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The neuroscience in Investment decision- making

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ABSTRACT

The investment decision-making of individual investors is influenced by various biological factors that provide explanations of the investor's behavior by using tools of neuroscience. Biological factors can influence investment decisions that provide explanation of the investor's behavior by using tools of neuroscience. The various tools of neuroscience aimed at provide understanding of how brain analyze information about decision choices that are monetary, uncertain, time constrained and risky and also provide understanding of neural processes that are involved in investment decision making. This modern aspect of neuroscience in investment decisions has emerged from the interdisciplinary field of neurofinance. Neurofinance is a new and growing field of discipline and practice that provides an understanding of the significant neurophysiological foundations underlying a variety of cognitive processes and behaviours. Electrophysiology, psychology and psychophysiology have contributed significantly to the field of neurofinance. Neurofinance seeks to understand what drives individual investor behaviour both at a theoretical level and practical level. The present paper is an attempt to answer three questions. First, how behavioural and cognitive biases influence individual investor's investment decision-making by exploring the field of neurofinance? Second, Is neuroscience capable of providing solutions to the behavioural aspects of finance? Third, what is the future scope of neuroscience in investment decision-making?

KEYWORDS: Neuroscience, Investment, Biases, Behaviour, Decision.

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INTRODUCTION

As it is universally evident that across a period of million of years, human have adapted certain brain mechanisms that may be considered sufficient for the survival but are not sufficiently fit for the present world's complexities, particularly with aspects of investments and trading. It is a natural and unconscious sense of survival in human mind that deals either with physical encountering or escaping from present menace. These types of traits of confrontation and escapism human beings still follow in handling the complexities of present world today. There are rationalists who believe that the decisions taken by human beings are purely rational and also influenced by emotions (Olga Markic, 2009)[1]. There are other thoughts by the behavioural researchers in addition to this thought that decisions taken by human beings are based on emotional response to stimuli and affect (Simon, 1959)[2]. Human being drives depend upon his motive to act. As soon as, his drives are satisfied, his actions come to an end. Therefore, objective of human being is to accomplish a sufficient level of return and thereby having the satisfaction (Simon, 1959)[2].

Neuroscience has invented that behaviour of human being to large extent follows the rules of autonomic processes. Human behaviour is the result of neurons processes that follows consciousness (Hsu, et.al, 2005)[3]. These processes are part of human brain that is considered to be an output of million of years of development and evolvement (McClure et. al., 2004)[4]. Human brain is designed to interpret information, facing the social structure complexities and direct actions towards accomplishing goals while avoiding any risk (Peterson, L.R., 2014)[5]. There are many levels in the part of the brain that ranges from the actions of individual molecules to vast communication between lobes. The structure of brain is 'made up of autonomy of the brain' and the function represents what brain does 'the physiology of the brain.' In reality, thinking, feeling and intelligence of the brain occur at the levels of neural networks. At a molecular level, genetic transcription, neurochemicals, epigenetic cellular milieu and small electrical currents drive neuron processes and at the anatomical level, neuron circuits cross regions and give rise to complex thought and behaviours(UlrikeMalmendier& Stefan Nagel, 2009)[6]. These all are considered as foundation stones of the neurological understanding of the brain. The understanding of structures, functions of brain have huge relevance towards investment decision making. Many academic literature of neuroeconomics and neurofinance, have concluded that there is significant statistical correlation between disciplines of biology and behaviour. The field of neurofinance that has evolved a few years back is considered to a blend of neurology, biology, psychology, economics and finance. These areas are of interest in their relation to investment and investment decision-making. The discipline of neurofinance has facilitated an understanding in the underlying behaviour with regard to economic

and investment decision-making. (Shariff, M. Z., Khasawneh J. A., Mutawa, M. A., 2012)[7]. The aspect of neuroscience in investment decision-making helps in bridging the gap between market efficiency and market reality. Proper understanding of neural processes, structure of human behaviour helps in explaining the numerous complexities of modern investment life. The aspect of neuroscience in investment decision making has been instrumental in presenting the parts and structures of the human brain that are most active during the process of decision making (Chen et. al., 2006)[8]. It also explains how certain decision taken by human beings are considered to be rational and irrational.

REVIEW OF LITERATURE

Neuroscientist has investigated a variety of aspects related to investment decision-making. Researchers have found genetic markets in the investment markets that predispose individuals to higher levels of risky investment decision making. In a genetic study, subjects who have taken the DRD4 gene 7 take more risk in investment task by 25% and subjects who have taken two copies of the short serotonin transporter gene that is 5-HTTLPR s/s take 28% less risk (CameliaM.Kuhnen& Joan Y. Chiao, 2009)[9]. In contrast to this finding, another group of researchers have conducted the same experiment but has not found the difference in risk taking across DRD4 allele and 5-HTT polymorphism carriers. However, the researchers have found significant relationship the MAOA-L gene. This MAOA-L gene produces an enzyme involved in catabolism of dopamine, norepinephrine, and serotonin. The researchers have found gene MAOA-L more active. Behavioural characteristics associated with MAOA-L gene has consisted of impulsive risk taking and aggression. Subjects with MAOA-L gene has taken more investment risks but with higher expected utility (Frydman et. al., 2011)[10]. Many studies have been contributed in providing an insight into the forces of emotions related to trading by studying the physiological traits of professional securities traders while they were actively engaged in live trading (Vergano, Dan, 2006)[11]. Another study conducted by researchers has found significant correlations between market trends and physiological traits. Another study conducted by researchers has indicated that how gains have been realized and losses have been incurred and both are activated to different regions of the brain. When gains have been realized, a subcortical region known as nucleus accumbens (NAcc) has become active. This region has dopamine a substance that has been associated with both the positive impact of monetary rewards and addiction. This region has been only activated during anticipated gains but not at losses (Knutson, et. al.,2001)[12]. Another brain imaging research has indicated that risk and uncertainty have been experienced in different ways (Rustichini, 2005)[13]. Research has indicated that while facing

uncertainty, the most active regions were orbitofrontal cortex. This region combines both emotion and cognition and amygdala (a region central to emotional reaction). In contrast to this research, other group of researchers found and concluded that while facing risk, the brain areas that responded during experiment were in the parietal lobes (Antoine Bechara&Damasio, 2005)[14]. They concluded that choices during this experiment were driven by cognitive determinants and hence uncertainty has significant correlation with an emotional response, while risk leads to a cognitive reaction (Sapra& Zak, 2009)[15]. A neural experiment of myopic loss aversion has also been conducted. Study has taken group of patients as subjects. Their brain lesions on areas known to be associated with the processing of emotions have been compared to a control group. The study concluded that the former group was more prone to take risk than control group (Shiv, et. al., 2005)[16]. Another study by using a gambling game, pointed out that how brain of decision makers reacted to varying levels of risk in comparison to learning or expected values (Preuschoff et. al., 2006)[17]. While monitoring the brains of participants variation in expected values and risk was taken into consideration. Researchers reported that brain activation varied in both time and location for risk and reward. They found that brain activation in response to reward was instant, whereas brain activation in response to risk was delayed. Addition to this, researchers also observed that time and location of brain activation is significant because if we can divide the effects of risk and reward in the brain during response activation, researchers can further investigate how alterations in risk perception affect decision-making. Researchers could also investigate how misperception of risk and cognitive problems contribute to unfavorable behaviour(Preuschoff, et. al., 2006)[17].

Neurofinance researchers and academicians also observed changes in risk taking over the lifetime, with age related alterations in investment risk taking. For instance, an assumed result of the biological change in early life experiences and changes in dopaminergic and serotonergic transmission over the lifetime on the saving and investment behaviour of people are different. People who came of age during traumatic economic events such as sub prime crisis, great economic depression has different investment risk taking attitude from those who did not witness the same (Malmendier& Nagel, 2009)[6]. One of the study conducted by a researcher few years back using Swedish Twin Registry has found that 25% of the individual variation in investment risk taking is due to genetic factors and this resulted variation in behaviour also applicable in investment preferences (Cesarini et. al., 2010)[18].

Several neurofinance researchers have found the assumptions of prospect theory with its neural correlation with loss aversion, reference point setting, and repurchase effect, the endowment effect and the disposition effect (Brooks. et. al., 2012)[19]. They have observed individuals have been more exposed towards taking excessive risk in order to cover losses. In support to this study, another

personality study also identify individuals with high neuroticism scores have more effective interior insula in the realm of experiencing losses. Neuroscientist has conducted an investigation and has found that behavioural bias of loss aversion has charged by fear of disappointment has appeared from amygdala activation of the brain region (Kuhnen & Knutson, 2005)[20].

There are ample of researches that have been conducted to understand the human behaviour under conditions of gain and losses, risk and reward and have determined significant neural correlation with human behaviour in areas of the brain that are involved in emotion, self realization, disposition and strategy. There are few studies that have provided comprehensive insights towards understanding the role of neuroscience in investment decision-making. This paper is an extended continuation of the previous research on this aspect that has made an attempt to cover how behavioural and cognitive biases influence investment decisions of individual investor through the field of neurofinance and also has made an effort to seek how neuroscience is predisposed in providing solution to the behavioural aspects of finance and at the end this paper has made an effort with the help of previous literature to provide the future realm of neuroscience in investment decision-making.

OBJECTIVES

- To analyze the influence of behavioural and cognitive biases on the investment decision making of individual from the insights of neurofinance.
- To provide insights of neuroscience in understanding the behavioural aspects of investment decision-making.
- To suggest the future paradigm of neuroscience in investment decision-making.

RESEARCH METHODOLOGY

The secondary data has been collected and analyzed to provide an insight on the theoretical framework of neuroscience in investment decision-making. Secondary data has been collected from the books of neuroscience, neurofinance, behavioural finance and investment behaviour and from research papers related to the study.

The influence of behavioural and cognitive biases on the investment decision making of individual investor

Over the life span, evidences from neuroscience have shown that the origin of investment decision-making is in emotional and motivation processes (LennartSjobreg&ElisabethEngelberg,

2006)[21]. This can be witnessed from the fact that most people become extremely emotional when it comes to monetary concerns and investment decision-making, which involves situation of risk and uncertainty (Lo and repin, 2002)[22]. Behavioural and cognitive concepts like anchoring, overconfidence, herding are also said to have neural basis. Other aspects that have significant correlations with neurological sciences are stock market and forecasted asset prices (spara&zak, 2009)[15]. The researchers has also founded that investment in stock markets has been seen as mirrors of human psyche that is considered to be an aggregate of fear, obsession, paranoia, exhilaration and the like (Ferguson, 2008)[23]. Neuroscience has also shown through various experiments that human decisions are the result of two opposite but simultaneous connected systems (Olsen, 2007)[24]. One system has been considered as fundamental or elementary in nature and other one has been taken as of most recent origin. The elementary system has possessed the traits of rapid, emotional and instinctive that have been considered most affective in nature. In this system not much alterations or modifications has witnessed besides over the years of human evolution. Focusing on the emotional part of human, it has been analyzed by the researchers over the life span that though individuals would want to view as 'logical' and 'rational' in decision-making, the reality is that emotional decision making is more or less like default choice for our brains (James Montier, 2007) [25].The second system has been seen as most recent at the biological side that has been considered as slow, computational and analytical in nature. Researchers has proved that human brain is connected in such a way that both systems interact simultaneously to influence decisions at monetary front.

Insights of Neuroscience in investment decision-making

If decision-making is dependent on to large extent on the insides of the brain system then medicines, dietary supplements, exercises and other illicit drugs can be used to show the activities in the brain system (Peterson, L.R., 2014)[5]. Researchers have used various medications and standardized dosage to examine the direct changes and alterations in the risk and reward perception in behavioural experiments (Paulus et.al., 2003)[26]. A study has conducted by group of researchers that has reported a common high blood pressure medicine in the beta-blocker family has decreased the experimental ability of the subjects to perceive projected investment losses during a risky task (Roger et. al., 2004)[27]. Results have also shown that drugs and medications have affected investment decisions. In one of the experiment, participants have been given choice positive value and zero value expected options with high return outcomes. In experiments there were 'control subjects' and 'THC intoxicated' subjects. It was found that THC intoxicated subjects preferred investing in the risky options more than the control subjects who had been administered as placebo. Experiment has

concluded that if THC intoxicated lost money after selecting the risky option, then they would be persisted with risky selections in comparison to control subjects who would likely to move to positive expected value option (Lane et. al., 2005)[28]. A similar study was conducted and it was reported by the researchers that a preference towards risky options among alcohol intoxicated subjects and control subjects (Lane et. al., 2004)[29]. Neuroscience has been used a number of scientific tools and techniques including brain imaging to understand the neural processes that lead to investment and economic decisions. Brain imaging that has helped to look inside the human brain and gain more insight as to how brain works when decisions are made. Explanation of few such tools are mentioned below:

- **Event related field:**

  Event related field is very small voltages generated in the brain structures in response to specific events or stimuli (Blackwood and Muir, 1990)[30]. Event related field helps in examining the information processing. ERF measures the brain responses that are directly the outcome of an event. This is measured with MEG (magnetoecepephalographics). It helps in watching the brain activity in both time and space including the mapping of normal activity of brain (Alonso et. al., 2012)[31]. For example, with the help of MEG, brain activity can be watched to see changes in the brain when an individual do trading in stocks or making an investment in various avenues. MEG helps to explain where in space this activity is happening.

- **Event related potential:**

  This records the electrical activity of the scalp. It measures the brain responses that are directly the result of a thought or perception, which is evaluated using Electroencephalography technique (Alonso et. al., 2012)[31].

- **Functional Magnetic Resonance Imaging**

  It is one of the most recent neuroimaging technologies. It provides information of brain activity through blood flow changes that accompany with neurons activities. FMRI helps the researcher in providing new insights into the inner workings of the human brain (Martin Lindquist, 2008) [32]. FMRI helps in studying which part of the brain is active when the individual performs a given task. A large number of studies have been conducted in neurofinance using FMRI technology. In one of the experiment, researchers have investigated that expected utility could be defined in the specific parts of the brain. They analyzed that three specific subcortical regions known as NACC of the brain, which consists of thalamus,

medial caudate and nucleus accumbens are linked with the anticipation of monetary gains. The experiment has shown that during rewards or gains, NACC has showed increased activation (Knutson, et. al., 2003)[33].

With the help of FMRI, the study has been conducted that found the brain parts have provided different response to risk and ambiguity. Experiment has found that orbitofrontal cortex (OFC) and the amygdala were the most active regions of the brain during ambiguity and those regions were not activated during the condition on risk (Hsu, et. al., 2005)[3].

The role of these tools and techniques are instrumental in presenting the regions and structures of the human brain that are most active while taking decisions related to investments (Xue, et. al., 2010)[34]. It has also helped in providing useful insights in decision-making processes that are considered to be irrational and only of human nature.

Future paradigm of Neuroscience in investment decision-making

Over the life span, there have been various evidences that have proved that the discipline of neuroscience has the capacity of providing various solutions to the behavioural and cognitive aspects of investment decision-making (Sapara, S.G., & Zak, P.J., 2009)[15]. So far the findings of neuroscience in context of investment life are still based mainly on laboratory experiments. There have been various studies that have been critiqued on the grounds related to its practical applicability of laboratory experimentation. The present limitations in this field provide potential opportunities to look for various inputs and ideas to better understand the implications of investment decision making in context of neuroscience. An understanding of this aspect can help policy makers and administrators to promote social welfare (Kuhnen, C., 2008)[35]. New developments in this field will help investment agents and regulators to prevent investors from market bubbles and help in developing appropriate investment and retirement strategies (Sapara, S.G., & Zak, P.J., 2009)[15]. So far studies that have been conducted in neuroscience has provided significant insights on the individual decision making under uncertainty and the role of dopamine is significant in this context but still there is much needs to be done (Hsu, et.al. 2005)[3]. It would be interesting to know if neuroscience would explain phenomenon of investment decision-making at aggregate level such as Uncertainty at investment markets or investment institution's related uncertainties, stockbroker's related uncertainties and investment regulator's related uncertainties (Peter Bossearts, Murawaski, 2015)[36].

CONCLUSION

Neuroscience is an experimental field that has provided various tools and techniques to the practitioners and researchers in many other fields to adopt to investigate problems of central interest (Peterson, L.R., 2014)[5]. The use of neuroscientific tools and techniques has helped many researchers in understanding and identifying the biological drivers of investment decision-making. Various issues have been addressed by neuroscience in investment decision-making, which include understanding human brain activities under risk, uncertainty and ambiguity and assessments of human responses under herding and social influences (Badeley A., 2010) [37]. By using tools and techniques of neuroscience in understanding human responses, scientists are gaining useful insights to develop comprehensive investment models of decision-making. Many investment practitioners have tried from time to time to systematize decision-making process. Practitioners have investigated from the studies that positively induced environmental cues can increase risk-taking (Knutson, Wimmer, Kuhnen, 2008)[38]. In a study risk taking has increased following activation of the NAcc by seeing external pictures and video clips. Furthermore one other study has also examined that a recent win or gain in recent investment or stock has made the subjects more likely to take irrational risk (kuhnen and Knutson, 2005)[39]. Neuroscience has evolved over the years and has provided significant contribution in solving the complexities of behavioural and cognitive biases that can influence investor's behaviour. Recent researches has provided important insights in explaining how the environment of investment decision makers and the context of their can be altered or improved to optimize investment decision-making (Richard L. Peterson, 2014)[5].

REFERENCES

1. Olga M and AG. Rationality And Emotions In Decision Making. Interdisciplinary Description of Complex Systems.2009; 7:54–64.
2. Simon HA. Theories of decision-making in economics and behavioural science. American Economic Review.1959; 49: 253–283.
3. Hsu, Bhatt, Adolphs, Tranel, Camere. Neural Systems Responding to Degrees of Uncertainty in Human Decision-Making. Science AAAS.2005; https://doi.org/DOI: 10.1126/science.1115327.
4. McClure, Sam M, Laibson D, Loewenstein, Cohen D,. Separate Neural Systems Value Immediate and Delayed Monetary Rewards.2004;503–507 https://doi.org/DOI: 10.1126/science.1100907.
5. Peterson, RL. Neurofinance in: Investor Behavior: The Psychology of Financial Planning and Investing. John Wiley & Sons.2014; 381–401.

6. Ulrike M, Stefan N. Depression Babies: Do Macroeconomic Experiences Affect Risk Taking? The Quarterly Journal of Economics.2011; https://doi.org/doi.org/10.1093/qje/qjq004.
7. Shariff MZ, Kasawaneh JA, Mutawa MA. Risk and Reward: A Neurofinance Perspective. International Review of Business Research Papers. 2012;8, 126 – 133.
8. Chen k, Laxminaraynan V, Santosh LR. How Basic Are Behavioral Biases? Evidence from Capuchin Monkey Trading Behavior. Journal of political economy.2006; 114. https://doi.org/doi/10.1086/503550
9. Kuhnen CM, Knutson. The Neural Basis of Financial Risk- Taking. 2005; 47:763–770.
10. Frydman, C, Camerer C, Bossaerts P, Rangel A. MAOA-L carriers are better at making optimal financial decisions under risk. Biological Sciences.2011; 2053–2059. https://doi.org/10.1098/rspb.2010.2304
11. Vergano, Dan. Study: Ask with Care: Emotion Rules the Brain's Decisions. USA Today.2006.
12. Knutson, Brain, Adam C, Fong, Hommer D. Anticipation of Increasing Monetary Reward Selectively Recruits Nucleus Accumbens. Journal of Neuroscience. 2001; 1–5.
13. Rustichini A, Dickhaut J, Ghirardato, KS, Pardo JV. A brain imaging study of the choice procedure. Games and Economic Behaviour. 2005;52: 257–282.
14. Antoine B, Hanna Damasio, Antonio RD. Emotion, Decision Making and the Orbitofrontal Cortex. Cerebral Cortex. 2005; 10(3):295-307.
15. Spara SG, Zak PJ.Neurofinance:Bridging psychology, neurology and investor behaviour. Working papers.2009;https://doi.org/10.2139/ssrn.1323051.
16. Shiv B, Loewenstein G, Bechara, Damasio A, Damasio H. Investment behaviour and the dark side of emotion. Psychological Science. 2005; 16: 435–439.
17. Preuschoff K, Bossaerts P, Quartz SR. Neural differentiation of expected reward and risk in human subcortical structures. Neuron.2006;51: 381–390.
18. Cesarini, David, Magnus, Johnnesson, Paul L, Sandewall, O. and Wallace, B. Genetic variation in financial decision-making. Journal of finance2010;65: 1725–1754.
19. Brooks, Monica, Berns GS. Neural insenstivity to up sticks in value in Is associated with the disposition effect. Neuro image.2012; 59: 4086–4093.
20. Lennart S, Elisabeth E. Money, Attitude and Emotional Intelligence. Journal of applied social psychology.2006.
21. Andrew, Repin. The Psychophysiology of Real-Time Financial Risk Processing. Journal of Cognitive Neuroscience. 2002;14: 323–339.

22. Ferguson N. Wall Street lays another egg, Vanity Fair. 2008.
23. Olsen RA. Investor's predisposition for annuities: a psychological perspective. Journal of Financial Service Professionals.2007.
24. James M.Behavioural investing: A practitioner's guide to applying behavioural finance. John wiley& Sons ltd.2007.
25. Paulus MP, Rogalsky C, Simmons A, Feinstein JS, Stein MB. Increased activation in the right insula during risk-taking decision making is related to harm avoidance and neuroticism.2003; 19: 1439–1448.
26. Rogers RD, Wakeley, Bhagwagar. Effects of Beta-adrenoceptorBlocade on components of human decision-making. Psychopharmacology. 2004;172:157–164.
27. Lane SD, Oleg TV, Lori ML, Sylvain N, Don RC. Acute effects of alprazolam on risky decision making in humans. Psychopharmacology. 2005; 364-373.
28. Lane SD, Don RC, Cynthia JP, Oleg VT. Alcohol effects on human risk taking. Psychopharmacology. 2004; 68-77.
29. Blackwood DH, Muir WJ. Cognitive brain potentials and their application. British Journal of Psychitary Supplements. 1990; 96-101.
30. Luis F, Nicolas A, Jaime GG. Brain computer interfaces, A Review. Sensors.2012; 12(2): 1211-1279.
31. Martin AL. The statistical analysis of FMRI data. Statistical Science. 2008;23(4) 439-464.
32. Knutson, Brain, Adam C, Fong, Hommer D. Anticipation of Increasing Monetary Reward Selectively Recruits Nucleus Accumbens. Journal of Neuroscience. 2003; 1–5.
33. GuiXue, Chuansheng C, Zhong LL, Qi Dong. Brain imaging techniques and their application in decision-making research. 2010; 42(1):120-137.
34. Camelia MK, Joan YC. Genetic Determinants of financial risk taking.PlosOne.2009.
35. Peter B, Carsten M. From behavioural economics to neuroeconomics to decision neuroscience: the ascent of biology in research on human decision-making. Elsevier.2015.
36. Alan B. Working Memory. Current Biology.2010; 20(4): R136-R140.
37. Knutson B, Wimmer GE, Kuhnen CM, Winkielman P. Nucleus accumbens activation mediates the influence of reward cues on financial risk taking.Neuroreport.2008;19(5): 509-13.
38. Lucy BM, Dowling M. The role of feelings in investor decision-making. Journal of economic surveys.2005;19:211–37.
39. Kuhnen CM, Knutson. The Neural Basis of Financial Risk- Taking. 2005; 47:763–770.