxpayers.

Echo Effect

Mittone (2006) audited participants in the laboratory either in the first half of the experiment (1st to 30th round) or in the second half (31st to 60th round). Audits in the first half impacted compliance positively, and compliance remained at a high level throughout the experiment. If no audits were experienced in the first rounds, compliance decreased and remained low even if, at a later stage of the experiment, taxpayers experienced repeated audits. This effect was coined the "echo effect" and describes the phenomenon that one overestimates the probability of an audit on the basis of the early experiences of audits. Consequently, the experience of an audit early in one's "taxpayer life" results in higher tax compliance in the following years. The effect might be caused by the availability heuristic (Tversky & Kahneman, 1973): audits at the beginning of a business life make tax duties salient, which affects decisions and behavior. The echo effect found support in a similar experiment by Kastlunger et al. (2009). However, they could also show that once high compliance was established by early audits, discontinuing audits weakened compliance in the long run.

Source of Income

According to economic assumptions, the source of income should not influence preferences. Whether income was easily earned or earned through hard work should not make a difference for taxpayers' behavior. However, studies on windfall gains (i.e., endowments that participants receive in an experiment without any effort) show that money earned without effort is less evaluated (Loewenstein & Issacharoff, 1994) and more readily spent than money earned through great effort or particular skills (Arkes et al., 1994). Moreover, the source of income has been found to influence decisions in a variety of economic game experiments, such as the ultimatum game (Ruffle, 1998), the dictator game (Cherry, Frykblom, & Shogren, 2002), and the public goods game (Muehlbacher & Kirchler, 2009). In line with the source dependence theory and sunk cost effect, participants tend to be less cooperative if their funds are earned rather than provided as a windfall gain. Putting effort toward earning income is likely perceived as a sunk cost. Therefore, a greater effort to earn income (i.e., sunk cost) leads to a higher subjective evaluation of one's income and, thus, to an increase in the willingness to take risks (Arkes & Blumer, 1985; Thaler, 1980; Thaler & Johnson, 1990), resulting in lower tax compliance.

Although these predictions are straightforward, Zeelenberg and Van Dijk (1997) found effects pointing in the opposite direction. Participants were asked to imagine that they had put effort and time into a job. Afterward, they were invited to gamble over their payment. Participants without prior investments (i.e., sunk cost) were more willing to take the risk of gambling, whereas those who had imagined high work investments were more risk-averse. Those who imagined that they had to work hard for their income had already invested too much to risk a gamble. Transferred to the tax context, taxpayers could be more risk-averse in case of hard-earned income than in case of easily earned income (e.g., capital gains).

Kirchler, Muehlbacher, Hoelzl, and Webley (2009) found that participants who earned their income through great effort were more compliant than those who received it with little effort (i.e., windfall income). These results are in line with the reverse sunk cost effect. Other studies reported interaction effects between effort and income level (Durham, Manly, & Ritsema, 2014) and between effort and tax rates (Boylan & Sprinkle, 2001).

Behavioral Choice Model

Consider two self-employed taxpayers, A and B, who are about to file their tax returns. Both have the same income and are taxed at the same rate, resulting in $20,000 in total taxes. While Taxpayer A has withheld $19,000 in anticipation of a tax payment during the year, Taxpayer B has withheld $21,000. Taxpayer A has to pay $1000 and Taxpayer B gets a refund of the same amount. According to the standard neoclassical theory, both should behave the same as they have to pay the same amount of tax with the same probability of getting audited. However, Taxpayer A is much more likely than Taxpayer B to claim deductions in order to reduce his tax liability (cf. Engström, Nordblom, Ohlsson, & Persson, 2015). This observation is not consistent with the neoclassical theory but can be explained with the prospect theory (Kahneman & Tversky, 1979).

In a series of experiments, Kahneman and Tversky (1986) observed that whether a situation is framed as a gain or a loss alters people's judgments and leads to choices that differ from the predictions of the standard economic model. For example, McCaffery and Baron (2006) showed that people are more likely to accept a tax that is framed as a bonus for people with children rather than a penalty for childless people. Contrary to the expected utility theory, prospect theory postulates that an individual's happiness depends not on the final state of wealth but on the changes in the wealth level (i.e., income) in relation to a reference point. If the individual's income is above the reference income, it is considered as a gain; if it is below the reference income, it is seen as a loss. This distinction is important because individuals are more sensitive to losses than to equivalent gains, as depicted by the value function (Fig. 13.2).

Because losses are perceived as greater in absolute terms than equivalent gains, the value function is steeper for losses than for gains. Additionally, the value function is concave for gains and convex for losses; thus, monetary losses weigh more than equivalent gains. Consequently, people tend to be risk-seeking in the loss domain (i.e., try to avoid a loss), whereas they are risk-averse in the gain domain.

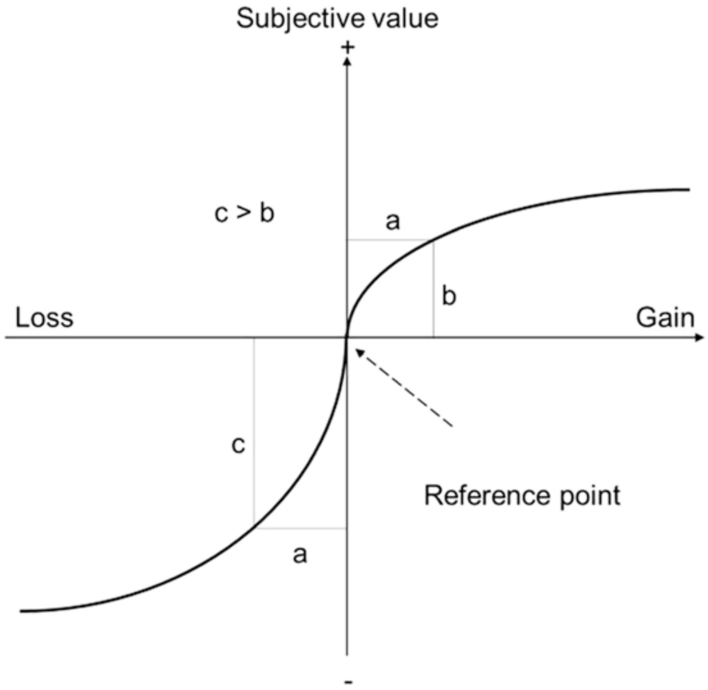

Fig. 13.2 The value function according to prospect theory (Kahneman & Tversky, 1979, p. 279). The function depicts the relationship between the objective outcome and the subjectively perceived outcome

Moreover, the weighting function shows that low probabilities are overestimated, whereas high probabilities are underestimated. Indeed, there is much evidence that taxpayers overestimate the probability of being subject to a tax audit (Alm et al., 1992; Bobek, Hageman, & Kelliher, 2013). Prospect theory helps to explain decision anomalies in compliance behavior that are not accounted for by the standard economic model, such as framing effects, withholding phenomena, effects of prior audits on subsequent compliance, and mental accounting practices.

Gain and loss framing effects have been shown empirically in a number of studies in the domain of taxes (Engström et al., 2015; Kirchler & Maciejovsky, 2001; Rees-Jones, 2018; Robben et al., 1990). Given the rather loose specification of a gain or loss frame in prospect theory, there is, however, an ongoing debate regarding which reference point is relevant for taxpayers. Based on the status quo bias (see Kahneman, Diener, & Schwarz, 1999), the reference point usually corresponds to the decision maker's current position. If we assume that self-employed taxpayers pay taxes out of their pockets, their reference point should be the pretax level of income (i.e., gross income). As this implies that a taxpayer would view any tax paid as a loss, everyone would be risk-seeking regarding their tax deduction.

Alternatively, the reference point may be the taxpayer's net income (Elffers & Hessing, 1997; Rees-Jones, 2018). In this case, the taxpayer is either under-withheld and in the domain of losses or he is overwithheld and in the domain of gains. In the previous example, Taxpayer A, who had a preliminary deficit, perceives a higher marginal value of extra income than Taxpayer B, who had a preliminary surplus of the same amount. Those with a deficit would consequently be more inclined to take (legal or illegal) actions in order to reduce their tax liability. Under this frame, following Schepanski and Shearer (1995), one might also use the model to explain the so-called withholding phenomenon, the evidence that taxpayers who are under-withheld at filing exhibit lower rates of compliance than those who are over-withheld. Engström et al. (2015) found that Swedish taxpayers claim a deduction for "other expenses for earning employment income" more likely than those who have a preliminary surplus, a finding consistent with loss aversion. Thus, policymakers should encourage slight overwithholding of preliminary taxes to increase tax revenues. Such a policy might also strengthen tax morale and reduce tax auditing costs. However, the overwithholding strategy should be applied cautiously because taxpayers can feel treated unfairly (Elffers & Hessing, 1997).

Another line of reasoning argues that, at least in some situations, gains and losses may be influenced by aspirations, expectations, norms, and social comparisons (Bernasconi & Zanardi, 2004). In this case, the reference point may be determined by expectations about outcomes or the income of people with similar socioeconomic characteristics. Some studies lend support to the expectation-based model (e.g., Crawford & Meng, 2011; Marzilli Ericson & Fuster, 2011), while others do not (Heffetz & List, 2014). The literature on sources of income suggests that taxpayers' reference may depend on the amount of effort invested in the income. In two laboratory experiments, Kirchler, Muehlbacher, Hoelzl, and Webley (2009) showed that taxpayers who invested effort in obtaining their income showed more compliant behavior compared to those who gained their income with little effort. This suggests that the aspiration level both is influenced by effort and serves as a reference point. Depending on the exact position of the aspiration level, greater effort can lead to more or less evasion. Consequently, tax administrations are advised to think about possible ways to change taxpayers' reference points to moderate aspiration levels (e.g., their net income).

Mental Accounting

Regarding financial decisions, the reference point is also influenced by different mental accounting strategies. In a business context, accounting describes the process of recording, summarizing, analyzing, and reporting a company's financial transactions. Individuals and private households are not required to keep track of their financial activities; however, in order to keep track of their finances, it seems advisable to at least mentally keep track of income and expenditures. As in a company's budget, individuals assign specific sums of money to specific matters (e.g., rent, groceries). Money is easily spent if the category's budget is still full, even if the purchases are not very prudent at all (Heath & Soll, 1996). By contrast, further purchases and investments are made tentatively if the budget for a specific category is empty. The effects of mental accounting in consumer decisions have already been studied in a large number of studies (e.g., Prelec & Loewenstein, 1998; Ranyard, Hinkley, Williamson, & McHugh, 2006; Thaler, 1985, 1999).

More recently, mental accounting has also been considered in the context of tax decisions. Adams and Webley (2001) interviewed 27 small-business owners in the UK about relevant factors involved in VAT compliance. The majority of the participants reported that they perceive that they have to pay the VAT from their own money ("VAT takes about twelve thousand a year from my business, (…)," p. 208), whereas only a few business owners believed that the customers pay the VAT and they just store it till the tax payment ("It is not a cost to the business, we are just looking after the money for the government." pp. 208–209). The results imply that there are two different mental accounting strategies to handle gross income. Segregators distinguish between their revenues and the related taxes. By contrast, integrators perceive taxes as some sort of expense that they have to pay from their revenues.

Based on these results, Muehlbacher and Kirchler (2013) interviewed 30 self-employed Austrian taxpayers on their behavior toward gross income. The participants either separated the gross income into taxes and personal money ("I transfer about 40% of revenues immediately to an extra bank account (…)," p. 419) or just kept it in one account ("I am not putting anything aside for paying my [income] tax (…)," p. 419). Based on the result of the interview, the authors developed a 10-item questionnaire and surveyed 172 Austrian participants. The results indicated three main factors of mental accounting: (1) mental segregation, (2) physical segregation, and (3) perceived ownership of tax money. Additionally, a relationship between the different mental accounting strategies and tax morale was found. Segregation strategies are related to more positive views of the tax system (Braithwaite, 2003) and to a more positive view on voluntary tax compliance (Kirchler et al., 2008). Further, the participants who preferred segregation strategies reported less frequently evading taxes in the past. The results of Muehlbacher, Hartl, and Kirchler (2017) also showed that those participants who used segregation as a mental accounting strategy were more compliant. In line with prospect theory (Kahneman & Tversky, 1979), the authors argue that segregation of income goes along with a shift of the reference point toward the net income, resulting as a consequence in higher tax compliance.

Olsen, Kasper, Kogler, Muehlbacher, and Kirchler (2019) showed further that individuals practicing mental accounting for one tax are also likely to apply it to other taxes. In their study, they looked at factors related to mental accounting. A high score on mental accounting, which indicates segregation strategies, is positively connected to tax knowledge. The strongest relationships between mental accounting and personality factors were observed for impulsivity, attitudes toward taxes, and financial scarcity. Highly impulsive taxpayers tend to use segregation strategies less, whereas attitudes toward taxes are positively correlated. Experiencing financial scarcity, which was used as a measure for business prosperity, was also found to be negatively related to segregation strategies. By contrast, a positive connection between tax planning and mental accounting has been found.

The Social Contribution Dilemma

Even though individual choice models have considerably contributed to explaining tax decisions, viewing individuals as isolated decision makers ignores the notion that they are also part of a group. As such, their individual interests may not always align with the collective interests of the group. Some individuals may put themselves at a financial advantage by free riding their contribution. In a scenario where all individuals try to maximize their utility at the cost of others, the financing of public goods and services can no longer be guaranteed. Thus, not only the community but also the selfish individuals themselves are harmed.

A social dilemma (Dawes, 1980) is defined as a conflict in which the interests of individuals are opposed to the goals of the community. Although taxpayers may acknowledge the necessity of their contribution to society through taxation, they may suspect that other taxpayers contribute and be tempted to reduce their contribution. Tax compliance may, thus, depend on not only audit probability and fines but also the cooperative behavior of others. If taxpayers doubt others' willingness to pay their fair share of taxes and perceive loose social norms toward cooperation, willingness to pay taxes is likely to be low (Rothstein, 2000).

Social dilemma research aims to explain why people do not cooperate, even though everyone would be better off by cooperating. Social dilemmas can be experimentally simulated in the laboratory through public goods games. In public goods games, the experimenter provides the participants with a starting capital, from which they can contribute any amount into a joint account. The experimenter promises to multiply the contributed sum (e.g., double it) and then distribute the total sum evenly among all players. If all players contribute their total starting capital, all players receive double their starting capital. However, each player can try to take advantage of the situation and maximize the outcome by paying nothing and hoping that the other players will contribute large shares of their own starting capital. If all players are uncooperative, everyone keeps only their starting capital. Because the participants do not know what the other participants are going to do, rational and selfish individuals are considered not to contribute anything. However, in public goods experiments, people cooperate much more than the standard economic theory predicts (Fischbacher, Gaechter, & Fehr, 2001).

Economic and Psychological Determinants of Compliance

Most taxpayers acknowledge the value of public goods that are financed by taxes (Kirchler, 1997). However, taxes are often perceived as a burden and are met with distrust. Taxpayers may doubt that their money is managed frugally, that tax-funded projects are in the best interest of taxpayers, and that a person's tax burden is fair in relation to other people's tax burdens and their own ability to make use of public goods. As described above, some taxpayers may conclude that it is in their best interest to withhold their own contribution to the common good, whereas the vast majority of taxpayers pay their statutory contribution. In order to gain a better understanding of how individuals form their taxpaying behavior, sociopsychological factors, such as taxpayers' knowledge and understanding of tax laws, their attitudes toward taxes, tax morale, personal values and norms, social norms, perceived fairness, and trust in the tax system, have to be taken into account (Kirchler, 2007). We review these factors below.

Knowledge, Attitudes, and Tax Morale

As the tax law is overly complicated, it comes as no surprise that taxpayers have difficulties complying with it. In a survey administered to Australian taxpayers by Sakurai and Braithwaite (2003), only a small percentage of the respondents considered themselves as fully competent to file their tax reports. Thus, it is not surprising that most taxpayers hire a tax agent (Sakurai & Braithwaite, 2003). Moreover, complicated tax laws may reduce taxpayers' perceived fairness of the tax system (Cuccia & Carnes, 2001) and result in unintentional noncompliance (McKerchar, 2001). Alm, Cherry, Jones, and McKee (2010) reported experimental evidence indicating that uncertainty reduces compliance but that the impact is mitigated when the tax agency provides information at a low cost to the taxpayer.

Additionally, tax knowledge has been shown to influence attitudes toward taxes (Eriksen & Fallan, 1996; Fallan, 1999), which are important predictors of tax compliance behavior (Jackson & Milliron, 1986). Social representation theory (Moscovici, 1961) offers a framework to explain the shared social understanding underlying the abstract concept of taxes. Social representations help make sense of the world and interact with other members of the community. In a survey assessing social representations about taxes, Kirchler (1998) asked the responders to describe a typical taxpayer, an honest taxpayer, and a tax evader. Typical taxpayers were rated most negatively and honest taxpayers most positively. Surprisingly, tax evaders were evaluated as quite positive as well. They were considered as being intelligent (even more intelligent than the typical taxpayer) and hardworking, whereas honest taxpayers were described as lazy and not very intelligent.

The concept of social representations is closely related to tax morale, moral obligation, or intrinsic motivation to pay taxes (Torgler & Schneider, 2007). Tax morale, among many other concepts, is assessed in the *World Value Survey* (WVS) or the *European Value Survey* (EVS). These large-scale surveys assess the basic value and beliefs of citizens. Tax morale is measured with one item: "Please tell me for each of the following statements whether you think it can always be justified, never be justified, or something in between: […] Cheating on tax if you have the chance." The question is answered on a 10-point-scale index ranging from 1 ("never justified") to 10 ("always justified"). Most individuals report having high tax morale, indicated by the high number of responses on 1 ("never justified"). The reported high rates of tax morale could explain the high tax compliance rates as higher tax morale is connected to lower tax evasion (Frey & Torgler, 2007).

Personal Characteristics: Demographics, Personal Values, and Norms

Taxpayers differ in their attitudes and moral views toward taxes. For instance, tax morale has been shown to be higher among older taxpayers, people with higher income, more religious people, female taxpayers, people with more financial experience, taxpayers who trust politicians, and employed taxpayers (Alm & Torgler, 2006; Grundmann & Graf Lambsdorff, 2017; Lago-Peñas & Lago-Peñas, 2010; Torgler, 2004, 2006). In particular, the group of self-employed entrepreneurs has received considerable attention in tax research. Self-employed taxpayers have to collect all the income and often also the VAT throughout the year. Then, at the end of the year, they have to pay their tax dues "out of their pocket." As already discussed earlier in this chapter, the reference point may be the gross income collected throughout the year. Consequently, all taxes should be perceived as a loss. As people are risk-seeking in the domain of losses, self-employed taxpayers are assumed to be more prone to tax evasion.

The beliefs and behaviors of the social group can represent implicit rules that act as a guide of what behavior is appropriate or socially desired in different situations. Personal norms include one's own behavior and attitudes toward paying taxes. As such, they are very similar to the concept of tax morale (Muehlbacher & Zieser, 2018). At the group level, social norms refer to the perception of common behavior and the notions of which behavior is right and which is wrong.

Social Norms

In tax research, social norms are commonly considered as the frequency (i.e., descriptive social norms) and acceptance (i.e., injunctive social norms) of tax evasion in a social group (Wenzel, 2005). Alm and Torgler (2011) highlighted that the experience of psychological loss by breaking moral standards might explain the impact of tax ethics on compliance decisions. For example, Bobek et al. (2013) showed that personal norms directly influence tax compliance decisions, whereas descriptive and injunctive social norms have an indirect influence. Similarly, Jimenez and Iyer (2016) concluded that social norms influence tax compliance indirectly through internalization as personal norms. In a laboratory experiment, Alm, Bloomquist, and McKee (2017) provided the participants with information regarding their "neighbors" tax compliance behavior. Their results suggested that introducing this descriptive norm had a significant effect on tax compliance. However, depending on the specific content of the information, it could also have a negative effect. While information regarding the actual prior behavior encouraged the participants to adjust their behavior to the social norm of compliance, just the mere presence of the information lowered the propensity to file and did not affect tax reporting. Thus, policymakers are encouraged to carefully adjust normative appeals in their pursuit to establish a compliance social norm.

Perceived Fairness and Trust

For taxpayers, it is important to be treated fairly, especially when being committed to pay their fair share of taxes. Wenzel (2004) differentiated among distributive, procedural, and retributive fairness:

(i) Distributive fairness concerns the fair distribution of the tax burden and the fair allocation of benefits and costs with the government.
(ii) Procedural fairness refers to the overall fairness of the process of tax collection, such as how taxpayers are treated by the tax authorities.
(iii) Retributive fairness relates to the proper use of rewards and punishment in the system.

Fairness promotes the legitimacy of political processes that can strengthen trust in the authorities (Tyler, 2006). For instance, when citizens feel that their preferences are considered in a fair decision process, this can increase the perceived procedural fairness of the political system, ultimately increasing trust in the government. Switzerland is often regarded as being the country with the highest tax morale within Europe (Alm & Torgler, 2006). One difference between Switzerland and other European countries is that the political system has a high degree of direct democracy, with citizens voting regularly on a wide range of issues. Indeed, those cantons in Switzerland that are characterized by a higher degree of direct democracy also show higher levels of tax morale (Frey, 1997). The positive impact of voting on tax compliance was also confirmed by Wahl, Muehlbacher, and Kirchler (2010). In a public goods game, they observed a positive effect of voting on perceived procedural fairness, which translated into higher trust in the government, ultimately increasing tax compliance. However, if taxpayers perceive procedural fairness to be low, sanctions or punishments can undermine the authorities' legitimacy.

Retributive fairness not only includes financial punishment but also can involve public shaming of tax offenders. Coricelli, Rusconi, and Villeval (2014) investigated the influence of public shaming on tax compliance. In a group experiment, they displayed pictures of the participants caught evading on all screens. In one group, the picture was only displayed for a single round, whereas in the other condition, it was displayed over multiple rounds. If the picture was only displayed once, the participants had the opportunity to restore their reputation by being compliant for the remaining rounds of the tax game, whereas this was not possible in the second condition. The results showed that public shaming increases tax compliance only if cheaters are successively reintegrated. If they are not immediately reintegrated, public shaming has no positive effect on tax compliance. Thus, public shaming may be an effective policy tool but should be handled with care as shaming could backfire if not implemented correctly.

Motivational Postures

Taxpayers are not a homogeneous group but show great diversity in their beliefs and attitudes toward paying taxes. As individuals and groups evaluate the authorities in terms of what they stand for and how they perform, they develop positions toward the authorities. These positions are reflected in the social distance that individuals want to place between themselves and the authorities. When individuals have positive attitudes toward the tax authorities, they wish to associate more with the authorities. In contrast, taxpayers that have negative attitudes toward the authorities try to disengage and distance themselves further from them. Social distance can be conveyed into motivational postures (Braithwaite, 2003). Braithwaite identified five different motivational postures relevant for tax compliance:

(i) Commitment. Committed taxpayers feel a moral obligation to taxpaying and believe in the benefits of the tax system.
(ii) Capitulation. Capitulated taxpayers accept the tax authorities' legitimate authority.
(iii) Resistance. Resistant taxpayers have doubts regarding the benevolence of the tax authorities and challenge their authority.
(iv) Disengagement. For disengaged taxpayers, the tax system is beyond repair; as a consequence, they try to detach themselves from it.
(v) Game playing. Game playing taxpayers seek to bend the rules and take advantage of loopholes to suit their own benefits. While commitment and capitulation reflect a generally positive orientation to tax authorities, resistance, disengagement, and game playing reflect a posture of defiance toward tax authorities.

Braithwaite proposed for tax authorities to be responsive to these differences in motivational postures (see Fig. 13.3). As most taxpayers show a positive attitude toward tax authorities, harsh regulatory strategies should be handled with caution. Instead, taxpayers should be treated in accordance with their motivational postures. For instance, deterrence is not necessary to motivate already committed taxpayers but could erode the established trust between both parties. Instead, tax authorities should follow an approach of service orientation and only refer to deterrence when taxpayers are already disengaged. Hartner, Rechberger, Kirchler, and Schabmann (2008) investigated the relationship between taxpayers' procedural fairness perceptions and motivational postures. When people feel treated in a procedurally fair manner by the tax authorities, and procedurally fair decision rules are employed, motivational postures of deference increase, whereas motivational postures of defiance decrease.

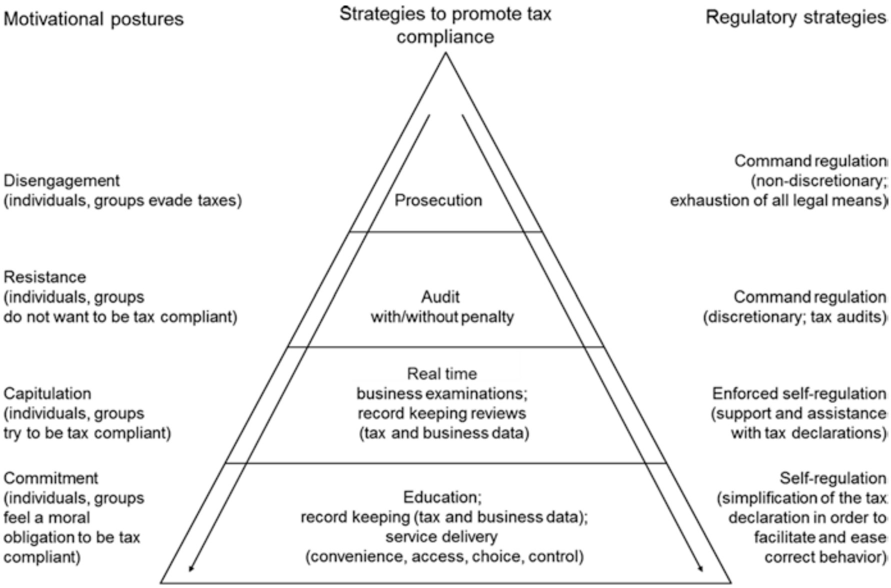

Fig. 13.3 Australian Taxation Office compliance model. (Adapted from Braithwaite, 2003, p. 3)

Integration of Economic and Psychological Insights: The Slippery Slope Framework

While individuals' beliefs, feelings, and attitudes influence their perception of taxes (Kirchler, 2007), taxpayer decisions are not exclusively driven by individual perceptions. Not only do taxpayers have to consider other taxpayers in their tax compliance decisions but they are also subject to the influence of the government and the tax authorities. This relationship can take the form of an implicit contract, implying duties and rights for each contracting party (Feld & Frey, 2007). The quality of the relationship and the interactions between the different actors (i.e., taxpayers, tax practitioners, tax authorities, and the government) affect taxpayers' decisions.

The influence of economic factors on tax decisions has been shown in some, but not all, situations. Depending on interpersonal and situational factors, sociopsychological determinants are sometimes weighted more strongly in tax decisions. The slippery slope framework (Kirchler et al., 2008) provides an integration of economic and sociopsychological factors. This framework consists of two dimensions: trust in the authorities and power of the authorities (Fig. 13.4). Trust describes the taxpayers' belief in the benevolence of the authorities, which is based on attitudes, social norms, fairness perceptions, and services provided for taxpayers. Power is defined as the authority's capacity to detect and punish tax evasion. Trust and power may interplay with each other; however, the exact nature of this interaction is not clear (Kirchler & Hoelzl, 2017). If audits are too frequent and fines too severe, taxpayers may interpret such behavior from tax authorities as distrust toward them and

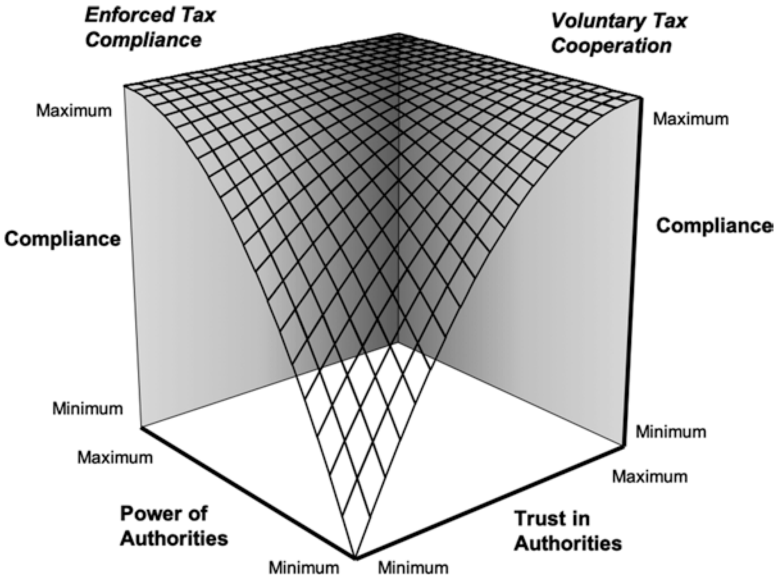

Fig. 13.4 Slippery slope framework of tax compliance. (Adapted from Kirchler et al., 2008, p. 212)

react with distrust themselves. However, power can also positively affect trust, if the audit scheme is perceived as a means to guarantee retributive fairness and enforce societal norms. The term "slippery slope" refers to the potential downward spiral that may happen if power and trust are both low. When trust in the authorities is low, audits are seen as a signal of a "cops and robbers" attitude on behalf of the tax authorities and create even more distrust.

The manifestation of the power and trust dimensions determines the prevailing interaction climate between tax authorities and taxpayers. When the authorities are predominantly perceived as powerful, we find an antagonistic climate, whereas a synergistic climate is described as a climate in which tax authorities are experienced as trustworthy and benevolent. On an individual level, the slippery slope framework differentiates between two qualities of tax compliance dependent on the interaction climate. In an antagonistic climate, taxpayers are presumably compliant because of the fear of detection and punishment; hence, they show enforced compliance. In a synergistic climate, on the contrary, compliance stems from a desire to contribute to society, and taxpayers show voluntary compliance. Deterrence strategies can be effective in enhancing enforced compliance, whereas voluntary cooperation is best encouraged through sociopsychological factors, such as norms and fairness. Recent empirical studies support the basic assumptions of the slippery slope system (e.g., Batrancea et al., 2019; Kastlunger, Lozza, Kirchler, & Schabmann, 2013; Kirchler, Kogler, & Muehlbacher, 2014; Kogler, Muehlbacher, & Kirchler, 2015). Thus, the slippery slope framework offers a possible integration of economic and sociopsychological determinants of tax compliance decisions.

Methods in Tax Research

The key challenge of research on tax compliance is that noncompliant behavior is by nature covert as individuals are prone to conceal such behavior. Thus, for researchers, the main challenge is to get reliable measures of noncompliant behavior (Hallsworth, 2014). There is an arsenal of research methods available, each having advantages but also suffering from shortcomings. Researchers, particularly from the field of economics, have traditionally relied on econometric models, simulations, and aggregate data. However, the limitations of these approaches have led to the increased use of surveys as well as laboratory and field experiments to measure tax evasion. As these approaches are especially influential in the field of tax psychology, we will focus on these methods in the following section, provide an overview of each method, highlight their advantages and weaknesses, and compare the results between them.

Surveys

Surveys are a cost-effective way to collect quantitative data on tax decisions. Thus, they are widely used to measure tax-related behavior, attitudes, and beliefs (i.e., perceived audit probability, trust in authorities, or perceived social norms). The validity of the results may, however, be limited. Since most people only have to do their tax returns once a year, they may have difficulties remembering their past behavior when asked in a survey. Inaccurate memories can also be the result of trying to keep congruence between the personal and the ideal self or to reduce concerns about social disapproval (Elffers, Weigel, & Hessing, 1987). As a consequence, the effects of overreporting and underreporting can be observed.

In a study by Bell and Buchanan (1966), the participants were asked if they had voted in a Los Angeles mayoral election. While 80% of the sample answered that they did, in fact, only 50% were eligible to do so, effectively overreporting their voting behavior. By contrast, an effect of underreporting was shown by Farrington (1973). Teenagers' self-reports significantly correlated with official records on their delinquency. However, when asked again 2 years later, the teenagers denied nearly half of the seriously delinquent acts (e.g., theft and physical aggression).

Since tax evasion is illegal and tax avoidance is at least morally questionable, it remains unclear whether the responses of the survey participants are consistent with their behavior, even if they accurately recall the taxpaying situation ("Why should one be honest about not being honest?"). To circumvent this, surveys on tax decisions often focus on indirect questions, for example, in the WVS (Inglehart et al., 2014): "Please tell me for each of the following actions whether you think it can always be justified, never be justified, or something in between (…). Cheating on taxes if you have a chance." However, Torgler and Schneider (2009) criticized that even indirect measurements such as the WVS do not eliminate socially desirable responses.

Experiments

The limitations of survey data have led researchers to increasingly use laboratory experiments. The main advantage of experiments is that behavior can be observed directly; thus, tax evasion becomes overt. Another advantage lies in the high validity of laboratory experiments (e.g., Brewer & Crano, 2000; Roe & Just, 2009; Shadish, Cook, & Campbell, 2002), which allows a researcher to manipulate and measure each individual parameter of the tax decision. This advantage of laboratory experiments is especially valuable for tax evasion studies as it is not easily possible to exogenously vary, for instance, the penalty rate or the provision of public goods (Hallsworth, 2014).

The underlying experimental design has not changed much since Friedland, Maital, and Rutenberg (1978) who set up the first "tax game experiment." Usually, a tax experiment in the laboratory consists of multiple money-earning and taxpaying rounds. In every round, the participants earn or receive fixed or variable income. Afterward, they have to declare their income to a fictional tax administration. The participants can freely choose the amount of income they want to declare. Their declaration is audited with a given probability (which is usually higher than in reality). If the participants underreport their income and are audited, they have to pay a fine (usually a multiple of the evaded sum). All parameters from the standard economic model of tax evasion (i.e., income, tax rate, audit probability, and fine) can be varied by the experimenter to test their effects on tax compliance. Usually, laboratory experiments are incentivized, and participants are paid depending on their performance in the experiment.

Applying experiments in tax research has its advantages but does not go without critique (for an overview, see Muehlbacher & Kirchler, 2016). While internal validity is considered high, the external validity and generalizability of experimental results are often put into question (e.g., Levitt & List, 2007; Roe & Just, 2009). Criticism is primarily directed at the fact that the complexity and relevance of the real tax payment situation cannot be reproduced in laboratory experiments. For instance, the experimental setting only provides one possibility to evade taxes (i.e., declare less income), whereas in reality there are many possible ways (i.e., undeclared work). Additionally, in reality, taxes are necessary for social investments (e.g., education, infrastructure), but tax money in the laboratory is commonly wasted (Muehlbacher & Kirchler, 2016).

The extensive use of computers and the Internet in private households in the past decades enabled researchers to conduct experiments outside the laboratory in a web-based environment. Web experiments reduce personal and organizational costs as there is no need for guidance by the investigator and no need for the participants to be present in the laboratory. Thus, a wider group of individuals can participate. However, individuals are free to participate using different devices. They can participate in a potentially disturbing environment or at times of the day when their level of concentration may be low. Individuals can participate multiple times or show other nefarious behavior to undermine the integrity of the experiment (Kraut et al., 2004). Consequently, the high control of the laboratory setting and, as a result, the internal validity and reliability of the experiment could decrease.

Field Experiments

In contrast to laboratory experiments, field experiments allow researchers to investigate tax decisions in real-world settings. The underlying processes, relevant influencing variables, and heuristics can be observed directly. For instance, the impact of tax policy decisions on taxpayers' behavior can be measured directly, which can significantly improve the efficiency of the policy (Blumenthal, Christian, Slemrod, & Smith, 2001). "The result is external validity at the highest level" (Wenzel & Taylor, 2004, p. 2798).

Despite the advantages of field experiments, they are comparably seldom implemented in tax research. From an academic view, one explanation lies in the high costs of field experiments, which are a multiple of a laboratory experiment or a survey. Researchers have to invest time in identifying partners, building relationships, understanding the context, and discovering the best opportunity to run the study (Feld, Frey, & Torgler, 2006). While field experiments have high external validity, they suffer from low internal validity. Tax decisions can be investigated under real conditions, but it is difficult to manipulate and compare specific parameters.

Further, tax authorities may have few incentives to participate in tax research projects. Regarding the strict data policies in most countries, careful work and great effort would have to be invested in guaranteeing anonymity. Additionally, officials could be concerned about disclosing too much information about their processes (Mascagni, 2018).

Comparison of Methods

Surveys, laboratory experiments, and field experiments all have their advantages and disadvantages. Therefore, we will now take a closer look at the comparability of the results obtained by these different methods. Because there are only very few field experiments in tax research, the following section focuses on a comparison between surveys, laboratory experiments, and real-world tax behavior.

As it is quite complicated to carry out a study together with a tax administration, the work by Elffers, Weigel, and Hessing (1987) and Elffers, Robben, and Hessing (1992) has received particular attention in the literature. They compared whether "honest taxpayers" and "evaders" (classified by the Dutch tax administration on the basis of the income tax return) show the same behavior in a tax experiment and report it honestly in a survey. Their results were notable because they found no significant correlation between the three measures.

However, not all results concerning the external validity of tax research are as devastating. Alm, Bloomquist, and McKee (2015) compared data of self-reported tax declarations from the North American IRS with results from a laboratory experiment comprising participants who also self-reported their tax declarations. On average, the participants were slightly more compliant in the experiment, but the compliance rate was bimodal in both datasets. This finding implicates that the absolute level of compliance in tax experiments cannot easily be transferred to the real-world. Still, evasion strategies seem to be similar (i.e., either being completely honest or evading the whole tax).

A review by Kirchler, Muehlbacher, Kastlunger, and Wahl (2010) allows for a more differentiated comparison. The authors reviewed a total of 31 studies (16 experiments, 6 surveys, and 9 aggregate data points) concerning results about the four parameters of the standard economic model (Allingham & Sandmo, 1972; Srinivasan, 1973). The results of the various methods show similar trends to a large extent but are also partly inconclusive (for detailed results, see Table 13.1).

(i) Level of Actual Income. The results are as ambiguous as the predictions of the model. Regardless of the method, higher income was found to have either a positive, negative, or no effect on compliance.

Table 13.1 Summary of the reviewed results concerning the effects of income, tax rate, audit probability, and fines on tax compliance

Method	Number of studies	Effect of income on compliance		
		Negative	Zero	Positive
Aggregate data	9	4 (44%)	1 (11%)	4 (44%)
Experiment	4	2 (50%)	1 (25%)	1 (25%)
Survey	6	2 (33%)	3 (50%)	1 (17%)
		Effect of tax rate on compliance		
		Negative	Zero	Positive
Aggregate data	7	6 (86%)	0 (0%)	1 (14%)
Experiment	7	5 (71%)	1 (14%)	1 (14%)
Survey	2	1 (50%)	1 (50%)	0 (0%)
		Effect of audit probability on compliance		
		Negative	Zero	Positive
Aggregate data	5	0 (0%)	0 (0%)	5 (100%)
Experiment	11	0 (0%)	1 (9%)	10 (91%)
Survey	3	0 (0%)	2 (67%)	1 (33%)
		Effect of fines on compliance		
		Negative	Zero	Positive
Aggregate data	3	0 (0%)	2 (67%)	1 (33%)
Experiment	8	0 (0%)	4 (50%)	4 (50%)
Survey	1	0 (0%)	1 (100%)	0 (0%)

Frequencies by Kirchler et al. (2010); depiction referring to Muehlbacher and Kirchler (2016, p. 10)
Note. Frequencies indicate how often a positive, negative, or no effect was found in studies using the respective method. The percentages show the relative frequencies of the results

(ii) Tax Rate. The model predicts two counteracting effects. A higher tax rate leads to less individual net income and makes tax evasion more profitable. In contrast, less net income should lead to higher risk aversion; as a result, evasion should decrease. Both effects find empirical support in the studies reviewed, although most studies reported that higher tax rates decrease compliance. All three methods show similar tendencies.

(iii) Audit Probability. According to the standard model, individuals weigh the risk of being audited and fined against the gain of successful evasion (resulting in an expected value of tax evasion). Consequently, a higher audit probability should increase tax compliance. Most of the considered studies support this assumption, although a few found weak effects or no effects at all. All studies containing analyses of aggregate data and the majority of experimental studies show positive but weak effects. Only one of the three surveys included in the review found a negative effect on tax compliance.

(iv) Magnitude of Fines. As the second important deterrence parameter, fines are closely linked to the audit probability. Combined, they should influence individuals' tax decisions, as long as one determinant is not set to zero. As higher fines make evasion more hazardous, they should lead to higher tax compliance. Barely half of the considered studies support the model's assumption, finding partly weak effects. All other studies report no effect of fines on compliance rates. Regarding the different methods, the results obtained by experiments and aggregate data are almost equally distributed, whereas the only survey considered found no effect.

As outlined above, laboratory experiments, in particular, have been increasingly implemented in tax research in recent years. In laboratory experiments, participants are usually provided with all the information necessary to make a rational decision, and it is assumed that they react to this information accordingly. However, it is hardly investigated whether participants also perceive and process all this information as traditional outcome-focused experiments usually do not provide information on the underlying decision making processes. This is a fundamental shortcoming of classic tax experiments, as attending to all relevant information of a decision problem is an important (implicit) process assumption of the rational or neoclassical model of decision making (Orquin & Mueller Loose, 2013). Moreover, outcome-focused analyses cannot convincingly differentiate between different decision theories. For instance, Glöckner and Herbold (2011) showed in an eye tracking study that while cumulative prospect theory (Kahneman & Tversky, 1979) predicts choices well, it fails to account for the underlying decision processes.

Furthermore, process tracing data help to understand how sociopsychological factors (e.g., social norms and fairness perceptions) might affect the perception and influence of economic factors of tax decisions. Understanding when and why people deviate from rationality might help improve currently existing economic and behavioral theories on tax compliance behavior. Finally, outcome-focused experiments do not account for differences in processing strategies between individuals (Schulte-Mecklenbeck, Kühberger & Ranyard, 2011; Willemsen & Johnson, 2011).

As individual differences and heterogeneity between taxpayers are important determinants to explain tax compliance behavior, a better understanding of the differences in individuals' decision making processes would allow policymakers to tailor incentive structures and control schemes for different target groups.

Information Processing in Tax Decisions

A relatively recent development in the judgment and decision making (JDM) literature promises to overcome the limitations of outcome-data-based experiments by applying process tracing methods like mouse tracking (Mouselab; Bettman, Johnson, & Payne, 1990; MouselabWeb; Willemsen & Johnson, 2011), eye tracking (Rayner, 1998), or brain imaging (i.e., functional magnetic resonance imaging [fMRI]; Bennett, Wolford, & Miller, 2009). All these process tracing methods rely on the assumption that the overt information acquisition process and the underlying covert cognitive processes are connected (Schulte-Mecklenbeck, Kühberger, Gagl, & Hutzler, 2017). More precisely, the information that an individual looks at is assumed to be processed at a cognitive level, which reflects the notion that this information is necessary for the decision (Svenson, 1979). Schulte-Mecklenbeck et al. (2017) suggested structuring process tracing methods on two axes. On the first axis, they differentiated between the minimal temporal resolutions (i.e., precision of measurement with respect to time), whereas on the second axis, they distinguished between methods that are more or less likely to distort the measured process (distortion risk). This results in four distinct groups, as depicted in Fig. 13.5. In this section, we focus on the most widely used techniques in economic research: interactive measures (Mouselab, mouse tracking, and eye tracking) and peripheral

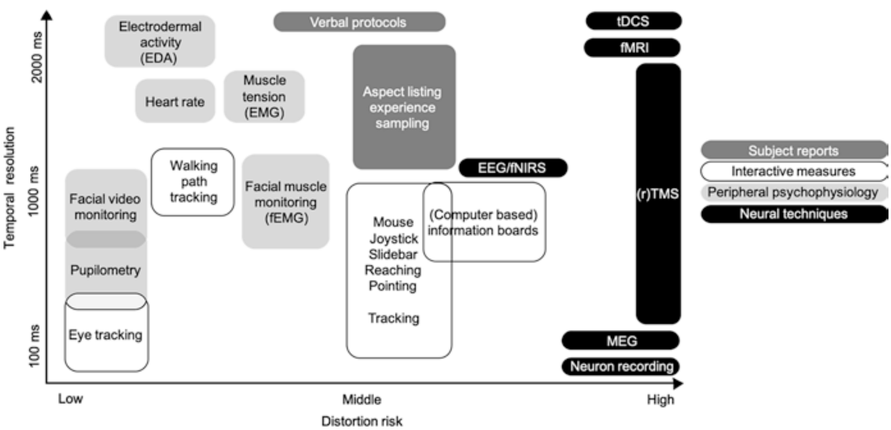

Fig. 13.5 Map of process tracing techniques. (Adapted from Schulte-Mecklenbeck et al., 2017, p. 445)

psychophysiology and neural techniques (e.g., fMRI, positron emission tomography [PET], electroencephalography [EEG], repetitive transcranial magnetic stimulation [rTMS], heart rate variability [HRV], and electrodermal activity [EDA]).

Eye Tracking

In order to make complex decisions, humans have to acquire and process information from their surrounding environment constantly. By investigating visual attention, it is assumed that cognitive processes underlying decision making can be uncovered. As such, the assumption behind eye tracking is that attention and eye movements are connected and that changes associated with eye movements are preceded by shifts of attention (Franco-Watkins & Johnson, 2011; Rayner, 1998). Eye trackers enable researchers to reveal these shifts in visual attention by recording a series of fixations (resting of gaze on a piece of information) or saccades (rapid micromovements between pieces of information) on different available information of a decision. Over the last decade, eye trackers have become cheaper and more precise, and thus the field of economics witnessed a rapid rise in research papers that are based on eye tracking data (Sickmann & Ngan, 2016).

While a fixation tells the researcher where participants are looking, it does not tell much about the mental processes underlying the decision. Thus, the biggest challenge is to interpret the recorded set of fixations. A common way to do so is by focusing on the frequencies and lengths of fixations. More fixations and, related to that, longer fixation times on a particular piece of information have been shown to correspond to the relative importance that information plays in decision making (Jacob & Karn, 2003; Poole, Ball, & Phillips, 2005). For example, Kim, Seligman, and Kable (2012) were able to confirm the preference reversal phenomenon (Lichtenstein & Slovic, 1971; Slovic & Lichtenstein, 1983). When faced with a decision between two gambles with the same expected value, the participants systematically chose the higher probability option but placed a higher bid on the option with the higher outcome. This preference reversal could be observed in the eye tracking data. The outcomes of gambles were fixated more frequently during bidding, whereas the probabilities were fixated more often during choices.

In an experiment by Hochman, Glöckner, Fiedler, and Ayal (2016), the participants had to do a simple task: answering which side of the screen showed more dots. By giving a false response (i.e., cheating), the participants could increase their payoff. Pupillary responses indicated that arousal has increased in the initial stage of a cheating attempt. At the same time, attention was turned away from unwanted information, indicating potentially unconscious avoiding processes. This means that people are aware of their ethical misbehavior but, at the same time, try to reduce the cognitive effort caused by the increased tension through avoidance strategies (Hochman et al., 2016).

Mouse Tracking: Mouselab and Mouse Tracker

Tracking of computer-mouse movements is regarded as an analogous tool to eye tracking, as mouse and eye movements have been shown to correlate (Chen, Anderson, & Sohn, 2001). Mouse tracking methods can be distinguished by how researchers make inferences on the underlying processes of decision making. Mouselab system (Bettman et al., 1990) and MouselabWEB (Willemsen & Johnson, 2011) record the frequency, opening time, and sequence of box openings, which have been shown to serve as proxies for the subjective importance that information receives (Schulte-Mecklenbeck, Sohn, de Bellis, Martin, & Hertwig, 2013; Willemsen & Johnson, 2011). The mouse tracker (Freeman & Ambady, 2010), on the other hand, builds on the principle of response dynamics recording, by tracing the trajectories of mouse movements in choice tasks.

Mouselab

Mouselab (Bettman et al., 1990) is the computerized version of the information board (Payne, 1976), in which the participants have to open envelopes that contain information during decision making tasks. In Mouselab, all information is hidden behind boxes labeled with the corresponding parameter. Moving the mouse cursor over a box displays the underlying information. After moving the cursor outside of the box, the information is hidden again. The successor of Mouselab, MouselabWEB (Willemsen & Johnson, 2011), applies the same principle to a Web-based software package. Figure 13.6 depicts an example of a MouselabWEB display used by Pachur, Schulte-Mecklenbeck, Murphy, and Hertwig (2018). As the evidence for loss aversion has recently been questioned (see Gal & Rucker, 2018), researchers have looked into what role loss attention plays in loss aversion (Ashby, Yechiam, & Ben-Eliezer, 2018; Lejarraga, Schulte-Mecklenbeck, Pachur, & Hertwig, 2019; Pachur et al., 2018). Pachur et al. (2018) found that loss aversion is associated with relative attention to losses versus gains. By manipulating the participants' attention

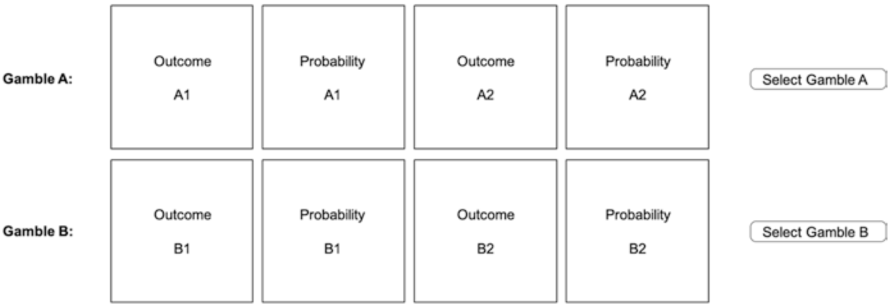

Fig. 13.6 Horizontal setup of a gamble decision in MouselabWEB with two outcomes and probabilities each. (Adapted from Pachur et al., 2018, p. 150)

to losses or gains, they observed that more exposure to losses increased subsequent loss aversion in comparison to exposure to gains. While loss aversion is likely preceded by attention to losses, loss attention is not sufficient to indicate subsequent loss aversion. Lejarraga et al. (2019) observed a robust pattern of increased attention to losses relative to gains, even though the vast majority of participants showed no loss aversion in their choices. They argued accordingly that loss attention is always present, but loss aversion seems to be state-dependent (e.g., if someone can afford to give up on potential gains).

Kogler, Olsen, Müller, and Kirchler (2020) tested the assumptions of the model of Allingham and Sandmo (1972) in an experiment, using MouselabWEB. The authors investigated whether higher audit probabilities and fine levels predict tax compliance in line with the theoretical model. However, the compliance rates were not well predicted by the model. In a between-subjects manipulation, they provided one group with additional information about the sure outcome of compliance and the expected value of evasion. Explicitly presenting expected values did not lead to more rational choices. Regarding the process data, almost all participants acquired all of the presented information (i.e., income, tax rate, audit probability, and fine level), but the choice patterns were inconsistent with the implicit process assumptions of the rational model (Orquin & Mueller Loose, 2013). Furthermore, when expected values were not provided, those participants who acquired information about income more frequently were also more compliant. The authors suggested an interpretation for this observation based on prospect theory. An increased focus on income makes a potential gain more salient; as a result, it is expected that the participants will show more risk-aversive behavior (i.e., compliance).

Mouse Tracker

Mouse tracking is based on the assumption that motor movements during a decision contain a signal of the cognitive processes during the decision process (Spivey & Dale, 2006). Specifically, it is assumed that the direction of movement toward or away from alternatives reflects their relative attraction at a given time point during the decision process. In a typical computer-mouse tracking experiment (see Fig. 13.7), the participants have to click a start button at the bottom center of the screen, which will reveal a stimulus. Usually, there are two options (although more than two options are accessible) presented at the top left and top right of the screen. The participants have to decide between the options by moving the computer-mouse toward the preferred option. By recording the cursor position with a high frequency, hand movements can be indirectly assessed and inferences about the underlying cognitive processes drawn accordingly.

In the first mouse tracking study in the field of judgment and decision making, Koop and Johnson (2011) presented the participants with different gain and loss gambles. The participants showed a direct trajectory toward the less risky gain, when this option was chosen, indicating that this option was more attractive to them. However, when the riskier gain was chosen, the participants first showed a slight

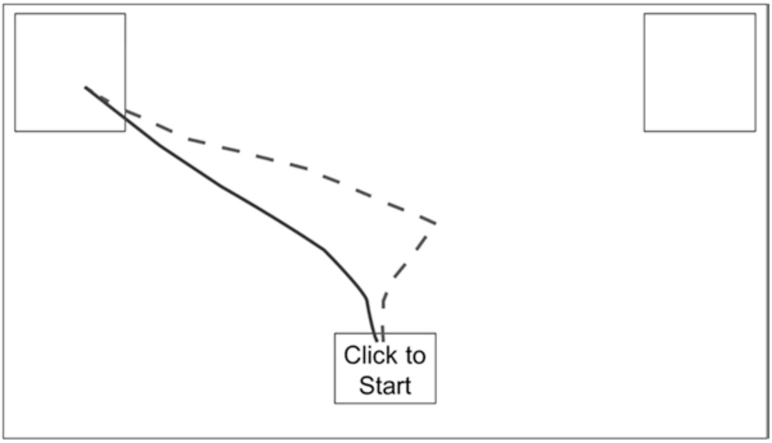

Fig. 13.7 Standard mouse tracking setup. Response buttons appear after the participants click on the start button. For visualizing the trajectories, they are remapped to one side and aggregated and time-normalized. (Adapted from Kieslich, Henninger, Wulff, Haslbeck, and Schulte-Mecklenbeck (2019, p. 121))

tendency toward the less risky option before moving to the riskier one, which they finally decided on. Though less pronounced, this effect was reversed in the loss domain. In another mouse tracking experiment, Kieslich and Hilbig (2014) investigated whether defection in social dilemmas induces cognitive conflict. The participants played simple two-person social dilemma games with two options (cooperation and defection). Indeed, when the individuals defected rather than cooperated, a cognitive conflict could be observed, indicated by response trajectories being more curved toward the nonchosen option. This observation confirms previous literature that considered cooperation to be characterized by spontaneous behavior, whereas defection is defined by effortful deliberation.

Neural Techniques and Peripheral Psychophysiology

Although eye and mouse tracking are useful tools to observe the processes underlying decision making, the brain is often considered to be the ultimate "black box" (Camerer, Loewenstein, & Prelec, 2005). Examining brain activity allows for the direct measurement of human thoughts and feelings, challenging our understanding of the relationship between cognition and behavior. Consequently, measuring brain activity helps to improve cognitive models (Frame, 2019), especially because it was demonstrated that neural activation could often predict outcomes better than what is possible with behavioral measures alone (Berns & Moore, 2012; Venkatraman et al., 2015). A relatively new discipline that utilizes such neural techniques is called neuroeconomics. Neuroeconomics is an interdisciplinary research field in which economists, neuroscientists, and psychologists try to develop more accurate models of human behavior by examining physical processes in the brain during economic decision making tasks (for an overview, see Camerer, Cohen, Fehr, Glimcher, & Laibson, 2015; see also chapters in the first part of this book). The premise of this approach is to better explain human decision making, especially in the face of the various anomalies from the rational model.

fMRI is currently the most popular neural technique (Camerer et al., 2015), which works by utilizing the increased oxygenation of brain regions that are responsible for a specific task by measuring the changes in the magnetic properties of oxygenated and deoxygenated blood (i.e., the BOLD signal). Thus, it is possible to obtain an indirect and correlative measure of local neuronal activity (Venkatraman & Reeck, 2019). For example, Sanfey, Rilling, Aronson, Nystrom, and Cohen (2003) used fMRI to study reactions to fair and unfair offers in the ultimatum game. They observed increased activity in the anterior insula (related to emotion) for rejected unfair offers, suggesting that emotions play an important role in decision making behavior (Sanfey et al., 2003). Harbaugh, Mayr, and Burghart (2007) reported from a tax compliance experiment that even mandatory tax-like transfers turn out to elicit neural activity in the ventral striatum, a key part of the brain's reward system. The authors speculated that a better understanding of the conditions under which taxation elicits these "neural rewards" could prove useful for evaluating the desirability of different tax policies.

One drawback of the fMRI method is its limited temporal and spatial resolution (Schulte-Mecklenbeck et al., 2017). Thus, social psychologists often apply a variety of other peripheral psychophysiological and neural techniques, such as EEG, PET, rTMS, HRV, and EDA. For instance, EEG offers better temporal precision in comparison to fMRI (Frame, 2019). Electrodes are placed along the scalp to measure the electrical activity of the brain. Gangl, Pfabigan, Lamm, Kirchler, and Hofmann (2017) measured the EEG activity in a tax experiment in which they manipulated the description of tax authorities as either legitimate or coercive. When the tax authorities were perceived as legitimate, the participants showed higher decision conflict (indicated by higher cognitive control) compared to when they were perceived as coercive. In another tax experiment, Coricelli, Joffily, Montmarquette, and Villeval (2010) measured skin conductance responses (SCRs) as well as self-reported emotional arousal and valence. SCRs are the phasic component (discrete and short fluctuations) of the EDA, measured alongside the skin conductance levels (SCLs), which is the tonic component (overall conductivity of the skin). Both measurements are associated with emotional arousal. Participants who evaded had higher SCRs compared to those that were compliant. Additionally, being audited was associated with higher self-reported arousal and negative affect. When pictures of evaders were displayed at the end of a taxing round, compliance increased. Hence, the authors concluded that people are feeling anxious not only because of the monetary risk involved in the risky decision to evade but also because of the risk of getting publicly shamed. Contrary to the findings of Coricelli et al. (2010), evidence from an HRV study suggests that the intention to evade taxes generates anxiety and guilt or leads to a reduction of self-esteem in the taxpayer, which in turn increases tax compliance (Dulleck et al., 2016).

Furthermore, personality traits and testosterone levels have been linked to tax evasion (Arbex, Carre, Geniole, & Mattos, 2018). In a series of tax evasion experiments, the authors could observe a negative effect for the testosterone level, as well as dominance and self-construal, on tax evasion. In a recent study integrating neural techniques and peripheral psychophysiology, Balconi, Crivelli, Castiglioni, and Lozza (2019) applied EEG, HRV, and EDA in a public goods game concerning tax payment. They reported increased SCRs and theta EEG activity in the social condition, compared to the individual one, as well as increased HRV when there was no audit. Their findings highlighted the importance of psychological and social-affective variables in explaining the decision making process underlying tax compliance decisions (Balconi et al., 2019).

Practical Implications

The standard economic model of tax evasion (Allingham & Sandmo, 1972; Srinivasan, 1973) has also been dubbed the "deterrence approach," as it postulates that taxpayers are only deterred of evading tax, because of the risk of getting audited, detected, and fined. Accordingly, tax administrations should combat tax evasion with frequent and effective audits and sensitive fines (i.e., imprisonment). However, as the implementation of frequent audits is very costly, in reality, the probability of being audited is low. For instance, the IRS reports that only 0.84% of income tax declarations have been audited in 2015 (IRS, 2016). Further, in contrast to the model's assumptions, in reality, audits are not always subject to random chance. Tax literature reports three primary audit schemes (Collins & Plumlee, 1991): (a) a random audit scheme, where all tax declarations are audited with the same probability; (b) a cutoff audit scheme (e.g., audits below a certain threshold of income); and (c) a conditional audit scheme (e.g., information-based audits).

Regardless of the objective audit probability, the subjective audit probability increases when individuals experience an audit themselves or in their social environment (Spicer & Lundstedt, 1976). As predicted by the model, audits deter evaders and further have a positive impact on honest taxpayers, as long as audits are perceived as an instrument used by the administration to protect the society from black sheep (Gangl, Hofmann, & Kirchler, 2015; Kirchler et al., 2008; Kirchler & Muehlbacher, 2010). However, the effects observed in tax experiments are rather weak (Andreoni et al., 1998; Fischer et al., 1992), and actual compliance rates are much higher than the model predicts (Alm et al., 2012, 1992). There is also evidence that the level of evasion can even increase immediately after an audit (e.g., bomb crater effect; Kastlunger et al., 2009; Mittone, 2006) or decrease in reaction to audits experienced early in one's "taxpayer life" (e.g., echo effect; Mittone, 2006).

As it is costly to increase the number of audits, it seems advisable to increase tax compliance through fines. In designing effective deterrence schemes, tax authorities have to find the right balance in adjusting the fine rate. Excessively low financial penalties can be regarded as a calculable risk and, thus, fail to have the intended deterrent effect (Muehlbacher & Zieser, 2018). If fines are too high, they can be perceived as unfair and lead to negative attitudes toward the tax administration (Strümpel, 1969), which may increase the urge to pass money by the tax. Instead of evading, tax-avoiding strategies aggrandize (Fjeldstad & Semboja, 2001). As it is common for a variety of economic crimes, it might be advisable to attach the fine rate to the financial capabilities of the evader. For instance, in a study by Kirchler and Muehlbacher (2007), taxpayers evaluated relative fines as fair and even more deterrent than fines depending on the evaded sum.

Considering the severity of the punishment, one would think that prison sentences are an effective tool to deter from tax evasion. However, even if currently existing fines are aggravated, this only has subliminal effects on the frequency of criminal behaviors. Even when imprisonment is executed, it does not reduce the probability of repeat offenses (Nagin, 2013). Moreover, most taxpayers speak out against imprisonment as a punishment for tax evasion (Kirchler & Muehlbacher, 2007).

Some states even go further than financial punishment or imprisonment. The idea of publishing the pictures and names of the worst tax evaders reentered the public discourse during the financial crisis in Greece. Countries such as the USA, Canada, Switzerland, Spain, and the UK published so-called lists of shame, making the identity of tax offenders public. For example, the tax administration of the UK, HM Revenue and Customs (HRMC), published pictures and information about the "HRMC Most Wanted" on the media platform Flickr. Besides the tax authorities themselves, media outlets are often involved in revealing tax frauds and publish the names of institutions and individuals involved (e.g., the so-called Panama Papers). As discussed in the first section of this chapter, shaming might indeed have a positive effect on tax compliance caused by the willingness to avoid negative emotions of potential detection and public denouncement. However, if evaders are not immediately reintegrated into the group after being publicly shamed, they might show even more delinquent behavior than before (Coricelli et al., 2014). Consequently, shaming could backfire and negatively impact the evaders' compliance level.

In conclusion, not only is the deterrence approach, based on frequent audits and severe fines, limited in its effect but also it is costly and has the potential to backfire when used extensively. Moreover, individuals deviate systematically from the standard models' assumptions with different mental accounting strategies, sources of income, and reference points, or they show reactions to audits like the bomb crater effect and the echo effect. In order to utilize these systematic deviations to increase tax compliance, policymakers and tax authorities increasingly use behaviorally informed strategies, the so-called nudges, to influence taxpayers' compliance behavior. In principle, a nudge is "[…] any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. […]" (Thaler & Sunstein, 2008, p. 6). In other words, nudges are intended to give a "little push" toward desired behavior instead of punishing unwanted behavior.

"Tax nudges" can help make tax policies more efficient and, thus, reduce enforcement costs. For instance, within two field experiments in Minnesota, USA, Coleman (1996, 2007) sent out four different types of formal information letters to four groups of taxpayers. In the first letter, the tax administration offered support for the tax declaration. In the second, a thorough audit was announced. The third letter provided information on the government's use of taxes. The fourth stated that, contradictory to the public assumption, most people are compliant taxpayers. In order to investigate the effects that the different letters had on tax compliance, the tax payments of the years before and after sending the letter were compared. Offering support and information regarding the filing of taxes had no effect on the compliance rates. The audit announcement had a positive effect on individuals with middle or low income, but no or even a negative effect on individuals with high income. The latter reacted to the threat of an audit with higher write-downs. The most substantial effect was found for the fourth letter, which provided information regarding the taxpaying behavior of other individuals. Thus, the introduction of a social norm was enough to push taxpayers toward more compliance. Shu, Mazar, Gino, Ariely, and Bazerman (2012) found that even just signing honor codes and tax self-reports before filing taxes increased the compliance rates.

The literature has shown that the deterrence approach, which is based on enforced compliance, is insufficient to ensure an acceptable level of tax compliance and that sociopsychological factors driving tax compliance have to be considered. Besides the power of the tax administration (e.g., audit and fine rates), the slippery slope framework (Kirchler et al., 2008) identifies taxpayers' trust in tax authorities as an important determining factor of tax compliance. If, for instance, distributional justice is perceived to be high, trust in tax administrations (Zmerli & Castillo, 2015) and the willingness to voluntarily cooperate increase (Kogler et al., 2015). In order to positively influence the perception of distributional justice (Alm et al., 2012; Alm & Torgler, 2011) and to create a positive connection between taxpaying and usage (Kamleitner & Hoelzl, 2009), governmental accomplishments and significant expenses should be communicated well (i.e., in media).

Besides that, trust can be built by demonstrating competence and providing professional services. Alm and Torgler (2011, p. 647) gave some simple advice on how to improve service quality:

- Promote taxpayer education
- Provide taxpayer services to assist taxpayers in filing returns and paying taxes
- Improve phone advice service
- Improve the tax agency website
- Simplify taxes
- Simplify the payment of taxes
- Simplify tax forms

Compared to audit schemes, services can easily be improved and implemented by the tax administrations. Many tax administrations have already implemented cooperative compliance strategies (OECD, 2013) to improve their services. One of the most prominent examples of a cooperative compliance strategy is Horizontal

Monitoring. Horizontal Monitoring aims to improve the process of taxpaying for large companies, promote mutual trust, and increase tax compliance. Administrations and participating companies transit from a "vertical" relationship, characterized by deterrence and control, to "Horizontal Monitoring," in which cooperation is promoted at the eye level. Instead of retrospective audits, companies are monitored in an ongoing process during the year. Thus, uncertainties can be discussed, and inconclusive tax decisions can be resolved immediately rather than negotiated in retrospect before a court. Tax authorities benefit from timely tax collection and full information disclosure from companies, whereas companies have the advantage of increased legal security, reliable planning, and higher-quality tax control frameworks (Goslinga, Siglé & Veldhuizen, 2019). Since the first implementation of Horizontal Monitoring in the Netherlands in 2005 (de Widt & Oats, 2017), several other countries developed similar cooperative compliance programs (e.g., Austria, Canada, South Africa, and Russia).

During the piloting of Horizontal Monitoring in Austria, Enachescu, Zieser, Hofmann, and Kirchler (2019) collected qualitative and quantitative data from different participating stakeholders and compared them with those who did not participate over the 3-year phase of the program. The results indicated that the employees of the participating companies perceived Horizontal Monitoring as highly positive, regardless of their direct participation in the Horizontal Monitoring process in their company. Positive perceptions regarding Horizontal Monitoring that were formed in the beginning were maintained throughout the whole process. By contrast, the employees of companies that did not participate reported to be poorly informed about Horizontal Monitoring and did not expect positive effects. Additionally, tax officials, who were involved in the program, perceived Horizontal Monitoring as more positive compared to those who were not involved. The latter also remained skeptical about the program during the whole 3 years of the pilot. Given these results, future implementations of Horizontal Monitoring should consider that direct contact with Horizontal Monitoring processes is important to decrease insecurity, skepticism, and resistance. Furthermore, information must be provided to employees involved in Horizontal Monitoring and also to other stakeholders to promote the challenging paradigm shift toward cooperative relationships (Enachescu et al., 2019).

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Chapter 14
A Psychological Perspective on Charitable Giving and Monetary Donations: The Role of Affect

Daniel Västfjäll and Paul Slovic

Introduction

What motivates people to do good things? This is a broad question that has been studied and debated for centuries, first by philosophers (e.g., Plato, Descartes, Hume, Kant) and more recently by psychologists, economists, political scientists, philosophers, and others.

Even though traditional theories of economic behavior cannot easily explain why people are willing to forego personal benefits in order to help other individuals (e.g., altruism; Andreoni, 1990), economists have been particularly active in studying this question during the past several decades. A very thoughtful and comprehensive review of the economic literature on philanthropy (Andreoni, 2006) notes the hundreds of articles on this topic since the 1980s, many attempting to understand and reconcile the seemingly unselfish or altruistic behavior of philanthropists with the assumption of self-interest motives (egoism) central to economics.

Psychologists, too, have been interested in the role of altruism and egoism in motivating helping behaviors. Creative experiments in social psychology have resulted in contradictory findings, some finding altruism as more important (Batson, 1991) and some egoism (Schaller & Cialdini, 1990). More recently, evidence seems to indicate that both factors are operating in tandem. Neuroscience evidence, for example, shows that helping others is personally rewarding, the same reward

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centers in the brain are activated when one receives a personal reward and when one is acting for the benefit of others (see also Harbaugh, Mayr, & Burghart, 2007). Observational studies, employing both correlational and experimental methods, find that happier people give more to charity and that giving more makes people happier, in a circular or mutually reinforcing relationship (Anik et al., 2009; Dunn, Aknin, & Norton, 2008).

Research also shows that feelings are a primary driving force of moral behaviors. For instance, Haidt (2001) draws a distinction between feelings generated by a fast, intuitive response to a moral dilemma (moral intuition) and the reasons and feelings resulting from a deliberative analysis of the issue (moral judgment). Specifically, he argues that "Moral intuition can be defined as the sudden appearance in consciousness of a moral judgment, including an affective valence (good-bad, like-dislike) without any conscious awareness of having gone through steps of searching, weighing evidence, or inferring a conclusion. Moral intuition is therefore … akin to aesthetic judgment. One sees or hears about a social event and one instantly feels approval or disapproval" (p. 818). Haidt further argues that the feelings associated with moral intuitions usually dominate moral judgment, unless we make an effort to use judgment to critique and, if necessary, override our intuitive feelings.

Our moral intuitions are, in many instances, sophisticated and helpful. They are much like human visual perceptions in this regard, which typically serve us well but occasionally lead us seriously astray. Unfortunately, moral intuition fails us in the face of genocide (Slovic, 2007) and in the face of much smaller moral crises (Greene et al., 2001; Baron & Greene, 2001; Singer, 1972, 2009).

Affect as a Motivator of Charitable Giving

Affective feelings have been central to the theories that economists have proposed to account for charitable or philanthropic behavior. Whereas early work focused on altruism as the sole motivational factor, Andreoni (1990) noted that people were not indifferent to their own voluntary gifts and the gifts of others, as the purely altruistic model predicted; they preferred that gifts come from themselves. He proposed that people may experience a "warm glow" from giving that could contribute to the utility of giving. Subsequent experimental data has given firm support to the concept of the warm glow, which Andreoni (2006), p. 23) views as "a solid foundation of human motivation."

Warm glow has much in common with the feeling states that are postulated by psychologists to motivate behavior, such as Damasio's somatic markers (Damasio, 1994), the affect heuristic (Slovic, Finucane, Peters, & MacGregor, 2002), or Haidt's (2001) moral intuitions. Andreoni and others have identified numerous feelings and desires that could contribute to the warm glow, such as empathy, sympathy, receiving gratitude and recognition, the pleasure of making someone else happy, relieving their distress, or relieving one's own guilt or regret. Many of these have been the subject of psychological studies of helping, especially in social psychology (Batson, 1991; Schaller & Cialdini, 1990). But the economic research has focused more on working with the global concept of warm glow and assessing its implication for social policy such as taxation of charitable giving. Andreoni's (2006) review concludes that:

> "Despite its importance, a clear understanding of philanthropy has eluded economists. One reason is the basic challenge in understanding the motives of givers—why people give?… The concept of warm-glow is only a convenient reduced-form representation for deeper and more complex considerations of givers." (p. 71) and "Despite being an active area of research for several decades, I view the literature on charitable giving as full of open questions". (p. 72)

An exhaustive review (500+ references) of the literature on generosity and philanthropy (Bekkers & Wiepking, 2011) concludes that "…a vast array of factors is associated with philanthropy. Philanthropic acts are commonly the result of multiple mechanisms working at once. However, formal models…have focused on only one or sometimes two motives…, which provides a challenge for model builders"(pp. 39–40). A central problem in psychology is to identify the societal, individual, and situational factors that afford cooperative behaviors such as prosocial acts (Greene, 2013). But to date, no unified theory or overarching framework for charitable giving exists.

It is still clear that altruistic and prosocial behaviors are an integral part of the society we live in today. The fact that individuals are willing to help other individuals—without expectations of direct reciprocity—is, arguably, the glue that holds society together (Greene, 2013). Given all the benefits of giving and receiving one would expect a positive feedback loop, where pro-social behavior (on a societal level) increases to an infinite point. This is clearly not the case. Therefore, the goal of this chapter is to review some of the *psychological factors that either facilitate or hinder the spreading of pro-social behavior.*

Our review is selective. We focus primarily on two related phenomena that we have studied on over the past decades and that are central to charitable giving; (1) scope insensitivity and compassion fade and (2) perceived efficacy and *pseudoinefficiency*. Both these phenomena show that assumptions by prevailing descriptive theories, such as Prospect Theory (Kahneman & Tversky, 1979), may not adequately describe how people react to the need of the many.

Scope Insensitivity and Compassion Fade

Prospect theory (Kahneman & Tversky, 1979) is arguably the most important descriptive theoretical framework ever developed in the field of decision making. It has been cited close to 8000 times by journals in business, economics, law, management, medicine, psychology, and political science. The heart of the theory is the value function (Fig. 14.1), proposing that the carriers of value are positive or negative changes from a reference point. Kahneman (2011) observed that "if prospect theory had a flag, this image would be drawn on it" (p. 282). The function is nonlinear, reflecting diminishing sensitivity to magnitude. In the positive domain, for example, a gain of two tends to be valued as less than twice that of a gain of one.

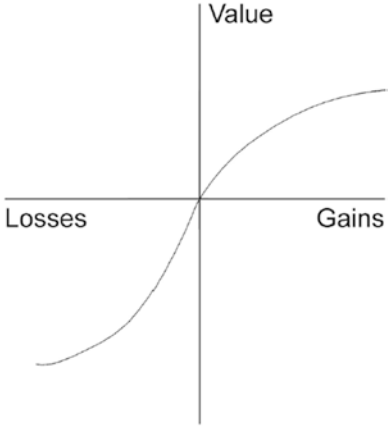

Fig. 14.1 Value function of prospect theory

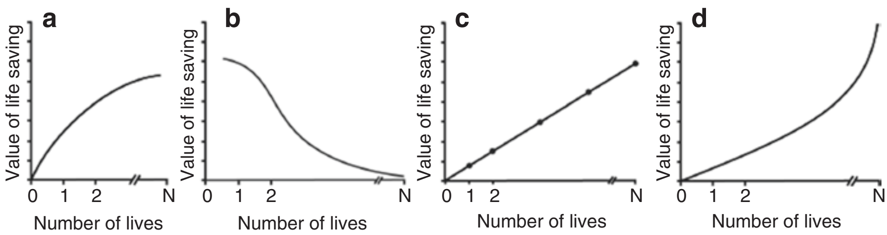

Fig. 14.2 Four alternative functions for the value of lives. (**a**) psychophysical numbing, (**b**) compassion fade, (**c**) linear function, and (**d**) exponential function

Figure 14.2 depicts four value functions pertinent to the saving of human lives that have been investigated in recent research (Slovic, 2007; Slovic & Västfjäll 2010). Two are descriptive (Fig. 14.2, panels A and B) and two are normative (panels C and D). Slovic (2007) have argued that behavior often conforms more to the descriptive models than to the normative models. This can be tragic. Model in panel A, which is the gain function of prospect theory, implies that the value of a life diminishes against the backdrop of a larger tragedy. Model in panel B is even more problematic from a normative perspective. It implies that value of life does not increase monotonically with magnitude but rather decreases, perhaps collapsing close to zero when many lives are at stake.

In our prior research, we and others have been testing these models and finding empirical support for the psychophysical model in Fig. 14.2, panel A (e.g., Fetherstonhaugh, Slovic, Johnson, & Friedrich, 1997). The collapse model (Fig. 14.2, panel B) has been studied less directly. Indirect support comes from a large literature documenting the singularity effect, wherein the value of a life is very high when it is the only life at stake, especially when the individual is identified (Jenni & Loewenstein, 1997; Kogut & Ritov, 2005a, 2005b; Slovic, 2007; Small & Loewenstein, 2003; Small, Loewenstein, & Slovic, 2007). Even a single, identified dog at risk can elicit hundreds of thousands of dollars for rescue (Vendantam, 2010).

When value is great at $N = 1$, it is unlikely to climb higher as N increases. At the other end of the magnitude spectrum, there are innumerable (nonexperimental) examples where large numbers of people or animals at risk from poverty, famine, disease, violence, or environmental degradation induce little or no response, suggestive of collapse (Slovic & Västfjäll 2010; Slovic & Slovic, 2012).

As we studied valuation of life empirically, we have become aware that the models in Fig. 14.2 may not completely describe the way people respond to increases in the magnitude of the threat. For example, Desvousges et al. (1992/2010) carefully elicited people's willingness to pay (WTP) to provide nets that would save 2000, 20,000, or 200,000 migrating birds from drowning in uncovered oil ponds that the birds mistake for bodies of water. The mean WTP was flat, about $80, although the number of lives saved varied by a range of 100-fold. This "insensitivity to scope" has been explained by Kahneman, Ritov, and Schkade (1999) as possibly resulting from a process, whereby a prototype individual (e.g., the image of an oil-covered bird) serves as a proxy for the larger number at risk. Attitudes and emotions toward this mental image create feelings that cue the valuation (e.g., the affect heuristic; Slovic et al., 2002, see also Chap. 6 in this Handbook). Note that this implies a value function that is essentially flat, rather than monotonically increasing as in prospect theory or in Fig. 14.2 (panel A). But this prototype explanation has not to our knowledge been tested, and there are alternative explanations. For example, both 2000 and 200,000 are very small percentages of the total population, and these small percentages may seem about equal. Moreover, the remedy, purchase of nets, may also call up a prototype image that has no clear link to the magnitude of the threat.

Limitations of the Affect System

We propose that the responses to magnitude of lifesaving depend heavily on affect. Affect, as used here, is a feeling (not necessarily conscious) that something is good or bad. Affective responses occur rapidly and automatically—note how quickly you sense the feelings associated with the work "treasure" or the word "hate." We, and others, have earlier suggested that affect has several functions (Peters, 2006). One of them is to add meaning to information (Cabanac, 1992). Another is to motivate behavior (Zajonc, 1980). Without affect, information lacks meaning and will not be used in judgment and decision making (Loewenstein, Weber, Hsee, & Welch, 2001; Slovic et al., 2002). Affect plays a central role in "dual-process theories" of thinking. Several researchers suggest that there is an interaction between more affective, experiential systems and deliberative systems (labeled System 1 (fast thinking) and System 2 (slow thinking), respectively; Kahneman, 2011). One of the characteristics of the experiential system is its affective basis. Although analysis is certainly important in many decision making circumstances, reliance on affect and emotion as sources of information tends to be a quicker, easier, and more efficient way to navigate in a complex, uncertain, and sometimes dangerous world (Schwarz &

Clore, 1988). Many theorists have given affect a direct and primary role in decision making (Damasio, 1994; Loewenstein & Lerner, 2003).

In his Nobel Prize Address, Kahneman notes that the operating characteristics of System 1 are similar to those of human perceptual processes (Kahneman, 2003). He points out that one of the functions of System 2 is to monitor the quality of the intuitive impressions formed by System 1. Kahneman and Frederick (2005) suggest that this monitoring is typically rather lax and allows many intuitive judgments to be expressed in behavior, including some that are erroneous. Kahneman (2011, p. 282) argues that the qualities of the value function are inherent operating characteristics of System 1.

Interestingly, the link between affect and perception has resulted in some limitations of the experiential system in dealing with quantities. The experiential system tends to be an on-off system driven by images. It is relatively insensitive to scope and variations in probability (Hsee & Rottenstreich, 2004). Given that we assign affect a primary role in motivating actions, this dissociation between affect and numbers is a problem for how we, as individuals, value the saving of human lives.

Fetherstonhaugh et al. (1997) documented this potential for diminished sensitivity to the value of life—an effect they named "psychophysical numbing"—by evaluating people's willingness to fund various lifesaving medical treatments. In a study involving a hypothetical grant funding agency, nearly two-thirds of the respondents raised their minimum benefit requirements to warrant funding when there was a larger at-risk population, with a median value of 9000 lives needing to be saved when 15,000 were at risk, compared to a median of 100,000 lives to be saved out of 290,000 at risk. By implication, respondents saw saving 9000 lives in the "smaller" population as more valuable than saving ten times as many lives in the largest. Several other studies in the domain of lifesaving interventions (Baron, 1997; Bartels, 2006; Fetherstonhaugh et al., 1997; Friedrich et al., 1999) have documented similar psychophysical numbing or proportional reasoning effects.

Kogut and Ritov (2005b) hypothesized that the processing of information related to a single victim might be fundamentally different from the processing of information concerning a group of victims. They predicted and subsequently found that people will tend to feel more distress and compassion when considering an identified single victim than when considering a group of victims, even if identified, resulting in a greater willingness to help the identified individual victim.

Our own research suggests that the blurring of individuals may begin to appear in groups as small as two individuals. Västfjäll, Peters, and Slovic (2014) gave one group of potential donors the opportunity to contribute part of their earnings from an unrelated study to a 7-year-old girl from Mali facing the threat of starvation. Her picture and name were given. A second group was offered the opportunity to donate to a named and pictured 7-year-old boy from Mali, also facing starvation. A third group was shown pictures of both children side-by-side and asked to give a donation that would go to both the girl and the boy. Feelings of compassion and donation amounts were about identical for the individual children but were lower for the two together, mirroring what Kogut and Ritov (2005a, 2005b) had found for donations to one child vs. a group of eight children, both needing the same stated amount of money for cancer therapy. The single child received far greater aid than the group of eight.

Iconic Victims and the Power of Affect to Motivate Charitable Giving

It is important to note that while the affect associated with single victims may lead to scope insensitivity and even compassion fade, it is also a strong motivator for helping. Without the affect, the overall donations would likely be significantly lower. In a recent study (Slovic et al., 2017), we found evidence for this for so-called iconic victims. On September 2, 2015, images of a young Syrian child, Aylan Kurdi, lying face down on a Turkish beach, were quickly seen by over 20 million people on social media. The next day they were on the front pages of newspapers worldwide. These images brought much needed attention to the Syrian war and the plight of its refugees, which resulted in short-term but important increases of individual aid and refugee policy changes in many countries.

Most interestingly, we were able to obtain data on monetary donations to the Swedish Red Cross for a fund specifically designated for aiding Syrian refugees. The funding campaign started August 4, 2015, almost a month before the photograph of Aylan appeared, and continued until November 30, 2015. Thus, we were able to use these data to estimate the photograph's effect in this specific context. We find that the mean number of daily donations during the week after Aylan's photograph was more than 100 times higher compared to the week before. This effect was sustained until 5 weeks after the photograph when the number declined to a level that was not different from the week before the photograph appeared. Similarly, the mean amount donated daily during the week after the photograph was 55 times higher (roughly two million SEK) compared to the week before (roughly 30,000 SEK). During the second week after the photograph appeared, donation amounts were lower (about 400,000 SEK) but still about 11 times greater than the week before the picture. It was not until 6 weeks after the photograph that the mean donations were at a level that was not different from the week before the photograph (i.e., the "half-life" of empathy). These data dramatically show that the affect associated with a single child can motivate increase helping behaviors.

Debiasing Scope Insensitivity and Compassion Fade

While affect associated with a single victim clearly can motivate helping, an important question is how decision makers can become more sensitive to scope?

It appears as if compassion fade mostly occurs when decision makers evaluate each option separately. In joint evaluation (where helping 1 vs 2, for example, is evaluated simultaneously), decision makers typically display a preference for more individuals saved (Kogut & Ritov, 2005a). Based on this, recently a promising attempt to increase scope sensitivity has been proposed by Hsee, Zhang, Lu, and Xu (2013). Hsee and colleagues propose a "unit-asking" method, where people are first asked for the valuation of one unit (in this case: one life) and then asked for the valuation of multiple units (i.e., multiple lives). While Hsee et al. (2013) did not find evidence for complete scope sensitivity (i.e., perfectly linear valuation responses), they found that unit-asking led to an increase in valuations due to increased scope consistency (i.e., participants were consistent in valuing multiple lives more than one life).

Perceived Effectiveness and Pseudoinefficacy

We inhabit a world of inequality on a scale that creates great personal suffering as well as dangerous political instability. Wealth and power are concentrated in a small proportion of individuals and nations, the rich and the poor, the haves and have-nots. Locally, domestically, and internationally, millions struggle to survive in the face of poverty, disease, food insufficiency, natural disasters, and human malevolence. Those individuals and governments fortunate to have the ability and desire to help those in need are inundated with requests for vital aid. Many do respond. Humanitarian aid provided by individuals, NGOs, and governments amount to hundreds of billions of Euros each year. Though large in some sense, it is but a fraction of what is needed and what could be provided (Singer, 2009). For those in a position to help, decisions are strongly motivated by perceived efficacy. Inefficacy, real or perceived, shrivels response, even among those who have the desire and the means to protect and improve lives. It is tragic, indeed, when efficacy goes unrecognized and vital aid that could be provided is withheld due to an illusion of ineffectiveness that we have named pseudoinefficacy.

A Dual-Process Model of Pseudoinefficacy

Two early studies asked people to provide clean water to aid people facing death from disease (Fetherstonhaugh et al., 1997) or to provide money to protect a child from starvation (Small et al., 2007). Fetherstonhaugh et al. (1997) found that people were less likely to send clean water that could save 4500 lives in a refugee camp when the number of people in the camp was large (250,000) than when it was small (11,000). Small et al. (2007) found that the money donated to a 7-year-old African child facing starvation decreased dramatically when the donor was made aware that the child was one of millions needing food aid. Andreoni (1990, 2007) has contended that we help others not only because they need our help but because we anticipate and experience the warm glow of good feeling associated with giving aid.

Subsequent empirical studies have supported this contention (e.g., Dunn et al., 2008). We hypothesize that the rather small proportion of people who could be helped, 4500 of 250,000 in the large refugee camp and one of millions of starving people in Africa, triggered negative feelings that diminished the anticipated warm glow of providing aid in those situations. These negative feelings may have resulted from recognition that the proportion of people helped was small (one of millions or 4500 of 250,000). Such recognition may have also been accompanied by the thought that the aid was trivial, that is, a drop in the bucket.

Although the results from these studies by Fetherstonhaugh et al. (1997) and Small et al. (2007) may appear at first glance to reflect inefficacy, this is not really inefficacy, because the donor can actually help some people (from 1 to 4500). It may be, instead, a form of *pseudoinefficacy that is non-rational*. We should not be deterred from helping one person, or 4500, just because there are others we cannot help. A more recent study by Västfjäll, Slovic, and Mayorga (2015) conducted 11 experiments, demonstrating a second form of pseudoinefficacy that cannot be described as arising from proportional reasoning or drop-in-the-bucket thinking. For example, in one study people made real donations to a single starving child, whose name and photograph they were shown. One group donated to a 7-year-old boy, a second group donated to a 7-year-old girl. A third group was shown both children and was told that their donation would go to one or the other. In this disjunction condition, people felt less good about donating, and the amount donated exhibited a statistically significant decrease. Since only one child was going to be excluded from receiving aid, this decrease seems unlikely to be due to a drop-in-the-bucket effect.

Additional studies by Västfjäll et al. (2015) systematically varied the number of children helped or not helped in both within-subject and between-groups designs (i.e., joint and single evaluation). Warm glow consistently decreased when attention was called to one or more persons who could not be helped. Donations decreased as well. Additional studies showed that the decrease in warm glow was associated with the strength of negative affect produced by pictures of children not helped. Irrelevant pictures of neutral visual distractors in place of pictures of children out of reach did not dampen warm glow, but pictures of other objects (e.g., a shark, a toilet, a menacing gun) created negative affect that intruded upon and diminished warm glow, much as did the pictures of children who could not be helped. Awareness of even one child who would not be helped was enough to depress anticipated warm glow significantly, even when as many as five children could be helped.

We propose that the demotivating effects in these studies, all of which involved small numbers of identified children who could or could not be helped, come from a form of pseudoinefficacy different from that observed in the Fetherstonhaugh et al. and Small et al. studies. Kahneman (2011) summarizes the extensive research documenting the differential effects of fast vs. slow thinking (see also Greene, 2013). We propose that the findings documented by Västfjäll et al. (2015) reflect fast thinking, where the images of children out of reach immediately produce negative affect that dampens the anticipated warm glow associated with helping those one can actually help.

Based on these various studies, we now conceive of pseudoinefficacy as having two facets or dimensions interacting in the mind. Fast or intuitive pseudoinefficacy is linked to virtually immediate blending (likely by averaging) warm glow with negative feelings, perhaps of sadness or unhappiness, in situations with small numbers of identified people in need and small numbers unable to be helped. In the context of large numbers of people who cannot be helped, relatively slow or reasoned pseudoinefficacy may arise from more complex thoughts involving calculations of proportions or drop-in-the-bucket imagery likely causing feelings of despair or hopelessness.

Table 14.1 further elaborates possible differences between fast and slow pseudoinefficacy. Fast pseudoinefficacy, as we have earlier documented, occurs in the context of relatively small numbers of people helped and not helped and therefore should be associated with strong affective reactions through the singularity effect (Kogut & Ritov, 2005a) and identifiability. Consistent with this literature. we propose that fast pseudoinefficacy is associated with processing the need as pertaining to an individual (high entitativity; Burson, Faro, & Rottenstreich, 2013), along with clear mental images (Dickert & Slovic, 2011) and high determinacy (both for those helped and those not helped; Cryder, Loewenstein, & Scheines, 2013). Emotion theory, and especially appraisal theories of emotion (Ortony, Clore, & Collins, 1988; Roseman, Wiest, & Swartz, 1994; Scherer, 2001), would indicate that fast pseudoinefficacy is associated with relatively low uncertainty (about who will be helped), self-caused agency (who will help), and high perceived control ("I can do something about it"). Given these appraisals, we would expect that fast pseudoinefficacy would be associated with interpersonal emotions, such as sadness, distress, worry, sympathy, or empathy (Shaver, Schwartz, Kirson, & O'Connor, 1987).

Table 14.1 A dual-process model of pseudoinefficacy

	Fast pseudoinefficacy	Slow pseudoinefficacy
	Small numbers Singularity/identifiability	Large numbers, small proportions Proportional reasoning/drop in the bucket
	High entitativity (seen as individual) Clear mental images High determinacy	Low entitativity (seen as a group) No/less clear mental images Low determinacy
Appraisals:	Low uncertainty Self-caused agency ("I could help") High control potential	High uncertainty Other-caused agency (others could help) Low control potential
Affect:	Stronger	Weaker
Primary emotions:	Sadness Empathy (negative valence) Sympathy (negative valence) Distress Worry	Despair Hopelessness Guilt Regret

Slow pseudoinefficacy, on the other hand, is likely associated with different forms of negative affect (likely less strong affect than for fast pseudoinefficacy but still an important part of the motivation to help or not help), coming from larger numbers of people in need or the small proportion saved. Given this, we propose that slow pseudoinefficacy is related to processing of the need within groups, characterized by low entitativity and indeterminacy, and is likely associated with appraisals of high uncertainty (about who will be helped), other-caused agency ("others will help"), and low control potential ("there is little I can do about it"; Scherer, 2001). Despair, hopelessness, and related emotions would, therefore, be expected to provide a distinct emotional signature for this type of slow pseudoinefficacy.

Debiasing Pseudoinefficacy

We have been conducting a series of studies to test various procedures for eliminating, or at least mitigating, pseudoinefficacy (Västfjäll, Slovic, Mayorga, & Peters, 2014). Using a version of our fast pseudoinefficacy paradigm, participants first learned about a child, Rokia, that could be helped. They then rated their feelings and indicated how much money they would be willing to donate to Rokia. All participants then learn about a second child, Moussa, whom they cannot help (since the charitable organization is not operating in Moussa's country). Participants were then again asked about their feelings and donations to the first child, Rokia. In our control condition, strong pseudoinefficacy is displayed—participants reduced their ratings of positive feeling toward donations from around 7 to 3 on a 10-point scale. Donations were reduced by 15%.

We then tried three different debiasing conditions: in the affect awareness condition, we adopted the procedure developed by Schwarz and Clore (1983) to block the intrusion of irrelevant feelings in judgments by simply reminding participants about the true source of their negative feelings (i.e., being unable to help Moussa).

In our second debiasing condition, child in the pond, we used a version of Peter Singer's (2009) famous "child in the pond" example to drive home the irrationality of pseudoinefficacy. Singer asks us to imagine ourselves walking past a shallow pond and seeing a small child playing in it suddenly slip under the water and begin to drown. Would you, he asks, rush into the water to rescue the child? Of course, you would, he answers. We tested the following version of the argument, designed to drive home the irrationality of pseudoinefficacy: "Now suppose, as you see the child go under, you also see, further away, another child begins to drown—one you cannot reach. Would you then be less motivated to rescue the child within your reach?"

In our third debiasing condition, the teach condition, we gave participants information about pseudoinefficacy: "many donors hearing about program A, where 100 people can be helped, feel more positive emotion and donate more than when they hear about program B, where 100 can be helped, but 5000 unfortunately cannot be helped."

The results showed that all the three conditions reduced pseudoinefficacy compared to the control condition. The average drop in positive feelings in all three debiasing conditions was from 7 to 5 instead of 7 to 3 on the 10-point scale. Similarly, the reduction of donations was significantly smaller in the debiasing conditions. Together these findings show that pseudoinefficacy can be reduced through both affect-based and deliberate and reasoning-based interventions.

Conclusions

In this chapter, we reviewed research showing that affect is central in driving charitable decisions. We focused on two phenomena, compassion fade and pseudoinefficacy, that both are primarily based on affect. While affect is a crucial component of good decision making (Västfjäll & Slovic, 2013), these two phenomena also show that the affective system has its limitations: it is scope-insensitive and primarily tailored to deal with single individuals. Further, it cannot separate true negative feelings about not helping everyone from the good feelings associated with those that can be helped. This "arithmetic of compassion" is problematic in that help sometimes is withheld from those that suffer the most. While various "debiasing" techniques, to some extent, may mitigate biases in charitable giving, we must also create ways to effectively integrate affect and slower, more analytic thinking into decision making (Slovic & Västfjäll, 2010). Both nudges and boosts (Hertwig & Grüne-Yanoff, 2017) aimed at promoting slow thinking as well as various decision aiding techniques designed to help structure decision making with the goal of highlighting key considerations and by making relationships among these decision elements more transparent (Slovic et al., 2017) may be the way forward.

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