

# Perception and the Brain

*What we are betting on is that the perceived risk exceeds the actual risk. That's fundamental to the theory of everything we do.*

—Wilbur Ross

**H**urricane Katrina struck the U.S. Gulf Coast in 2005, and it was followed by another category 5 hurricane—Hurricane Rita—several weeks later. Following Katrina's impact, the media were saturated with tragic images of submerged residential neighborhoods. Videos cycled on major news networks of flooding victims stranded on their rooftops. They waved to news helicopters for help against a backdrop of dead bodies floating in the murky brown floodwaters. Katrina was the most expensive natural disaster in U.S. history with total property damage estimated at \$108 billion (in 2005 USD). At least 1,833 people died in Hurricane Katrina and the subsequent floods. Insurers were liable for billions of dollars in damage claims, and they raised their premiums over 50 percent in each of the following two years.

There was an increasing perception that category 5 hurricanes would devastate the Gulf Coast more frequently. An influential scientific study published in 2005 identified an acceleration in the rate of powerful hurricanes in the Atlantic Ocean. Al Gore's movie, *An Inconvenient Truth*, about the catastrophic environmental risks of global warming, was released shortly after the hurricanes struck. The devastating 2005 Atlantic hurricane season appeared to imply that worst-case scenarios were coming to fruition even faster than predicted.

Savvy investors, especially reinsurers, smelled opportunity in the heightened risk perceptions. Both Warren Buffett's Berkshire Hathaway and billionaire investor Wilbur Ross poured money into Gulf Coast reinsurance enterprises. In a *Wall Street Journal* interview, Ross explained such investments by stating, "What we are betting on is that the perceived risk exceeds the actual risk. That's fundamental to the theory of everything we do."<sup>1</sup>

Fear, by definition, is an emotional response to the perception of danger. Fear arises when humans anticipate threat, and the unpleasant feelings associated with fear motivate action to avoid those threats and eliminate the uncomfortable feelings (e.g., urgently buying insurance against the next storm). Savvy investors locate such fear-driven opportunities and exploit them.

It's worth considering what investors fear. They fear zombie investments that never live up to their potential. They fear fat fingers, hackers, and ghosts in the machinery of Wall Street that can bankrupt them in milliseconds. They fear debt, incompetent governance, and terrorist attacks. There are too many risks to track on Wall Street (and in life). And while investors cannot understand or anticipate every risk, they can strive to understand when others are going astray in their assessments of such risks.

This book examines the market price patterns created by investor psychology. Prices typically don't respond in an obvious way. Sometimes they respond to events within milliseconds, other times over days, and sometimes not at all. Sometimes prices fluctuate and sometimes a trend is born.

Price patterns are a result of collective investor buying and selling in response to new information. That dry description doesn't adequately embody the euphoria, anguish, and boredom behind the real-world market events that drive manias, panics, and price trends. This book's goal is to demonstrate how information flow in the media-through effects on investor psychology such as the increased risk perceptions following a hurricane-creates opportunities for investors.

## A LONG ESTRANGEMENT

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*When I went to financial economist training school, I was taught the "Prime Directive":*

Explain asset prices by rational models. Only if all attempts fail, resort to irrational investor behavior.

—Mark Rubinstein, from "Rational Markets: Yes or No? The Affirmative Case" (2001)<sup>2</sup>

The academic disciplines of psychology and economics were largely estranged from the Second World War through the early 21st century, but it was not always thus. Josef De La Vega's book *Confusion De Confusiones* was the first to describe the market microstructure of a stock market—the Amsterdam exchange—and it is also the first historical commentary on the emotions of market speculators. De La Vega notes that the Amsterdam bourse was dominated by the perpetual conflict between the *liefhebbers*

(“lifters-up”) who were “scared of nothing” and the *contremines* (“underminers”) who were “completely ruled by fear, trepidation, and nervousness.”<sup>3</sup> In ensuing centuries, such influential economists as David Hume (1780) analyzed the “motivating passions” that drive human economic behavior.<sup>4</sup> In 1939, John Maynard Keynes famously speculated that “animal spirits” drive economic growth.<sup>5</sup>

Despite these early references to psychological forces driving stock traders and economic activity, another field—physics—served as the inspiration for most post–World War II academic economists. Physicists were successfully applying complex mathematics to model natural phenomena, with the atomic bomb being the most dramatic example of the advances in that field. Emulating physicists, economists crafted overarching theories and employed complex mathematics to model economic processes. In order to streamline assumptions, economists adopted a view of human judgment and behavior as being purely rational. As Mark Rubinstein noted in the epigraph, many (if not most) academic economists consider this assumption the default position in theoretical models.

The assumption of the rational investor is generally quite useful in modeling, but it misses many important exceptions. As Peter L. Bernstein, a money manager and the first editor of *The Journal of Portfolio Management*, put it, “Indeed, as civilization has pushed forward, nature’s vagaries have mattered less and the decisions of people have mattered more.”<sup>6</sup> Overlooking the complexities and irrational nuances of human behavior has become a significant impediment to the advancement of academic economics.

Like economics, psychology was similarly beholden to theoretical orthodoxies in the latter half of the 20th century. Many psychologists worked based on the assumptions of Freudian theory and other unempirical dogmas. Behaviorists were an exception to this empirical drought, and research by experimental psychologists such as B. F. Skinner and Ivan Pavlov captured the public imagination. Their work demonstrated that human behavior could be systematically and predictably irrational, and it could be shaped with incentives such as rewards and punishments.

Rather than working on a grand unified theory of behavior, psychologists took a piecemeal approach to understanding human nature. They crafted independent theories—often based on experimental results—to explain individual idiosyncrasies or to solve specific clinical problems (such as how to relieve paralyzing anxiety). Meanwhile in medicine, research on pharmaceuticals identified chemical compounds—both recreational and therapeutic—that uniquely altered mood, judgment, and even financial risk taking. Based on work by empirical psychologists and psychopharmacologists, evidence-based treatments are currently deployed in the treatment of specific mood (e.g., anxiety, depression, impulsivity) and cognitive disorders (e.g., psychosis).

Over the past three decades, with new investigational tools and interventions, experimental psychologists and economists have begun collaborating. The fields of behavioral finance and behavioral economics represent these interdisciplinary, data-driven efforts. Researchers have now catalogued numerous predictable patterns in human judgment and decision making. These patterns include systematic cognitive and behavioral biases in risk-related judgment and behavior. A few of these biases occur collectively, across large groups, and they appear to impact economic trends and market price patterns, as described in this book. Rather than seeking a grand unified theory of market price behavior, this book takes a psychological approach, examining the unique information and crowd responses that independently fuel recognized price patterns, resulting in actionable opportunities.

The English economist John Maynard Keynes was one of the first economists to explore the relationship between mental processes and economic activity. He approached the problem from the cognitive perspective, attempting to understand market behavior from the perspective of a rational investor. In his allegory of the Beauty Contest, Keynes described how the best investors use cognitive skills (superior thinking) to outsmart their competition.

## **THE BEAUTY CONTEST**

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*Therefore it is not important that the basic value of the shares be practically nothing as long as there are other people willing to close their eyes and support those contradictions.*

—Joseph De La Vega, 1688.<sup>7</sup>

Keynes used an allegory to demonstrate how the collective behavior of investors moves stock prices. In the 1930s, newspaper beauty contests were occasionally held. In these contests one hundred photographs of faces were displayed in the newspaper. Participants were asked to identify the six faces that they believed would be chosen as the prettiest by all players. Those who guessed the consensus six faces won a prize. In this contest, one's own opinion of attractiveness was not as important as the collective preference. The key to selecting the winner lay in anticipating the faces others would select.

There are several ways to approach this game. The simplest strategy is to select the six prettiest faces in one's own opinion, without considering the preferences of others. According to game theory models, such a strategy is a Level 0 strategy. A more sophisticated player ought to understand and consider others' perceptions of beauty. Using that information, this strategy should be more likely to succeed—a Level 1 strategy according to game theory.

There is another, even more sophisticated level of play. A Level 2 player would consider the preferences of the Level 0 and the Level 1 players, asking, “What will the Level 1’s think the others will like?” As you can probably guess, this strategy can be extended to Level 3 and higher. Each level is attempting to predict the consensus based on the reasoning of the level below. According to Keynes:

*It is not a case of choosing those [faces] that, to the best of one’s judgment, are really the prettiest, nor even those that average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practice the fourth, fifth and higher degrees.*

Keynes believed that investors use similar layers of thinking-about-thinking. Sometimes investors estimate the fair value of stocks based on fundamental value or where the price is heading. Other times they consider what the other investors think.

Rosemarie Nagel developed an experimental version of Keynes’s Beauty Contest.<sup>8</sup> In Nagel’s version, she asked participants to guess a number between 1 and 100 that is two-thirds of the average guess. A Level 0 player would select a number randomly. A Level 1 player will choose a number consistent with the belief that all other players are Level 0. Since Level 0 players guess randomly, the average of those guesses would be 50. Therefore, a Level 1 player would choose two-thirds of 50, or 33.

A Level 2 player would choose a number consistent with the belief that all other players are Level 1. Since a level-one player will choose 33, a level-two player should choose 22. This process repeats for higher-level players. The Nash equilibrium of this game, for a player with Level Infinity, is to choose the number 0.

Several magazines and research labs have performed variations of this game. On average, when asked to choose two-thirds of the average guess, the correct answer of a single-shot (onetime play) game is around 23, implying that the ideal strategy is between Level 1 and Level 2.<sup>9,10</sup> Several variations of the game have been tested, including pitting groups in competition against individuals. Interestingly, groups give worse guesses initially, but over several trials they learn faster than individuals. In another variation, experienced players were closer to the correct answer than inexperienced ones.

Beauty Contest games are static and learnable, and thus they are very different from the dynamism of asset markets whose prices surge with rumors and information, buffeted by traders’ hopes, fears, and prejudices. But there are key similarities, as well. To win the Beauty Contest, investors ought to

identify what features the other players are paying attention to. Do they value large doe eyes, bobbed hair, or prominent chins?

From the experimental Beauty Contest evidence, an approach to investing somewhere between Level 1 and Level 2, but probably closer to Level 2, appears optimal given the experience and learning that investors can accrue (versus the Beauty Contest games, which are one-shot). To think optimally in the financial markets investors benefit from understanding the rumors and information Level 0 investors are attuned to. Secondarily, investors should consider how the Level 1 players believe the Level 0 players will respond to information. To get the balance right, an estimate of the proportion of Level 0 and Level 1 players in the market is useful. During a speculative bubble, markets will have more Level 0 players. When there is little new information, price action may be dominated by Level 1 traders.

One of the oldest behavioral strategies in markets is called alpha capture. In a classic alpha capture system, researchers and analysts submit trading ideas to a central location, typically owned by a portfolio manager. The idea generators may be compensated depending upon the overall value of their ideas to the owner. Alpha capture was first deployed by Marshall Wace in 2001. TIM Group currently operates the largest alpha capture system globally.<sup>11</sup> Use of alpha capture is now common across the financial industry.

Alpha capture was originally a Level 0 methodology, but recent advances have elevated it to Level 1 and above. In its Level 0 manifestation, an automated portfolio manager acted quickly on the ideas from the top-performing researchers, typically those with the best historical risk/reward track records. In the Level 1 advancements, algorithms consider factors such as trade crowding, whether a particular researcher performs better in certain industries than others, and the optimal time period to hold recommendations from that researcher. Sometimes, if a researcher has particularly poor accuracy, the system trades against their recommendations. In fact, researchers who provide consistently wrong ideas may be financially compensated in order to encourage their continued delivery of (bad) trading advice. Trading against an inaccurate research provider can be as lucrative as trading alongside a good one—consistency is key.

Keynes theorized that thinking-about-thinking (the Beauty Contest) drives investor decision making. Long after Keynes' death, in 2012 researchers found that a trader's accuracy in predicting price changes in an experimental market correlates with an empathic understanding of others' intentions (called "Theory of Mind"). Empathy was dominant, and there was no correlation between accuracy in price prediction and mathematical problem-solving ability.<sup>12</sup> This result suggests that Level 1 (and above) thinkers have an advantage over math geniuses. The skill of thinking-about-thinking was the key differentiator of trading performance.

Keynes noted that there are two ways of looking at markets, investment and speculation: “Investing is an activity of forecasting the yield over the life of the asset; speculation is the activity of forecasting the psychology of the market.” The dualism in Keynes’ statement is false. Market psychology itself affects asset prices, and in the process yields change, as is described in this book. Every investor—even those who believe in the supremacy of rational markets—will benefit from an understanding of the psychological forces that drive investors. This book is written for all those who are now, or who aspire to be, higher level investors.

## **WHAT MOVES TRADERS?**

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By deploying the skill of thinking-about-thinking, investors could be successful using a variety of real-world tools and insights. Through my experience as a coach, I’ve seen that most successful traders access information derived from three types of market analysis to generate buy and sell decisions:

- Fundamental analysis
- Technical analysis
- Sentiment analysis
- Institutional activity

These four types of information are the foundation of most traders’ toolkits. Traders look at fundamentals to understand the economic reality underlying prices. There are a variety of fundamentals to keep track of for each asset, including macroeconomic data, earnings, and interest rates. Traders examine technicals to understand price trends, price pressure, and resistance levels. Technical analysis may involve transformed price and volume data such as moving averages, stochastics, relative strength indicators, and market internals such as the order flow and bid–ask dynamics. Traders examine market consensus, positions of traders, and news reactions to ascertain market sentiment. The market behavior and impact of institutions on liquidity and volatility such as central banks, large funds, and high-frequency traders also change market price dynamics, so these are tracked as well.

When leading seminars, I occasionally ask the question, “What moves asset prices?” I then ask the audience to vote on which of the four options listed above is the primary driver of prices; the audience consensus varies. Accountant and analyst audiences typically choose fundamentals. Chartist audiences, predictably, often prefer technical factors or sentiment. College student audiences choose fundamentals (perhaps to appease their finance professor) or sentiment (if they suspect I am grading them). A sizable

minority in most audiences believes (and blames) institutions for influencing prices. Wise (or confused) audiences don't vote at all.

Why would a wise audience abstain? The academic evidence on what moves asset prices is a smorgasbord, a compendium of stylized facts showing evidence for earnings, price patterns, sentiment, and institutional policies impacting prices over various time periods and in various situations. There is no single answer to the question, "What moves asset prices?" In fact, it's a useless question if one doesn't understand what drives traders to buy and sell in markets.

At its core, it is the behavior of traders—their buying and selling and order flow—that moves prices. A more useful question than "What moves asset prices?" is "What causes traders to buy or sell?" And the answer is much more complex than it may seem. Trader behavior is driven by influences from external news (e.g., an earnings surprise), to the molecular level (e.g., neurochemistry), to the societal level (e.g., what will others think?). Both neurochemistry and social perceptions are altered through observation of information flowing through the world around. Those observations are filtered in and processed through in the trader's brain. The simplest answer to what makes traders buy and sell is then: *Traders respond to information*. They respond on a brain level, and sometimes their resulting buy-and-sell behavior is synchronized.

Yet information itself does not move traders to take action. A positive earnings surprise doesn't press the buy button in a trader's account. What fundamentally moves traders to buy or sell is the motivation they get after receiving that earnings news—the "*Ab ha!*" or the "*Uh-oh!*" The emotion that the information evokes is the key motivator of trader behavior.

The English word *emotion* is derived from the Latin words *ex* (out) and *movere* (move).<sup>13</sup> Information provokes emotion when it is relevant to a mental model, beliefs, or expectation. For example, if one's mental model of expected earnings agrees with the consensus estimate, and the company reports earnings below the consensus (the reference point), then that positive earnings announcement is in fact a disappointment.

Crucially, the brain generates good or bad feelings, depending on how new information compares to its expectations. When traders compare new information to their expectations, neurochemistry shifts, and a feeling arises. If the information is better than expected, they feel good; if it is worse than expected, they feel disappointment. Going forward in time, a series of such events and their associated feelings accumulate and subtly pressure the trader to take action.

Intense, short-term emotions arouse an inclination to take action because "doing something" is how one discharges that emotion and restores balance to one's neurochemistry. When traders fail to take action,



that emotion will linger—even if they're no longer conscious of it—and it will subtly affect judgment and decision making. Think of a short-term emotion as a pebble in one's shoe: It will irritate, and it will eventually alter one's gait if it is not dealt with.

It is human nature to react emotionally when events do (or do not) go one's way. Furthermore, nothing has to *happen* for someone to experience emotional reactions. The simple act of imagining possible outcomes, such as great successes or terrible losses, stimulates emotion. Every investor has emotional reactions to market price action, although this diminishes with experience. Most investors have felt elation, pride, and the fear of missing out during bull markets and intense doubt, anger, or panic during sharp market downturns. Each emotion uniquely alters how investors think and what they subsequently do with their capital.

In order to comprehend patterns in markets, first this book explores how information evokes both emotional reactions and behavioral responses. Then it examines how other factors—the mental models, expectations, beliefs, time horizons, attention placement, and reactivity of the mass of traders—predictably affect prices.

## **CHAINED TO THE MAST**

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*First she said we were to keep clear of the Sirens, who sit and sing most beautifully in a field of flowers; but she said I might hear them myself so long as no one else did. Therefore, take me and bind me to the crosspiece half way up the mast; bind me as I stand upright, with a bond so fast that I cannot possibly break away, and lash the rope's ends to the mast itself. If I beg and pray you to set me free, then bind me more tightly still.*

—Homer, *The Odyssey*

Odysseus is a legendary Greek king of Ithaca renowned for his cunning and resourcefulness. In Homer's epic poem *The Odyssey*, he spends 10 eventful years returning home after the Trojan War. During that long journey, he passed by the Sirens. The Sirens were beautiful female humanlike creatures who lured nearby sailors with their enchanting music and voices. If sailors were drawn too near, as they usually were, they shipwrecked on the rocky coast of the Sirens' island and remained there, frozen in enchantment.

Odysseus wanted to hear the Sirens' song, but he knew that doing so would render him incapable of rational thought. He made a pact with his men as they approached the Sirens, putting wax in their ears so that they could not hear the Siren song. He asked his men to tie him to the mast of his ship so that he could not jump into the sea as they rowed past. He ordered

his men not to change course under any circumstances, to keep their swords pointed at him, and to attack him if he broke free of his bindings. Upon hearing the Sirens' song, Odysseus was driven temporarily insane and struggled with all of his might to break free. Figure 1.1 depicts Odysseus fighting to join the Sirens.

Odysseus passed the Sirens safely. He did so because he understood his emotional weaknesses, and he planned ahead for his moments of vulnerability. Trusting his leadership, his crew refused to untie him, and they kept their ears plugged with wax. In *The Odyssey*, Homer commented on the weaknesses of human nature: "Men are so quick to blame the gods: They say that we devise their misery. But they themselves—in their depravity—design grief greater than the griefs that fate assigns." The human struggle to do what is right, while resisting temptation, is a pervasive theme in classical Greek literature.

In Plato's *Phaedrus*, the human intellect is likened to a charioteer that commands two horses: one that is irrational and crazed while the other is



**FIGURE 1.1** "Ulysses and the Sirens." Herbert James Draper, 1909.

noble and of good stock. The job of the charioteer is to control the horses as they proceed toward enlightenment and truth. Plato's characterization of the mind contained one key flaw. Humans *think* they are the charioteer, in control, but in fact the thinker is itself one of the horses. Controlling emotion is easy to consider intellectually, but reality is not so simple.

## **THE BRAIN: STRUCTURE AND FUNCTION**

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*Of all creatures that breathe and move upon the earth, nothing is bred that is weaker than man.*

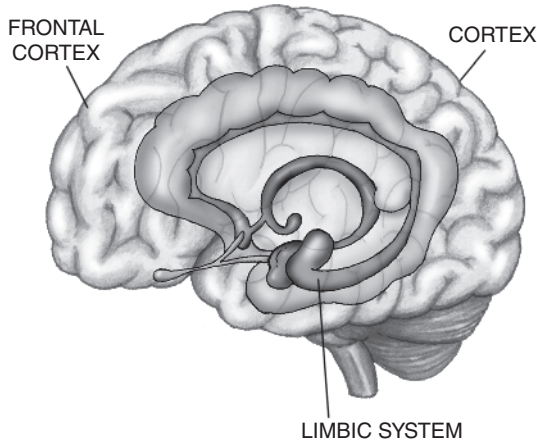
—Homer, *The Odyssey*

The human brain is the product of millions of years of evolution, and it is designed to efficiently and effectively interpret information, compete in a social hierarchy, and direct activity toward achieving goals while avoiding danger. However, the human brain evolved in a stone-age world where dangers and opportunities were largely immediate, and social interactions were limited to other members of a clan. As the modern world grows ever more interconnected and fast paced, it is apparent that some features of the stone-age brain are not optimized for managing the complexities of modern life.

The brain can be conceptualized as having three anatomical divisions. Each division is like the layer of an onion, with complex processes such as analytical decision making in the outer layer—the cortex; motivations and drives arise from the middle layer—the limbic system; life-sustaining physiological processes originate in the innermost core.

The cortex is the brain's logistical center. It is the director of executive function and motor control. The part of the cortex called the prefrontal cortex is involved in abstract thinking, planning, calculation, learning, and strategic decision making.<sup>14</sup> The brain's limbic system is the emotional driver of the brain. The limbic system is the source of primitive motivations and emotions including fear and excitement. Both the cortex and the limbic system are displayed in Figure 1.2. The third division of the brain is called the midbrain (a.k.a. "the reptilian brain"). The midbrain manages the body's basic physiological processes, including respiration and heart rate, and it will not be discussed further in this book.

Running across the three brain divisions are neural circuits that operate two types of goal-directed behavior: (1) reward pursuit and (2) loss avoidance.<sup>15</sup> The existence of reward approach and loss avoidance systems has been hypothesized since the time of Aristotle.<sup>16</sup> Prior to the late twentieth century, both the reward and the loss systems were thought to drive



**FIGURE 1.2** A depiction of the brain. The limbic system is seen situated underneath the cortex. The prefrontal cortex lies behind the forehead.

organisms toward pleasure and away from pain. Currently, scientists believe that these systems encompass complex brain processes involving emotions, cognitions (thoughts), and actions.

The evolution of the frontal cortex was an excellent thing—it's essentially what makes someone human, allowing one to reflect on the future and past, think strategically and abstractly, and plan ahead. The problem is that the prefrontal cortex evolved after the limbic system, and thus while it sits on top of the limbic system and manages and directs impulses, at times the frontal cortex is knocked offline by emotional surges. When it is placed back online, it tries to clean up the consequences as best it can.

The brain's prefrontal cortex helps humans to regulate emotions. In children and adults of advanced age, the prefrontal cortex is thinner, and emotions are more likely to influence financial judgment in unfortunate ways (which is why children aren't allowed to have credit cards and older adults are more susceptible to financial scams). For normal adults, emotional self-regulation is intact when markets are trading as expected. When price volatility arises, even normal adults lose their cognitive tether as emotions come to dominate investment decision making.

Lying within the limbic structures is a motivational circuit called the reward system. The reward system is comprised of neurons that predominantly communicate via the neurotransmitter dopamine. Dopamine has

been called the “pleasure” chemical of the brain, because people who are electrically stimulated in the reward system report intense feelings of well-being. The reward system coordinates the search for, evaluation of, and motivated pursuit of potential rewards.

A second motivational complex governs loss avoidance. The anatomy of the brain’s loss system is less well defined than that of the reward system. The loss system is thought to consist of the anterior insula (pain and disgust), the amygdala (emotional processing), the hippocampus (memory center), and the hypothalamus (hormone secreting center). Loss system activation affects the entire body through bloodstream hormone and neurotransmitter release. The perception of a threat activates the hypothalamus-pituitary-adrenal axis (HPA axis), which results in stress hormone and epinephrine (“adrenaline”) secretion into the bloodstream. The body’s sympathetic nervous system (SNS) prepares the whole body for the “fight-or-flight” response to danger with nerve signals transmitted to every major organ system. When under threat and experiencing fear, signs of SNS activation include trembling, perspiration, rapid heart rate, shallow breathing, and pupillary dilation. The SNS is also responsible for the physical signs and symptoms of panic.

Because the reward and loss systems influence thought and lie beneath awareness, they often direct behavior automatically through subtle emotional influences on judgment, thinking, and behavior. Based on the structure of the brain itself, humans don’t *think* emotion is as influential over their behavior as it actually is. When thinking about emotion, one is thinking *as* the frontal cortex, a region that evolved in humans 70,000 years ago and is architecturally superimposed on top of the limbic system. Emotions are generally unconscious—humans usually don’t feel them or think about them, and as a result, humans consciously—on reflection—underappreciate their significance in driving behavior.

While the reward and loss systems are largely independent, when one system is highly activated, it may trigger a reciprocal deactivation of the other. In some (unpublished) neuroimaging research, evidence indicates that anticipating large financial rewards deactivates the anterior insula. Loss-avoidance is turned off by positive excitement. That is, excitement about potential wins deactivates the threat detection areas of the brain. This brain activity may be the source of the market aphorism: “Pigs get fat, hogs get slaughtered.” Wanting to profit in markets is good (being a pig), but being so greedy as to ignore all risks (being a hog) leads to long-run ruin. Yet while the emotional explanation for trader behavior is simple and elegant, it is also incomplete.

## EMOTION VERSUS REASON

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*There is nothing either good or bad, but thinking makes it so.*

—William Shakespeare, *Hamlet*

So far, this chapter has vetted the idea that out-thinking others is the key to success in trading. It also explored how emotional inputs—arising from fundamental neural circuits and structures—influence decision making. In order to find gaps between perceived and actual risk, as Wilbur Ross suggested in the opening quote, then traders ought to understand how emotions alter perceptions, leading to such opportunities in market prices. Another question then follows: Is it more important to work on cognitive or emotional factors in decision making?

The information that traders receive is much more complex than that used in neuroimaging experiments, and it cannot be easily identified as “cognitive,” as opposed to “emotional.” Some high-impact cognitive information, such as a corporate bankruptcy, induces emotional response. On the flipside, information about others’ emotions—such as hearing of a market panic—can drive a rational decision to buy shares from those who are overreacting. Following Hurricane Katrina, it was likely the emotional state of fear drove homeowners to purchase insurance at premiums far above those justified by the actual flooding risk. While media might report high degrees of emotion among investors, savvy traders make cognitive assessments of such collective emotions. Wilbur Ross’s was a cognitive decision to take advantage of that mispricing.

Using neuroimaging, researchers exploring the Beauty Contest game found that the level of activity in the brain’s prefrontal cortex during decision making correlates with improved contest performance. Higher performance results from having a superior strategic IQ,<sup>17</sup> which is the ability to think analytically about others’ thinking (and feeling). The prefrontal cortex receives useful information from, and also sometimes inhibits, the emotional circuits. Like Odysseus, the best traders use their cognitive powers to plan ahead for moments of emotional weakness. To take advantage of the gap between perceived risk and actual risk, investors can use cognitive strategies that consider the importance of emotion in driving market behavior.

## IN SUMMARY

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- Savvy investors identify when risk perceptions diverge from actual investment risk.
- The academic fields of behavioral finance and behavioral economics investigate the role of human psychology in economic decision making using statistical analysis and experimental technique.

- The Beauty Contest theorized by Keynes describes the importance of game theory and metacognition in markets.
- Traders are moved by information and their reactions to information. Such reactions are influenced by preexisting expectations, beliefs, and moods.
- The story of Odysseus and the Sirens illustrates how intellect is often subsumed by emotion. As Odysseus demonstrates, cognition may be used to plan ahead in order to avoid emotional and behavioral traps.
- The brain's structure, with the prefrontal cortex evolving 100,000 years ago on top of the limbic system, explains why humans think they have more control over their reactions and behavior than they actually do.
- The brain's major motivational pathways—the reward and loss avoidance systems—play a significant role in every risk-related human behavior. Their activity is reciprocal at times, amplifying vulnerabilities.
- To take advantage of the gap between perceived risk and actual risk, investors use cognitive strategies that consider the importance of emotion in driving market behavior.

## NOTES

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