# EMERGING TRENDS IN INNOVATIVE COMPUTING & INTELLIGENT SYSTEM
## (Book Chapter)

### Editor
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# Acknowledgement

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**Abstract -** The term Clear Aligner Therapy consists of a wide range of appliances and different models of action, methods of construction and applicability to various malocclusion treatments. All share the use of clear thermoformed plastic aligners that cover many of all the teeth, but from the common point, there are major and significant differences which affect the ability of any given system to treat a wide range of orthodontic problem. The developments of Artificial intelligence and computing systems have greatly changed the perspective of Clear aligner treatment. As Clear aligner therapy aims at predictive tooth movements and eventually fabrication of Aligner trays for correction of a particular malocclusion. Artificial intelligence is used in prediction and fabrication of a treatment plan with Clear aligner therapy. Clear aligner therapy consists of thermoplastic trays which are customized for tooth movements and eventually provided by the orthodontists to the patient. Diagnosis and treatment planning yet remain the most important part of the Clear aligner therapy. In the first stage of Clear aligner therapy intraoral scanning is done for the patient. Intraoral scanner accurately scans the hard and soft tissue structures and replicated them in the form of Digital models which can be accurately used for fabrication of treatment plan for Clear aligners. Digital models are obtained through intraoral scanning and a tentative treatment plan is provided by the software to the orthodontists. The software provides the information regarding the placement of attachments over the tooth surface to facilitate movements of teeth. Also, the software provides the information regarding the progress of the treatment plan and the final changes which can be obtained with the Clear Aligner Therapy. The Orthodontists can make changes in the treatment plan as per his/her opinion regarding the malocclusion. Hence with the help of this newer trends in computing and intelligent system with the help of artificial intelligence the orthodontists can look into the future and can provide accurate and stable results for the patients.

## 1 INTRODUCTION

The term Clear Aligner Therapy consists of a wide range of appliances and different models of action, methods of construction and applicability to various malocclusion treatments. All share the use of clear thermoformed plastic aligners that cover many of all the teeth[1], but from the common point, there are major and significant differences which affect the ability of any given system to treat a wide range of orthodontic problems.

Although thermoplastic sheets were manufactured as far back in 1896[2], plastic sheet forming, or thermoforming, was not well known before 1950[3]. The process shapes a plastic product by applying air pressure or vacuum to a heat softened sheet. On occasion, pressurized steam or hot oil has been used instead of air pressure. As pressure forming machines improved by combining heating and forming process on a single machine, the development of materials and technology advanced rapidly.

The development of Artificial intelligence and computing systems have greatly changed the perspective of Clear aligner treatment. As Clear aligner therapy aims at predictive tooth movements and eventually fabrication of Aligner trays for correction of a particular malocclusion. Artificial intelligence is used in prediction and fabrication of a treatment plan with Clear aligner therapy.

Artificial Intelligence[4,5] is subfield of computer science which encompasses both hardware and software that can perceive its environment and take actions that maximizes its chances of achieving goals successfully. Artificial Intelligence refers to stimulation of human intelligence in machines that are programmed to think like humans and mimic their actions such as problem solving and learning. The characteristics of artificial intelligence is the ability to understand and rationalize things and take actions that have the best chance of achieving specific goal.

Artificial Intelligence is generally used in fields where possible outcomes are limited, computational power is scarce or human intervention is essential. However, in healthcare fields Artificial intelligence may require a serious human intervention and input though making the outcome and procedure difficult yet possible.[6,7]

### 1.1 Clear Aligner Therapy

The Clear aligner therapy is unique in that the clinician must be able to plan the path to optimal results before treatment is initiated so that a series of aligners can be constructed to achieve treatment objectives. Clear plastic tooth moving appliances are excellent options for adults or responsible adolescents who might be reluctant to wear fixed appliances, who will follow the clinician's directions and whose chief complaint centres around mild to moderate alignment problems.

## 2 THE CLEAR ALIGNER THERAPY PROCESS

The Clear aligner therapy involves several steps[8]. The first step is the acquisition of complete patient records from the treating orthodontist. Once the records are received by the Aligner company, the records go through a series of steps from scanning to case setup and then back to the clinician for the review. The process of manipulating virtual tooth movements is completed when the clinician approves the review provided

by the Aligner company. Once the review is approved, the aligners are processed and sent to the clinician.

## 2.1 The Clear Aligner Process:
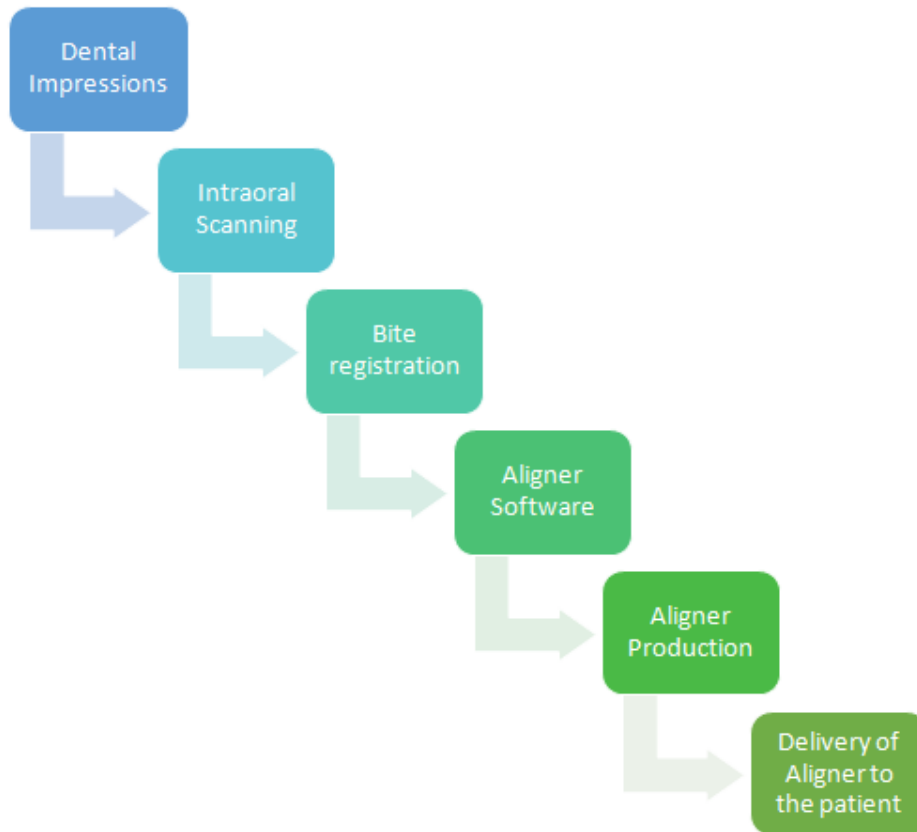


**Figure 1 Clear Aligner Process**

## 3 DENTAL IMPRESSIONS

Dental impressions for scanning are carried out with the help of Polyvinyl siloxane material[9,10]. Usually 2 step impression method is carried out for accurate impression.



**Figure 2 Dental Impression**

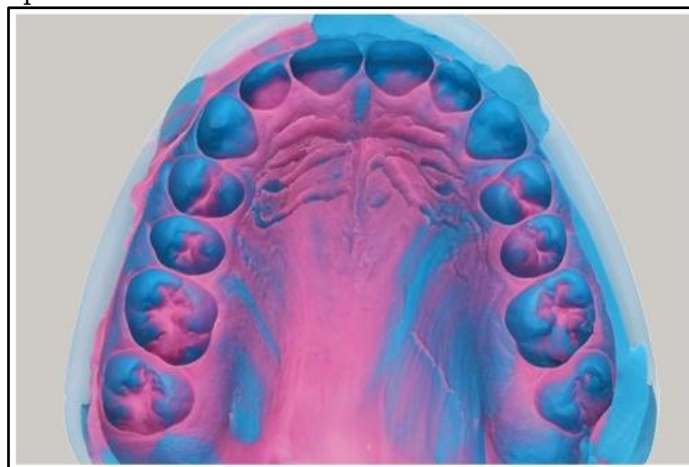**Scanning** is a method used to describe the process of converting a physical object into three-dimensional electronic data[11]. Scanning of the Impressions can be done through various methods such as:

1. Laser Scanning[12]
2. Destructive Scanning
3. White-light Scanning
4. Computerized Tomography
5. Rapid Manufacturing of molds- SLA (Stereo lithography apparatus)



**Figure 3 Intraoral scanned image created by the aligner software**

The most important aspect or the connection between the Clear Aligner therapy and the computing systems is the **Aligner software and the Aligner production** part. The software used accurately cuts a single tooth virtually enabling its tooth movement with the gingiva[13]. Thus, a software will modify the tooth positions and provide the Orthodontist with the accurate results regarding the progression of the treatment. Results can also be further modified as per the requirement by the Orthodontist.

The Clear aligner software can successfully achieve the following tasks:
- Model the hard and soft tissues of mouth.
- Plan a final, treated position for the teeth that takes into account proper occlusion.
- Plan and execute how the movement from the initial to final position will take place[14].
- Produce a virtual model that could be fabricated using rapid prototyping technology, to allow the forming of the individual aligners through conventional processes.

**Figure 4 Pretreatment Digital models created by the aligner software**

In final setup, the individual teeth are placed into a clinically and esthetically acceptable final position. A key requirement at this step is to provide methods to evaluate the final position of the teeth. Once the final position is defined, the path of each tooth will take from its initial position to its final position needs to be defined. These motions are planned during the staging process, which also includes projections of the rate of movement for each tooth as well as the time required. In the review step, the clinician is shown the virtual treatment model and is given the opportunity to comment and request any changes to the final position, tooth movements or both.
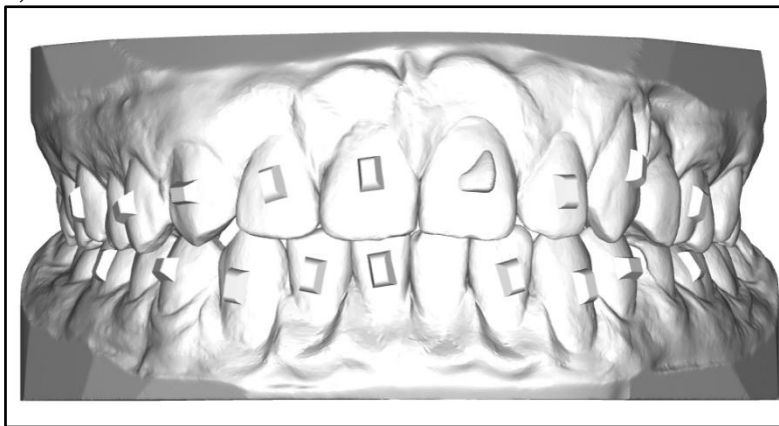


**Figure 5 Final teeth position predicted by the aligner software**

Once the Orthodontist approves the review then the three-dimensional computer images are converted to physical models using a process called rapid prototyping. These models are then used to fabricate Aligners on a Biostar pressure molding machine.

**Figure 6: Fabricated Clear Aligner**

Finally, the attachments are placed on the patient's teeth as suggested by the review check. The attachments are made of composite material which help is application of the pressure by the aligner over the teeth.



**Figure 7: Attachments placed over the tooth surface**

Finally, the Clear Aligners are delivered to the patient with the instructions for proper wearing and removal of the aligners and scheduled for the follow up visits.

**Figure 8: Clear Aligners worn by the patient**

## 4 CONCLUSION

The Clear Aligner Therapy aims at improving the field of Orthodontics to a newer height. Clear Aligner therapy works with the principles of Artificial intelligence that encompasses both hardware and software that can perceive its environment and take actions that maximizes its chances of achieving goals successfully. So newer trends and development in the field of computer science can help in advancement of the healthcare fields which can provide tremendous changes in the field which can be of used for the benefit of the entire mankind.

## REFERENCES

1. Mota Júnior SL, Hartmann GC, Vitral RF, Tanaka OM. Efficacy of incisor movement with clear aligners: What about interval changes for aligners? Am J Orthod Dentofacial Orthop. 2021 Oct; 160(4):489.
2. Tuncay OC. The Invisalign System. Quintessence Publishing Company; 2006. 320 p.
3. Butzko RL. Plastic Sheet Forming. 1958. 181 p.
4. Sabouret N. Understanding Artificial Intelligence. CRC Press; 2020. 160 p.
5. Russell S, Norvig P. Artificial Intelligence: A Modern Approach. Createspace Independent Publishing Platform; 2016. 626 p.
6. Balicer RD, Cohen-Stavi C. Advancing Healthcare Through Data-Driven Medicine and Artificial Intelligence [Internet]. Healthcare and Artificial Intelligence. 2020. p. 9–15.
7. Nordlinger B, Villani C, Rus D. Healthcare and Artificial Intelligence. Springer Nature; 2020. 279 p.
8. Society of Orthodontics, Chinese Stomatological Association. [Guidelines for clear aligner orthodontic treatment (2021)]. Zhonghua Kou Qiang Yi Xue Za Zhi. 2021 Oct 9;56(10):983–8.
9. Anusavice KJ, Shen C, Ralph Rawls H. Phillips' Science of Dental Materials - E-Book. Elsevier Health Sciences; 2014. 592 p.
10. Farah JW, Clark AE, Ainpour PR. Elastomeric impression materials. Oper Dent. 1981;6(1):15–9.
11. Jabri MA, Wu S, Pan Y, Wang L. An overview on the veracity of intraoral digital scanning system and utilization of iTero scanner for analyzing orthodontic study models both and. Niger J Clin Pract. 2021 Jan;24(1):1–7.
12. Kuroda T, Motohashi N, Tominaga R, Iwata K. Three-dimensional dental cast analyzing system using laser scanning. Am J Orthod Dentofacial Orthop. 1996 Oct;110(4):365–9.
13. Kesling HD. Coordinating the predetermined pattern and tooth positioner with conventional treatment. Am J Orthod Oral Surg. 1946 May; 32:285–93.
14. Faber RD, Burstone CJ, Solonche DJ. Computerized interactive orthodontic treatment planning. Am J Orthod. 1978 Jan; 73(1):36–46.

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# PROSPECT THEORY IN INVESTMENT DECISIONS

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**Abstract-** Recently, several publications have been published that address the role of prospect theory in investment decisions and its impact. Prospect Theory is one of the most vital ideas in finance, as it describes the majority of behavioral patterns. It describes how individual investors behave when confronted with probabilistic alternatives including some risk, even though the outcomes' probabilities are known.Investors should be aware of their biases, which show that losses have a bigger emotional impact over similar gains. The prospect theory attempts to understand how investors make decisions. Various applications of prospect theory have been discussed in this chapter to deeply understand the theory of prospects.
**Keywords:** Prospect Theory, Mental Accounting, RegretAversion, Loss Aversion, Investment Decisions.

## 1. INTRODUCTION

Savings means the money leftover over after a person's consumption expenditures have been removed from their expendable income over a period of time. Savings refers to a person's or households net surplus of funds after all expenses and obligations have been met.Savings alone are not sufficient at this time. Financial stability is ensured by investment, both now and in the future.

An investment is a payment made to earn a profit on the securities of other entities. Bonds, common stock, and preferred stock are among the examples. It may also entail the purchase of additional assets, such as a property that can generate rental income. In making investing judgments, prospect theory is crucial.

According to prospect theory, investors are risk-averse whenever it comes to profits and risk-seeking whenever it comes to losses. Even when the projected value of both is the same, investors place a higher value on the one that is certain. Investors also try to avoid losing money, even if it means taking on more risk.

"Investment decision-making is the practice of choosing an investment from a set of selections that are controlled by several aspects including past investment returns and expected future returns." (Kumar and Goyal, 2015; Kartini and Nahda, 2021)

"An investment decision is essentially a largely irreversible commitment of resources made in the expectation of securing generally uncertain future gains."(Briston and Liversidge, 1979)

## 2. TRADITIONAL FINANCE AND BEHAVIORAL FINANCE

Traditional finance posits that financial actors make rational decisions by forecasting market outcomes and business behavior. They make sensible decisions based on realistic economic expectations after considering all relevant data. Expected utility theory, modern portfolio theory, and the

efficient market hypothesis are examples of conventional finance theories that all discuss investor rationality. Traditional finance, on the other hand, cannot explain the financial crisis of 2008. It necessitates the development of a new field of research to investigate the impact of non-rational investor behavior.

According to Behavioral Finance, Investors are not rational always. These decisions may change according to the prevailing situation. Behavioral finance is a relatively new field of study/practice that believes that emotions impact investors' judgments in many ways and that as a result of those emotions, individuals make irrational decisions.

"The study of the impact of psychology on the behavior of investors and financial analysts is known as behavioral finance." (Statman, 2017)

## 3. PROSPECT THEORY

Prospect Theory is one of the most well-known behavioral finance theories. Prospect theory was introduced by (Kahneman and Tversky, 1979) as a viable alternative to anticipated utility theory. Prospect theory defines how persons make decisions in situations when they must choose between several risky investments.

According to prospect theory, anticipated gains and losses influence investors' decisions, but the outcome is unimportant. It's because personal judgments regarding the levels of benefits and losses generated as a result of the investment are tainted by cognitive biases. Prospect theory, in contrast to expected utility theory ("which models the decision that perfectly rational agents would make"), seeks to represent actual human behavior.

Another implication of prospect theory is that persons are more willing to take bigger risks to evade losses than to obtain profits. Extreme risk aversion in the area of zero is the most prominent element of prospect theory.

Overall, the prospect theory was originated by encircling dangerous actions as well as demonstrates that individuals dislike loss or calamities, therefore they are more willing to face challenges to avoid catastrophe.

There are three prospects under Prospect Theory i.e. Loss Aversion, Regret Aversion, and Mental Accounting.
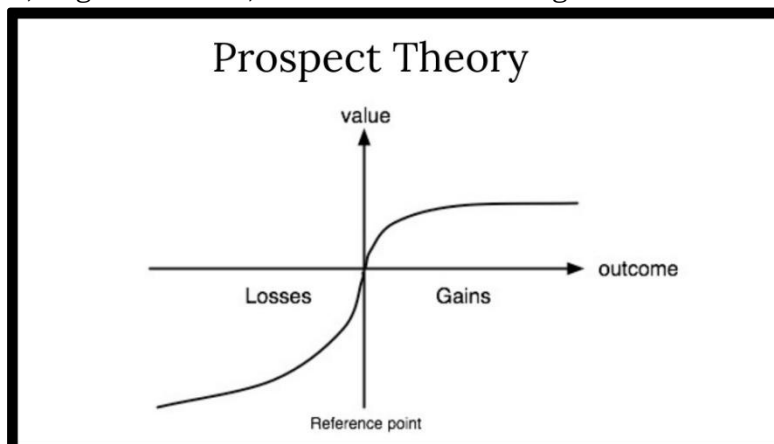
**3.1. Regret Aversion:** Regret is a feeling that people experience when they make a mistake. By denying selling diminishing shares and consenting to sell growing ones, investors avoid regret. Likewise, investors are more possibly to regret keeping dropping equities longer than selling winning ones too quickly(Lehenkari and Perttunen, 2004; Fogel and Berry, 2006).

**3.2. Loss Aversion:** The varied levels of psychological penalty individuals have from a same size loss or growth is referred to as loss aversion (Barberis and Huang, 2001). Persons are more disturbed by the potential of losses than they are delighted by similar benefits, according to studies (Barberis and Thaler, 2003). Furthermore, a loss following again appears to be less unpleasant than normal, whereas a loss following a loss appears to be more disturbing than normal (Barberis and Huang, 2001).

Furthermore, (Lehenkari and Perttunen, 2004) discover that positive, as well as negative returns earlier, might amplify the negative association amid the selling trend and investor capital losses, implying that investors are risk-averse. Risk aversion is a frequent investment habit; none the less, it can lead to bad decisions that negatively impact an investor's wealth (Odean, 1998).

**3.3. Mental Accounting:** "The process by which people think about and assess their financial transactions" is what mental accounting refers to (Barberis and Huang, 2001). Investors can divide their holdings into various accounts using mental accounting (Ritter, 2003; Barberis and Thaler, 2003). According to (Rockenbach, 2004), a connection amidunlike investment options is often not created, even though it is beneficial for arbitrage-free valuing.

## 4. PROSPECT THEORY APPLICATIONS

**1. Disposition Effect:** Investors are more possibly to sell equities that have flourished in value and keep stocks that have devalued in value since they purchased them. The explanation for this phenomenon is that if an investor sells a losing investment, the loss is expected to cause pain because it would be recorded. There will be no grief if it is sold because the loss will not be recorded.

In a 1985 research, Hersh Shefrin and Meir Statman uncovered and called the effect, finding that people loathe losing far more than they like winning. Because investors will hold equities that have lost value while selling stocks that have gained value, the disposition effect has been defined as one of the most powerful realities surrounding individual investors.

**2. The subjectivity of economic agents:** Different economic agents subjectively frame the results of an event in their minds, and this subjectivity influences the utility they expect or receive.

**3. Reflection Effect:** It refers to gambling in experimental economics and psychology. The rational preferences of the investors may differ according to prospect theory in an S shape of the value function, even though the outcomes are of the same size. The reflection effect is the reversal of risk aversion or risk-seeking in the situation of profits and losses.The reflection effect (Kahneman and Tversky, 1981) is defined as having opposing preferences for gambles with outcomes that differ in sign (i.e. whether the outcomes are gains or losses). Reflection effects entail

gambles with opposite-sign outcomes, even though they have the same magnitude.

**4. Equity Premium Puzzle:** It explains why equities have historically outperformed government bonds in terms of actual returns. The equity premium represents the relative risk of shares versus government bonds, which are seen as risk-free.

The equity premium puzzle refers to an imperative class of financial models' inability to describe the average equity risk premium supplied by a varied portfolio of US equities over US Treasury Bills, which has been observed for over a century.

**5. Pseudo-certainty effect:** Individuals have a predisposition to make risk-averse choices in conditions when the expected outcome is favorable and individuals have a tendency to make risky choices to avoid undesirable outcomes. The certainty effect reflects people's tendency to choose an option that eliminates risk rather than one that reduces it.

This inclination refers to people's tendency to perceive the outcomes of an occurrence as certain, even if they are unpredictable because they relate to the future. This can be seen in portfolio management as well. When portfolio returns are expected to be favorable, investors want to minimize their risk exposure. Alternatively, if they anticipate losses, they engage in risk-taking behavior. This type of behavior is opposed to the behavior of rational investors, as has long been assumed.

**6. Status Quo Bias:** The status quo bias is named after investors' proclivity to preserve the status quo. Simply put, if an investor is presented with several options, many of which are complex and difficult, they are more likely to choose the option that extends their current arrangement.

Several studies show that many people tend to stick to the status quo as a reference point. Loss aversion and the Endowment Effect are the justifications for the status quo. In layman's terms, status quo bias suggests that people prefer not to change at all.

**7. Reference base utility:** The prospect theory claims that utility is reference-based, which is in opposition to the additive utility function, which is commonly used in psychological studies of human satisfaction.

**8. Endowment-based utility:** This implies that people give things more importance because they own them, and hence give them a higher worth. Individuals are more likely to pay more to keep something they already own than to purchase something they don't.

**9. Relevance of Prospect Theory:** Some people would rather not deposit their money in a bank, and others would rather not work overtime. They are doing so because they do not want to pay higher taxes. Prospect Theory also explains the disposition effect, which occurs when investors tend to hang on to losing securities while selling winning ones.

Overall, we can say that prospect theory has ushered in a new era of inquiry. Only since the development of this theory has behavior been recognized as a major issue in financial and economic study. Prospect theory is not an exaggeration when it is said that behavioral finance is the result of it.

## 5. CONCLUSION
Prospect Theory is one of the most vital ideas in finance, as it describes the majority of behavioral patterns. It describes how individual investors

behave when confronted with probabilistic alternatives including some risk, even though the outcomes' probabilities are known. Prospect theory has a wide range of applications since it plays such an important part in investment decisions. The factors of risk are dealt with in prospect theory, and risk is a crucial consideration to consider while making investing decisions. Prospect theory's aspects make it a significant consideration in investment decisions. Various earlier studies check the impact of prospect theory on investment decisions and found a significant impact on investors' decisions.

## REFERENCE

1. Barberis, N. and Huang, M., 2001. Mental Accounting, Loss Aversion, and Individual Stock Returns. The Journal of Finance, [online] 56(4), pp.1247–1292. Available at: <http://doi.wiley.com/10.1111/0022-1082.00367>.
2. Barberis, N. and Thaler, R., 2003. A survey of behavioral finance. In: G.M. Constantinides, M. Harris and R.M. Stulz, eds. Handbook of the Economics of Finance, 1st ed. [online] Elsevier.pp.1053–1128. Available at: <https://econpapers.repec.org/RePEc:eee:finchp:2-18>.
3. Briston, R.J. and Liversidge, J., 1979. The Investment Decision Process. In: A Practical Approach to Business Investment Decisions. [online] London: Palgrave Macmillan UK.pp.1–23. Available at: <http://link.springer.com/10.1007/978-1-349-02136-9_1>.
4. Fogel, S.O. and Berry, T., 2006. The Disposition Effect and Individual Investor Decisions: The Roles of Regret and Counterfactual Alternatives. Journal of Behavioral Finance, [online] 7(2), pp.107–116. Available at: <http://www.tandfonline.com/doi/abs/10.1207/s15427579jpfm0702_5>.
5. Kahneman, D. and Tversky, A., 1979. Prospect theory: An analysis of decision under risk. Econometrica, 47, 263-291. Econometrica, 47(2), pp.263–292.
6. Kartini, K. and Nahda, K., 2021. Behavioral Biases on Investment Decision: A Case Study in Indonesia. Journal of Asian Finance, Economics, and Business, [online] 8(3), pp.1231–1240. Available at: <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85102318768&doi=10.13106%2Fjafeb.2021.vol8.no3.1231&partnerID=40&md5=9fc580e97b21b29733a0d865e2a667f9>.
7. Kumar, S. and Goyal, N., 2015. Behavioral biases in investment decision making – a systematic literature review. Qualitative Research in Financial Markets, [online] 7(1), pp.88–108. Available at: <https://www.scopus.com/inward/record.uri?eid=2-s2.0-84996490810&doi=10.1108%2FQRFM-07-2014-0022&partnerID=40&md5=19bf6b049c2d3595eb4e3878f3c96718>.
8. Lehenkari, M. and Perttunen, J., 2004. Holding on to the Losers: Finnish Evidence. Journal of Behavioral Finance, [online] 5(2), pp.116–126. Available at: <http://www.tandfonline.com/doi/abs/10.1207/s15427579jpfm0502_5>.
9. Odean, T., 1998. Volume, Volatility, Price, and Profit When All Traders Are Above Average. The Journal of Finance, [online] 53(6), pp.1887–1934. Available at: <http://doi.wiley.com/10.1111/0022-1082.00078>.
10. Ritter, J.R., 2003. Behavioral finance. Pacific-Basin Finance Journal, [online] 11(4), pp.429–437. Available at: <http://www.sciencedirect.com/science/article/pii/S0927538X03000489>.
11. Rockenbach, B., 2004. The behavioral relevance of mental accounting for the pricing of financial options. Journal of Economic Behavior & Organization, [online] 53(4), pp.513–527. Available at: <https://linkinghub.elsevier.com/retrieve/pii/S0167268103000970>.
12. Statman, M., 2017. Finance for Normal People: How Investors and Markets Behave. Oxford University Press.

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