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Thesis Niklas Strieder

Neuromarketing: Human Behaviour & Decision Making in consumer based Neuroscientific Research

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Abstract

“A good rule of thumb is to assume that everything matters”

- Richard H. Thaler, Nobel Laureate 2017

Neuromarketing is a field within Marketing and influenced by many other research areas that all focus on consumer decision making. This process can be analysed on different levels, either from a biological view to a neurological perspective, or a behavioural and psychological angle. This thesis aims at presenting decision making in consumer based research in the spirit of Richard Thaler, by including viewpoints from many academic fields to show the interconnectedness and interdependent influences. However, commercial application and the public image are another influence towards the steady development and evolution of Neuromarketing.

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Abbreviations

AAU	Aalborg University
CalTech	California Institute of Technology
CBS	Copenhagen Business School
CEO	Chief Executive Officer
EEG	Electroencephalography
fMRI	Functional magnetic resonance imaging
INSEAD	Institut Européen d'Administration des Affaires
MIT	Massachusetts Institute of Technology
NSMBA	Neuromarketing Science and Business Association
PhD	Doctor of Philosophy
SaaS	Software as a Service
UK	United Kingdom
US	United States
USD	United States Dollar
VR	Virtual Reality

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1. Introduction

Since its beginning, Marketing has always been about people's needs, and how to identify and address them most successfully. Over time, there have been many categories discovered, added to and evolved from Marketing. One of the most controversial sections within Marketing in the last years is Neuromarketing (Lee, N., Broderick, & Chamberlain, 2007) (Berns & Ariely, 2010) (Lindstrøm, 2010). The increasing presence of Neuromarketing in academic and commercial environments started due to a dissatisfaction with traditional marketing techniques and their lack of a holistic consumer understanding, beyond the conscious consumer mind (Rothensee & Reiter, 2019). Nobel Laureate Francis Crick defines the field of Neuromarketing in a Harvard Business Review publication as follows: *"Neuromarketing - Sometimes known as consumer neuroscience—studies the brain to predict and potentially even manipulate consumer behaviour and decision making."* (Harrell, 2019) p.3). Most researchers differentiate between consumer neuroscience and Neuromarketing, as the former focuses on academic research and an in depth understanding of the brain and its activated areas, whereas the latter tries to take the conclusions from the studies to apply them to practise and use them for business related matters (Plassmann, Ramsøy, & Milosavljevic, 2012). A more thorough definition and analysis on consumer neuroscience will be given in a later chapter. Rothensee and Reiter (2019) define Neuromarketing as a subdivision in marketing research which studies consumer behaviour by applying methods from neurosciences (Rothensee & Reiter, 2019). Lange (2014) argues that Neuromarketing lies at the intersection between neuroscience and neuroeconomics, with a broad interdisciplinary background from neurology, physics, economy, radiology and psychology (Lange, 2014). Other researchers such as Scheier (2012) see the roots of Neuromarketing in neuropsychology, psychophysiology, artificial intelligence, cultural studies, and developmental psychology (Scheier & Held, 2012). However, almost all researchers agree that Neuromarketing emerged from many different fields and it is not a fully developed area yet, but still in motion with new developments and influences from many directions (Zurawicki, 2010).

In general, it can be said that Neuromarketing is the commercial use of neuroscientific tools such as fMRI's, EGG, and Eye-Tracking to achieve more

reliable consumer insights. It is supposed to show what consumers really feel, even if they are not aware of it. Neuromarketing identifies consumer reactions towards brands, slogans, and advertisements by applying medical technology (Phan, 2010).
In an often cited experiment by McClure et at, conducted in 2004, participants drank both Pepsi Cola and Coca-Cola in a blind testing. Most people preferred Pepsi over Coca-Cola. When the participants could decide on a brand, most of them chose Coca-Cola. The surprising fact is, that via brain scans, recorded with an MRI, researchers could see that the brain triggered a much higher emotional response towards Coca-Cola. This means that the brain made the participants think they prefer Coca-Cola over Pepsi, because of all the attached emotions to the brand, although their body reacted in favour of Pepsi-Cola (McClure et al., 2004) (Lee et al., 2007) (Phan, 2010).

Neuromarketing techniques are used by some of the largest companies in the world like Google, Facebook, IKEA, twitter, Tik Tok and Visa (Neurons,). Due to sensitive commercial information and limited public access to the research done for these companies, the actual techniques and fields of application are restricted and often not openly available (Lee et al., 2007).
The student elaborates on this limitation, as well as other boundaries like the high costs and limited availability of research devices further in the paper. Nevertheless, some basic information is publicly available, mostly due to Neuromarketing agencies that have specialised on the field of combining academic research with practical application for their customers and that share some insights as Marketing content on their websites and blogs. Neurons, among others, is one example of an applied neuroscience company, founded by Copenhagen Business School (CBS) professor Thomas Ramsøy and located with its headquarter in Taastrup, Denmark (Neurons,). The analysis chapter presents a selection of Neuromarketing companies, for a better overview of the different solutions offered on the market.

Another influence for Neuromarketing and a field that studies decision making to understand the how and why behind it is Behavioural Economics. Researchers from that field argue that the context a consumer is in, especially situational factors and emotions, influence the decision-making a lot (Grapentine & Weaver, 2009). Many scholars, Tversky and Nobel Prize winner Kahneman (1974) at the forefront, have

researched in which way humans simplify the decision process (Tversky & Kahneman, 1974). Kahneman and Tversky (2011) argue that the mind is divided into *System 1*, which is in charge of intuitive and fast thinking and *System 2*, responsible for more analytic and slow thinking (Kahneman, 2011). The brain is designed by evolution to use less resources whenever possible and to prefer a quick solution over an energy intensive decision making process. Simon (1990) was the first one that coined the *"methods for arriving at satisfactory solutions with modest amounts of computation"* as "Heuristics" (Simon, 1990), p.11). Heuristics are mental shortcuts, used for a fast and intuitive decision making (Shah & Oppenheimer, 2008). A common example for a heuristic, especially one that most often leads to a false conclusion, is the following: Are there more words that begin with the letter K or more words that have the K as their third letter in the English language? Tversky and Kahneman (1974) show that the vast majority says that there are more words that begin with the letter K, because the mind comes up with more examples for the first case (Tversky & Kahneman, 1974).

To sum up the presented information and bring the different fields of research into a suitable context for this thesis, it can be said that Neuroscience is the discipline of studying how different brain areas interact and how mental processes occur (Plassmann et al., 2012). Behavioural Economics studies the psychological decision making process (Grapentine & Weaver, 2009). Neuromarketing, thus combines the research of many different fields, by making use of neuroscientific tools and Behavioural Economic decision making methods and studies, to determine ways how to predict and influence consumer choices (Kenning, Plassmann, & Ahlert, 2007; Plassmann et al., 2012) (Grapentine & Weaver, 2009) (Renvoisé & Morin, 2007). The objective of this thesis is to present the reader to the studies of Neuromarketing, explain what it is and show its application in consumer decision processes, embedded in a neuroscientific and behavioural context.

1.1 Research statement

This thesis aims to present Neuromarketing in a holistic way, acknowledging its influences from other academic fields, its perception in the public and media, and its application for commercial results in business. As a prerequisite for this thesis, the

fields of Neuromarketing, Neuroscience, Neuroeconomics and Behavioural Economics are introduced, as well as the terms are defined and similarities and differences are pointed out. The research formulation of this thesis is:

Neuromarketing: Human Behaviour & Decision Making in consumer based Neuroscientific Research

To support the research statement and to further detect and clarify possible problems, the following research questions are specified:

1. *What theoretical and practical methods exist in the field of Neuromarketing and how do they work in terms of consumer decision making?*

As Neuromarketing analyses the consumer brain with different neuroscientifical tools, a presentation of the most accepted and used techniques is important for a better understanding. The presented approaches are further analysed for their practicability and how they can help analysing consumer decision making.

2. *What are the requirements to conduct a proper academic and scientific Neuromarketing research that is also applicable to a commercial scenario?*

This question relates to the concerns of some researchers that the term Neuromarketing is experiencing a certain hype resulting in an increased offer of sometimes defective, fraudulent or just unprofessional application of neuroscience techniques or as such disguised techniques (Lee et al., 2007) (Murphy, Illes, & Reiner, 2008). Since Neuromarketing is still a young field of study and at the same time a very complex topic, there are some misconceptions as for example an ultimate buying stimulus in the human brain that serve as arguments for an academic approach (Rothensee & Reiter, 2019) (WILSON, R. M., GAINES, & HILL, 2008).
The third research question aims for a better understanding of industry standards and rules in terms of a responsible use of Neuromarketing.

3. *What are the legal and ethical implication of Neuromarketing and what are, or should be, the regulations for practitioners?*

Many researchers have raised concerns not only about the academic application of Neuromarketing but also about the morality of studying and applying these techniques in a commercial setting that can be aimed at selling most profitably (Pop, Maria, Radomir, & Ioana, 2009). Hence, the third research question takes these concerns into account and presents existing literature about ethics in Neuromarketing displayed from different perspectives. The next question is raised to understand factors which can guide a consumer decision and that can be analysed with Neuromarketing techniques.

4. *How is human consumer decision making influenced and affected by biases?*

This last question is based on Kahneman's and Tversky's (2011) studies in Economics and their research towards heuristics, that the human brain makes use of (Kahneman, 2011) (Tversky & Kahneman, 1974). Although the roots lie in a Behavioural Economics, Neuromarketing can use some of these heuristics and cognitive biases to influence a consumer decision (Plassmann et al., 2012) (Ramsøy, Thomas Z., Friis-Olivarius, Jacobsen, Jensen, & Skov, 2012).

1.2 Project Outline

The present report is divided into six chapters that build upon each other to give the reader a holistic understanding of Neuromarketing and its influence on consumer decision making.

The first and current chapter serves as an introduction towards the topic, declares the research statement and specifies it further with four research questions that should be answered during the thesis.

In the second chapter, namely theoretical background, the student introduces the reader to the studies of Neuroscience, Neuroeconomics, Behavioural Economics and Neuromarketing. The brain is subdivided into two parts, the conscious part of the brain, and the unconscious part. This classification will be further explained with the

help of scholars from different academic fields and their definitions for the functions, effects and influences of each part of the brain. As part of Behavioural Economics, Niklas describes System 1 and System 2, two classifications of mental thought processes by Kahneman (2011) before elaborating on heuristics and cognitive biases (Kahneman, 2011). After the following subchapter about Neuromarketing, the student presents Neuromarketing techniques, more precisely, functional magnetic resonance imaging (fMRI), Electroencephalography (EEG), and Eye-Tracking. The last part of the theoretical background chapter introduces a consumer decision-making framework based on the work of scholars from all aforementioned fields (Plassmann et al., 2012).

The third chapter deals with Methodology and Niklas' point of view towards his own role in academic context. It includes the Philosophy of Science, i.e. questioning what science means, how science works and how it creates knowledge through a plausible and organised process (Cunningham, 1980). Further parts of this chapter include Ontology, Epistemology and the applied methods.

The fourth chapter analyses the current state of knowledge in Neuromarketing research. It serves as a literature review and a comparison between research and practitioners. Niklas approached two neuroscientific researchers to gather direct insights. The written statements of Antonio Rangel, Bing professor of Neuroscience, Behavioral Biology and Economics at the California Institute of Technology (CalTech) are presented, analysed and interpreted (Appendix C). The second researcher is Martin Skov, a neuroscientist at the Danish Research Centre for Magnetic Resonance at Copenhagen University Hospital Hvidovre and professor at CBS, who was interviewed by Niklas (Appendix B). Behavioural Economics and mental shortcuts during the decision making are also explained in a Neuroscientific context.

The data gathering process is further explained in the methodology chapter while the analysis part focuses on the examination, findings and interpretations both from literature and praxis. It also takes a closer look at the different definitions of Neuromarketing services and investigates their academic and professional application in a commercial context. The consumer decision making is further investigated, measured by means of academic sources and compared against the view from Antonio Rangel and Martin Skov. The thesis explores consumer decision making and how it can be subject to wrong conclusions or manipulation by others.

The following subchapter deals with the neuronal detection of consumer choices, more precisely via Neuromarketing techniques like EEG and Eye-Tracking. In addition, the student presents a subchapter about heuristics and mental shortcuts influencing consumer decisions before evaluating research and other scholars' opinions about legal restrictions and ethical implication.
Chapter five gives space for a discussion about the topic and the different viewpoints towards Neuromarketing and consumer decisions. What does the student personally think about Neuromarketing and its commercial application? The thesis closes with a conclusion and a final statement.

2. Theoretical Background

The theoretical background elaborates on the formerly introduced fields by presenting different definitions and viewpoints from researchers and their studies of the subjects, to define a common academic ground for this thesis.

2.1 (Consumer) Neuroscience

For most of the time, Marketing researchers were not able to study consumers and especially their emotional reactions in a decision making process on a neuronal level, due to the unavailability of such measures and in its beginning the exorbitant costs of the machines which were primarily manufactured for medical purposes (Berns & Ariely, 2010). Many researchers argue that the first major research that connected neuroscience with consumer preferences was McClure's et al (2004) Coca Cola/ Pepsi Cola study. It answered the question *"What are the underlying brain processes of how brand information alters brand evaluations during consumption?"* by analysing the subjects' brains in an fMRI machine during blind tasting and known tasting of Coke and Pepsi (Lee et al., 2007; McClure et al., 2004; Smidts et al., 2014).

Neuroscience in general is known as the study of the nervous system with the goal of understanding the biological foundation of behaviour. It encompasses everything from cellular neuroscience, i.e. the study of single cells, to systems neuroscience, which is the investigation of how different areas of the brain interact with each other (Plassmann et al., 2012). Due to the studies of McClure et al (2004) and following researchers like Hsu et al (2005), the academic field of Consumer Neuroscience was established (McClure et al., 2004) (Hsu, Bhatt, Adolphs, Tranel, & Camerer, 2005).

Consumer Neuroscience offers insights of the brain as well as tools for studying the neural events that occur during decision making (Rangel, Camerer, & Montague, 2008). The discipline employs neuroscientific findings and methods to better understand the fundamentals of consumer behaviour as they apply to marketing (Kenning et al., 2007). Plassmann et al (2012) go on to argue that developing a neuroscientifically sound theory to understand consumer behaviour requires combining methods and theories from neuroscience with behavioural theories,

models, and tested experimental designs from consumer psychology and related areas like behavioural decision sciences (Plassmann et al., 2012).

It is important to emphasise the academic focus and not the commercial exploitation as the driver for neuroscientific studies. Neuroscience provides enhanced theory building and empirical validation, especially when the context such as hunger, stress and social influence on the consumer, its choice and its preferences are taken into account. It can help to predict consumer behaviour better by understanding the decision-making process on a neuronal level. Yoon et al (2012) point out that understanding the underlying mechanisms that lead to an observed choice, allow researchers to "*(a) generalize this knowledge, (b) understand contextual influences that may interact with the different neural circuitry leading to different choices, and (c) create interventions or influence those decisions more effectively*" (Yoon et al., 2012) p.475).

In other words, by taking the consumer context into account and observing the neuronal responses, it is possible to create decision making models. Such a consumer decision framework is introduced at the end of the theoretical background chapter.

The following subsections divide the brain in three areas with different functions, regarding its neuroscientific classification: Cerebrum (1), Cerebellum (2) and Diencephalon and Brainstem (3). There are many possibilities to categorise and dissect the brain. The following division has been chosen for a better overview.

2.1.1 The Cerebrum

First of all, it should be mentioned that there is no absolute medical cut between the three presented parts of the brain. For a long time, there was a widely popular theory, that the brain evolved in different stages and could be clustered into the oldest part, i.e. the "Reptilian brain", with a later expansion of the "Mammalian brain", and the "Homo Sapiens brain" each on top of the previous. This has been scientifically disproven, or to say it in the words of Cesario et al (2020) *"Your brain is not an onion with a tiny reptile inside"* (Cesario, Johnson, & Eisthen, 2020), p. 255).

The so-called *Triune brain*, invented in the 60's, proposed three independent areas of the brain that each respond to different mental activities: The reptilian brain should only be activated in fight-or-flight and other primal actions, the mammalian brain in emotional situations, and the homo sapiens brain for rational decisions (Macklin,

1978; MacLean, 1964). Although the clinical separation into three brains and most importantly the evolutionary “stack up” have been discredited, the rough segmentation into three parts that control, in cooperation with the other parts, the human decision-making process finds continuous support by many popular-scientific Neuromarketing authors such as Patrick Renvoisé & Christophe Morin (2007) or Martin Lindstøm (2010) (Renvoisé & Morin, 2007) (Lindstrøm, 2010) (Butler, 2009).

The human brain is made up of two sections that are joined by corpus callosum. Hemispheres is the medical term for the two sections. In addition, the brain is divided by medicine into four major sections (Ackerman, 1992). These are the following:

- Cerebrum
- Cerebellum
- Diencephalon
- Brainstem

Around 80-85% of the human brain consists of the cerebrum, as shown in figure 1 (Abhang, Gawali, & Mehrotra, 2016).

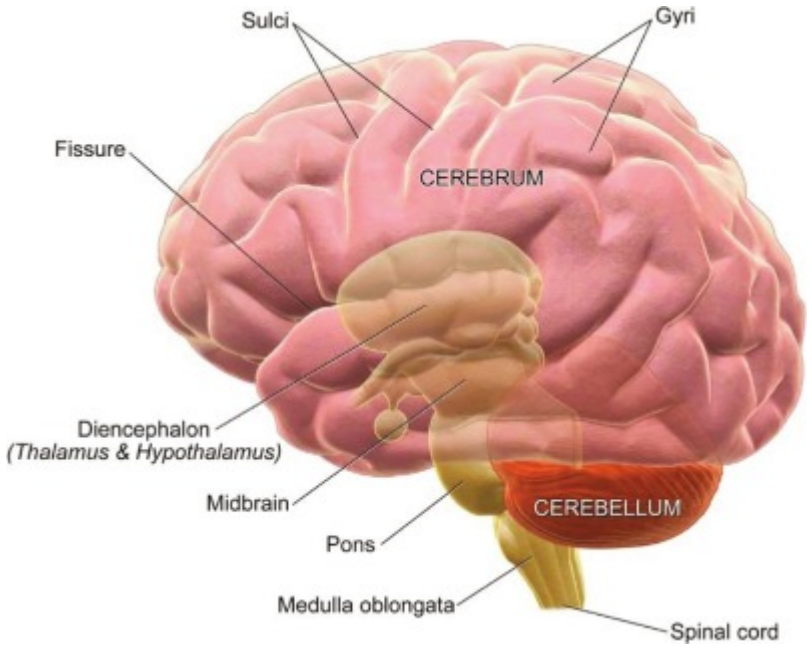

Figure 1: The parts of the brain Source: (Moini, Koenitzer, & LoGalbo, 2021)

It is therefore the largest part of the brain and controls memory, senses, speech and emotional responses. It can be further clustered into four lobes, as seen in Figure 2, that each are responsible for a certain task.

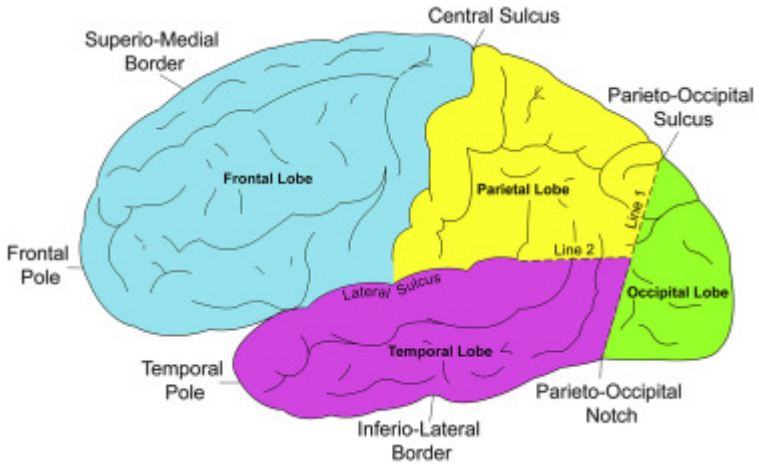

Figure 2: The four parts of the Cerebrum Source: Prabhakar (2017)

The frontal lobe is the centre for emotional and cognitive processes. Voluntary motor controls, mood, motivation, decision-making and planning, emotional control, speech and the judgement of appropriate behaviour are all controlled by that area (Moini et al., 2021). More specifically the frontal lobe sits in the front of the brain and stretches back to a fissure called the central sulcus. It includes the motor cortex, which is responsible for movement planning and coordination; the prefrontal cortex that is in charge of more demanding cognitive performance; and Broca's area, necessary for linguistic knowledge (Prabhakar, 2017; Spielman et al., 2014). A lot of neuroscientific studies take a closer look onto the prefrontal cortex, as it has shown that this area activates in many situations for prediction of value, evaluation of price, decision utility and self-reflection (Berns & Ariely, 2010; Plassmann, O'Doherty, & Rangel, 2007; Plassmann et al., 2012). As a small digression, the cerebral cortex covers the cerebral hemispheres and makes up to 40% of the total mass of the brain, whereas the neocortex accounts for 90% of the former (Moini, Avgeropoulos, & Samsam, 2021).

A famous example out of history that also answers the question of what happens when the frontal lobe, including the prefrontal cortex is damaged, was Phineas Gage in 1848. He was working on the railroads in the US, when by an accident, an iron rod penetrated his skull and severely damaged his prefrontal cortex. Although Gage

survived by wonder, his personality changed completely, as he was described by friends and family like a social, well-educated and nice man before the accident, and irrational, impulsive and generally antisocial after the incident (Plassmann et al., 2012; Spielman et al., 2014). Later autopsies confirmed that the damage to his prefrontal cortex caused a malfunction in rational decision making and emotion processing (Damasio, Grabowski, Frank, Galaburda, & Damasio, 1994).

Two other of the four lobes, parietal lobe and occipital lobe, are mainly responsible for visual processing and host the main visual centre of the brain (Moini et al., 2021). The final lobe is called temporal lobe and is mostly responsible for learning and memory consolidation (Moini et al., 2021).
As a short summary, the cerebrum is the biggest part of the brain that hosts four lobes of which the frontal lobe, especially the prefrontal cortex receive the most attention for neuroscientific studies (Yoon et al., 2012). It is labelled as the more rational and conscious part of the brain (Plassmann et al., 2012).

2.1.2 The Cerebellum

The cerebellum accounts for around 10% of the brain's mass and sits under the cerebrum, below the temporal and occipital lobes, as previously seen in figure 1 (Abhang et al., 2016). It is responsible for skilled repetitive movements, posture and balance of the body. Injuries of the cerebellum can cause a loss of coordination and problems in moving the extremities (Ghez & Krakauer, 2000). The cerebellum also acts as a rerouter of impulses for movement from areas inside the cerebrum to the spinal cord (Ackerman, 1992). Although possible, dividing and explaining the cerebellum further is not necessary for the outcome of this thesis and does not limit the understanding of the brain and its presented functions.

2.1.3 The Diencephalon and Brainstem

The diencephalon is located inside the cerebrum above the brainstem. It is not part of the cerebrum but surrounded by it, as figure 1 shows. The tasks of the diencephalon include sensory functions, monitoring of food intake and the body's sleep cycle. It is further divided into the sections of the thalamus, hypothalamus, and epitheliums (Abhang et al., 2016). These areas are all important for perception, movement and the body's vital functions. The thalamus with its 4x1,5cm, accounting

for up to 80% of the diencephalon, sorts information from the four senses; sight, hearing, taste, and touch and sends them further to the cerebral cortex. It is also responsible for sensations, such as pain, temperature and pressure, as well as the categorization of pleasant or unpleasant experiences (Ackerman, 1992; Moini et al., 2021; Prabhakar, 2017).
Although the hypothalamus is very small in size (like a pearl), it regulates the endocrine system, i.e. the hormone system in the human body. A damaged hypothalamus can cause uncontrolled eating, obesity and uncontrolled increases in body temperature (Moini et al., 2021). The hypothalamus is also part of the limbic system, explained below, and translates the six fundamental emotions into physical responses, further explained below. When a strong feeling whether triggered by an external stimuli or by the mind occurs, the cerebral cortex sends impulses to the hypothalamus that converts them into a physical reaction by the relief of hormones. Examples for this are a racing heartbeat, gasping, or a “gut feeling” that some people describe (Ackerman, 1992).

At this point it is important to define *emotions* for a better understanding of this thesis. Emotions can be either of behavioural, automatic, or hormonal nature. There are further six fundamental emotions: Happiness, sadness, anger, disgust, fear and surprise (Abhang et al., 2016). Emotions are usually described as an individual’s immediate behavioural reaction to a cue or a stimuli that can be either negative or positive. Ramsøy & Skov (2010) argue that positive emotions stem from reward and approach behaviours and can be traced back on a neuroscientific level from the ventral tegmentum in the midbrain (part of the brainstem) to the frontal lobe. Negative emotions, linked to distaste and avoidance behaviours, can be mainly controlled by the amygdala (Ramsøy, Thomas Z. & Skov, 2010).

The aforementioned limbic system is a complex neural network that includes among others the hypothalamus and the amygdala. The limbic system also influences emotions, memory, and motivation (Moini et al., 2021). It is one of the oldest parts of the brain. Ackerman (1992) describes the limbic system as a collection of interconnected structures that form a *“loose circuit”* throughout the brain and react to “stimuli that can affect the emotional brain”. (Ackerman, 1992), p.21). She continues to link the thalamus, hypothalamus and amygdala to the limbic system that are part

of the diencephalon and brainstem. Lindstrøm (2010) states that the amygdala, located in the middle of the brain, deep inside the temporal lobe and lining the brainstem, is named after the Greek word for almond, based on its size (Abhang et al., 2016; Lindstrøm, 2010). It controls negative emotions as fear and based on that also determines which memories are stored in the brain (Bailey, 2018). Several researchers conducted experiments and studies that highlight the amygdala as an important player in aversion and avoidance behaviours.
The limbic system, with the amygdala at its forefront, is responsible for an automatic emotional response and sends this information to other areas such as the neo frontal cortex, to support a more cognitive decision making. The amygdala also creates pavlovian responses over time, i.e. conditioning of the human brain to certain stimuli that have been experienced before (Ramsøy & Skov, 2010; Rangel et al., 2008). LeDoux (2004) adds that the Amygdala "*has a greater influence on the cortex than the cortex has on the amygdala, allowing emotional arousal to dominate and control thinking" (LeDoux, 2004; Renvoisé & Morin, 2007)*, p.8).

In conclusion, it can be said that the presented areas of the brain are mainly responsible for what sensorial information will be forwarded to the other parts of the brain and what decisions will be intuitively made. The process happens unconsciously (Plassmann et al., 2012). This part of the brain, including amygdala and basal ganglia, plays an important role not only in consumer behaviour but also in the formation of consumer choices and is therefore further analysed in chapter 4.2 Intention and Effect of Neuromarketing in Practice.
A different field of studies that is also taking neuroscience and human behaviour into account is Neuroeconomics.

2.2 Neuroeconomics

Some argue that Neuroeconomics takes the macro view from economics and the micro view from neuroscience, to combine it to an own research (Braeutigam, 2005). What can definitely be confirmed is the interdisciplinary field of Neuroeconomics, which not only influences other schools of thought but is also influenced by them like Psychology and Behavioural Economics. Lee et al (2007) describe Neuroeconomics

as the analysis and understanding of economic behaviour by applying neuroscientific tools (Lee et al., 2007).

Neuroeconomics analyses value-based decision making on the basis of neurobiological studies. It investigates human behaviour in the decision making process by taking a closer look at the brain on a neuronal level and researching the computations of the brain towards a decision (Rangel et al., 2008). Most neuroeconomic models make the assumption that value-based decision making includes both cognitive and emotional elements. Neuroeconomics holds that the predicted values (also called the predicted utility) of available options influence decision making (Ramsøy & Skov, 2010). Lindstrøm (2010) describes Neuroeconomics as *"the study of the way the brain makes financial decisions"* (Lindstrøm, 2010), p.13).

The goal of neuroeconomics is to comprehend the neural systems that support and influence economically relevant behaviour in the real-world. It further tries to examine how the neural system as a whole engages and how it might use scarce resources like metabolic energy, attention, or other processing capacities (Braeutigam, 2005). Some neuroeconomic studies research how decisions are influenced by the judgement of the situation, the preference for specific information, and conditioning based on previous experiences and behaviour (Ramsøy & Skov, 2010). Other studies try to comprehend how the human brain examines objectives during decision making, as well as how other cognitive, emotional, and visceral processes influence the processing of economic value.

2.3 Behavioural Economics

Economists like John Stuart Mill in the 19th century used to believe in the idea of a homo economicus, i.e. a complete rational and analytical individual, always looking to maximise its value and outcome. This has been disproven by many researchers and countless studies. It has been shown that humans very often act irrational, emotional, impulsive and without complete information (Reed, Niileksela, & Kaplan, 2017). Therefore, some researchers even suggest the term "Homer economicus", instead of homo economicus, to draw the comparison of Homer Simpson to human behaviour and decision making (Thaler & Sunstein, 2008). Because humans and

their choices, as well as the process of choices are not explainable with the homo economicus model and traditional economic theories, scientists started to search for more plausible models, taking psychology and behaviour into account (Angner & Loewenstein, 2007). Behavioural Economics is the approach to understand decision making and behaviour, from both an economic and a psychological standpoint (Camerer, Loewenstein, & Rabin, 2011). Researchers thereby consider irrational behaviour in decision making (Reed et al., 2017).

Behavioural Economics, same as Neuroeconomics, has a choice-centred approach. This means that Neuroeconomics uses neuroscientific tools and Behavioural Economics psychological tools, to better understand the decision making. This is at the core of all studies (Bossaerts & Murawski, 2015).

The studies of Behavioural Economics focus most often on heuristics, biases, cognitive mistakes, decision tendencies and rules of decision making, analysed in empiric experiments (Reisch & Oehler, 2009). Heuristics and biases are to be further explained in subchapter 2.3.3, as well as biases and their application.
Individual judgements and choices deviate from optimal decision making and information processing in a variety of ways, according to researchers. The majority of these discrepancies from rationality are caused by a limited capacity for processing information relevant to the decision problem (Milosavljevic, Navalpakkam, Koch, & Rangel, 2012). Kahneman & Tversky are two of the most famous scholars on this topic, also due to the fact that Kahneman has been decorated with the Nobel prize for their decade-long research on heuristics and the way the mind, or better said two minds, also declared as System 1 and System 2, work towards decision-making (Kahneman, 2011; Tversky & Kahneman, 1974).

2.3.1 System 1

Looking at the history of theories and thoughts that evolved around a mind that is divided into different parts from a behavioural aspect, it is possible to go back even to Plato, who already had the idea of reason, spirit and appetite. On a less philosophical and more psychological and modern level, there have been more and more scholars starting in the 1970's to come up with dual-process theories. The focus is sometimes a different one, but almost all researchers agree on two systems,

entities, or structures of the mind, regarding mechanisms to process information (Frankish & Evans, 2009).

Kahneman (2011) describes System 1 as the automatic and quick part of the mind. It works largely without any effort (Kahneman, 2011). Evans (2008) clusters System 1 and System 2 into four overall categories, namely consciousness, evolution, functional characteristics and individual differences, to compare both (Evans, 2008). Not surprisingly are they almost always contrary in characteristics. System 1 acts cognitively unconscious, implicit, automatic and rapid. Automation refers to the acquisition of motor skills that have been automated or programmed, in contrast to the controlled and conscious skills (Chaiken, 1999). System 1 further has a high capacity and works on default, which means that it is more often activated or kind of 'always on', in comparison to system 2 (Evans, 2008; Kahneman, 2011). It is also the evolutionary older of the two systems, being shared with animals, and not linked to language (Evans, 2008). However, this has nothing to do with the *Triune brain,* which has a biological and neurological argumentation, instead of a behavioural one. System 1 works independent of the general intelligence of the individual and is also autonomous of the working memory, hence universal and not heritable, i.e. not dependent on genes (Frankish & Evans, 2009).

2.3.2 System 2

Just as System 1 is responsible for thinking fast, System 2 takes the part in slow-thinking. System 2 directs attention to demanding mental activities, including complex calculations. The operations of System 2 are often accompanied by the subjective experience of freedom of decision and concentration (Kahneman, 2011). Frankish & Evans (2009) argue that System 2 is responsible for decontextualized abstract thinking that only humans are capable of (Camerer et al., 2011; Frankish & Evans, 2009). It is the analytic and systematic mind of the two. Table 1 shows both systems and their different attributes in an easy overview.

System 1	System 2
Evolutionarily old	Evolutionarily recent
Unconscious, preconscious	Conscious
Shared with animals	Uniquely (distinctively) human
Implicit knowledge	Explicit knowledge
Automatic	Controlled
Fast	Slow
Parallel	Sequential
High capacity	Low capacity
Intuitive	Reflective
Contextualised	Abstract
Pragmatic	Logical
Associative	Rule-based
Independent of general intelligence	Linked to general intelligence

Table 1: Feature of the two systems Source: (Frankish & Evans, 2009)

System 2 thinks logically and acts based on rules, rather than pertaining to simple associations (Frankish & Evans, 2009). As slow and analytical thinking is more energy consuming, it also has a lower capacity, i.e. it takes more effort to act consciously (Evans, 2008). To save energy, the mind automatically prefers System 1 over System 2, also to derive to faster conclusions. These fast conclusions when processing information are further presented in the following subchapter.

2.3.3 Heuristics

As stated in the introduction, these fast conclusions or also *“methods for arriving at satisfactory solutions with modest amounts of computation”*, are called heuristics (Simon, 1990) p.11). The main function of heuristics is to reduce the mental energy that is consumed to solve a task (Shah & Oppenheimer, 2008). Heuristics can be seen as a replacement of complex calculations of the mind towards a simplified judgement and decision outcome. (Johnson, Payne, & Bettman, 2012).

Yoon et al (2012) are of the opinion that heuristics work best in a situation that demands a rapid decision (Yoon et al., 2012). Tversky and Kahneman (1974) have been at the forefront for researching and detecting heuristics that occur in decision-making contexts (Lee, V. K. & Harris, 2013; Tversky & Kahneman, 1974). In their widely recognised paper "*Judgment under Uncertainty: Heuristics and Biases*" from 1974 that also laid the foundation for the Nobel prize in Economic Sciences in 2002 for Kahneman, they present three heuristics (Kahneman, 2011).
Namely, the representativeness heuristic, showing that people judge the probability of how characteristic a person for a certain job is, based on stereotypical information. So when a random person by the name of Steve is described as a shy and introvert person, people rank the probability of him being a librarian higher than the probability of Steve being a farmer, although there are statistically more farmers than librarians (Tversky & Kahneman, 1974). These heuristics have been empirically proven many times in studies, and many researchers have detected additional heuristics, since Tversky's and Kahneman's article in 1974 (Camerer et al., 2011; Lee & Harris, 2013; Reisch & Oehler, 2009). Thaler & Sunstein (2008) draw the connection between heuristics and the possibility to frame these for a better outcome of everyone involved. They argue, since humans commit so many mistakes, a pre-designed, positive heuristic could *'nudge'* people towards a better decision making (Thaler & Sunstein, 2008), p. 10). This also takes part in the discussion in chapter five.

In addition to heuristics, it is also important to explain the aforementioned term of biases and point out its differences. Biases are the result of heuristics, rather than a synonym, as explained by Tversky and Kahneman (1974) (Tversky & Kahneman, 1974). In easy words, heuristics are often built because of previous experiences and a mental shortcut or overly simple assessment of a situation. In comparison, a bias is based on preference and a certain belief that has also manifested over time and repetition. An example is the confirmation bias, when a person prefers reading information that endorses their own position, instead of critically searching for more sources. Even when this person is aware of the confirmation bias, he or she is still most likely to continue consuming information that fits their worldview. This is in contrast to heuristics as the reader has been introduced to the representativeness heuristic with Steve the farmer. The next time when the reader is confronted with such a message, he or she might remember this example and adapt its first and

intuitive thought, unlike the confirmation bias (Kahneman, 2011).
The next subsegment describes Neuromarketing in more detail and with which tools it is possible to detect, make visible and analyse heuristics in a consumer's mind.

2.4 Neuromarketing

Although Neuromarketing is first defined in the introduction, this segment adds further definitions by other scholars and researchers and illustrates the most important characteristics of Neuromarketing, before continuing with the presentation of the three most often used neuroscientific tools for Neuromarketing purposes.
Neuromarketing has undisputedly many origins in different academic fields. Depending on the perspective and the individual focus, some roots have a higher influence than others, but in general and with a focus on this thesis, it can be said that Neuromarketing connects research and tools from Neuroscience, Neuroeconomics and Behavioural Economics (Lange, 2014; Rothensee & Reiter, 2019). Lee et al (2007) argue that Neuromarketing is the application of neuroimaging to market research (Lee et al., 2007).
Neuroimaging, i.e. studying the brain with neuroscientific tools, offers new ways to analyse and understand preferences, decision making and behavioural patterns in a consumer and marketing context. Even if the test subjects are not able to verbalise their explicit preferences, the neuronal reactions in the brain can much better measure the effectiveness of an advertising campaign and might predict possible consumer choices (Berns & Ariely, 2010). Therefore, Neuromarketing is used to analyse and comprehend consumer behaviour in relation to markets and marketing exchanges (Lee et al., 2007) The aspirations of neuromarketing investigations are to gain objective data about the insides of consumers' brains without relying on subjective evaluations (Murphy et al., 2008).
Plassmann et al (2012) argue that Neuromarketing attempts to put the findings of studies into practice and to utilise them for business issues (Plassmann et al., 2012).
Rothensee & Reither (2019) reinforce the statement that Neuromarketing is a label for a group of neuroscientific measurement technologies and concepts for a better consumer understanding (Rothensee & Reiter, 2019). These technologies allow insights into the brains of consumers and show their responses to marketing stimuli, even if the consumer is not consciously aware of them (Renvoisé & Morin, 2007).

This is seen as an advantage in comparison to traditional Marketing approaches, as the results can be obtained independently from the ability and willingness of the subjects to state their viewpoint or behaviour (Lee et al., 2007).

2.5 Neuromarketing Techniques

2.5.1 fMRI

Brain imaging technologies (including among others fMRI) are the predominant neuroscientific tools used for Neuromarketing (Rothensee & Reiter, 2019).

fMRI machines are huge medical equipment that weigh at least eight tons. The cost in 2017 was between 500000 USD and 3 million USD for a machine (Gaskin, Jenkins, Meservy, Steffen, & Payne, 2017). The study subject is moved into a magnetic tube, lying down, without movements, while the machine itself emits a lot of working noise (Berns & Ariely, 2010). fMRI is short for functional magnetic resonance imaging and has its origin in medicine some 30 years ago, to research and better understand neurodegenerative diseases, such as Alzheimer's and Parkinson's (Phan, 2010; Prabhakar, 2017).

In simple terms, fMRI describes the level of haemoglobin, i.e. a protein in red blood cells that transports oxygen through the body, and highlights the areas of the brain that receive an increased amount of the oxygenated blood, due to a stimulus (Lindstrøm, 2010). More specifically, signals are being sent from one neuron to another via neurotransmitters. This starts a reaction, so electrical impulses fire up to increase synaptic activity that results in an increased blood flow towards the activated area. This increased blood flow, nurtured with haemoglobin, increases the magnetic field during a scan, to make it measurable with the fMRI machine. The computer then generates a visual representation of the contrasts between activated and inactive areas of the brain (Berns & Ariely, 2010).

When the brain is confronted with a task, it requires energy. The harder one area of the brain has to work on that task, the more oxygenated blood it requires, which is then visible via fMRI. To see the difference between an active and inactive brain part, the scientists take images of the inactive brain of the subject, before starting with the study purpose, to later compare it to the active-working brain (Lindstrøm, 2010).

Neuromarketing researchers use fMRI machines to study multiple things as for example the aforementioned Coca-Cola/ Pepsi-Cola study and the activation of the pleasure centre of the brain, when blindtasting the soft drinks (McClure et al., 2004). The activation of this centre, i.e. the nucleus accumbens in the limbic system as part of the old brain, can program future popularity of certain experiences or products (Karmarkar & Plassmann, 2019). An article in Forbes magazine describes a study at Harvard Business School, where scientists could predict the commercial success of a OneRepublic song, and the failure of others, by analysing the brain activities of adolescents in an fMRI scanner that were listening to these songs (Nobel, 2013).
Apart from being very big in size, emitting loud sounds and being expensive until today, fMRIs have two more downsides. The study subjects have to lie completely still in a loud and very narrow tube, inside the machine. Also, only certain types of things can be shown or used in an fMRI machine, mostly visual representations, that do not require the individuals to move (Berns & Ariely, 2010).
McClure et al (2004) acknowledge that *"with the behavioural results, it is possible that this finding may suffer from noise in our estimates of subjects' preferences"* (McClure et al., 2004) p.382).
As a quick digression, 'noise' is considered as all distracting stimuli, data and information that would not occur in the same way in a real-life environment, such as lying down in the scanner. One definition of the Merriam Webster dictionary for noise that is also valid for this thesis is: "*Irrelevant or meaningless data or output occurring along with desired information"* (Merriam Webster,).

2.5.2 EEG

Electroencephalography (EEG) is a non-invasive brain imaging technique that records the electrical activity of the brain at the scalp's surface. It was first introduced in 1929 to record brain activity. In 1957, an improved model was used to monitor the brain with electrodes and its rhythmical changes as a result of different mental tasks.

An EEG device is typically a cap with multiple electrodes or sensors attached to the surface of the head. An EEG measures neurons' postsynaptic potentials (Abhang et al., 2016). In other words, it assesses shifts in the electrical field via the electrodes that sit on top of the subject's head. An EEG has a high temporal resolution, which

means that it can trace short changes of the neurons in milliseconds to gain insights into the subjects' cognitive state (Berns & Ariely, 2010).

In another study at Harvard Business School, scientists found via EEG research the main selling reason behind Cheetos, a US cheese puff/crisps brand. Researchers let the study probants try Cheetos, while being connected to EEG's that could measure anger, lust, disgust, and excitement. Reportedly, the consumers enjoyed the cheese dust that stuck to their fingers, when eating the crisps, as their neurons fired in the moment of sensing the sticky cheese powder (Nobel, 2013).

A disadvantage of EEG is that it only measures the outer layers of the brain, namely the cerebral cortex, while it is not possible to reach the deeper areas of the brain as with fMRI. At the same time, EEG lets consumers move freely during the study which allows it to apply in real life scenarios as in a supermarket (Phan, 2010).

2.5.3 Eye-Tracking

This neuroscientific tool differs from the previously presented techniques in the way that it is not analysing the brain, but rather focuses on the eyes, its movements, and the change in size of the pupil, reacting mainly to visual stimuli (Phan, 2010). The eye movements serve as an indicator to consumers' attentional patterns (Milosavljevic & Cerf, 2008).

Although not scanning the brain frequencies, Eye-Tracking is still a valid neuroscientific technique due to the fact that most incoming information is of visual nature, and the reaction to visual stimuli can tell researchers about the involvement of individuals (Plassmann et al., 2012). Regarding the reaction time, a single eye-movement takes only 200 milliseconds (Nobel, 2013). It takes 313 milliseconds to build a preference for a certain brand or product (Milosavljevic, Koch, & Rangel, 2011). The pupillary dilation serves as an indicator to arousal and pleasure (Bray, Rangel, Shimojo, Balleine, & O'Doherty, 2008). This has been proven in different experiments, one example is Ramsøy et al's (2012) study where they tested different sounds on subjects, wearing Eye-tracking devices. An unpredictable sound was associated with a negative emotional response and made visible by a reduction of the size of the pupil. The scientists show that when a subject was asked to rate their first perceptions of new brand logos while listening to simple sounds, brand logos paired with unexpected sounds were rated less positive than logos with an expected sound (Ramsøy et al., 2012).

Plassmann et al (2012) derived three types of eye movements for people that are viewing ads. In a time, recognition, and involvement ascending order, the first type is scanning, where the eyes move to the headline and image. The second one is scanning, which includes looking at the brand. The third and most intense eye movement is called sustained and includes looking at the headline, pictorial, brand, and text (Plassmann et al., 2012). These eye-movements are put into the context of a Neuromarketing model in the next subchapter.

2.6 Consumer-Decision Making Framework for Brand Preference

One aspect that Marketers have always been interested in is the decision making process of consumers.
How do consumers get to make a decision and how does Marketing affect this decision making process?

As Neuromarketing techniques allow researchers to take a closer look into the brain of consumers, it is therefore also of great interest to many marketers to understand the decision making on a neuronal level.
The now presented model has been developed by Plassmann et al (2012) building on top of previous work in consumer psychology, behavioural economics and consumer science (Kahneman, 2011; Plassmann et al., 2012; Rangel et al., 2008; Yoon et al., 2012). It describes the steps for brand preference formation in the consumer mind, to better understand and influence consumer decisions for Neuromarketing purposes (Plassmann et al., 2012). Figure 3 shows the ingredients that are necessary.

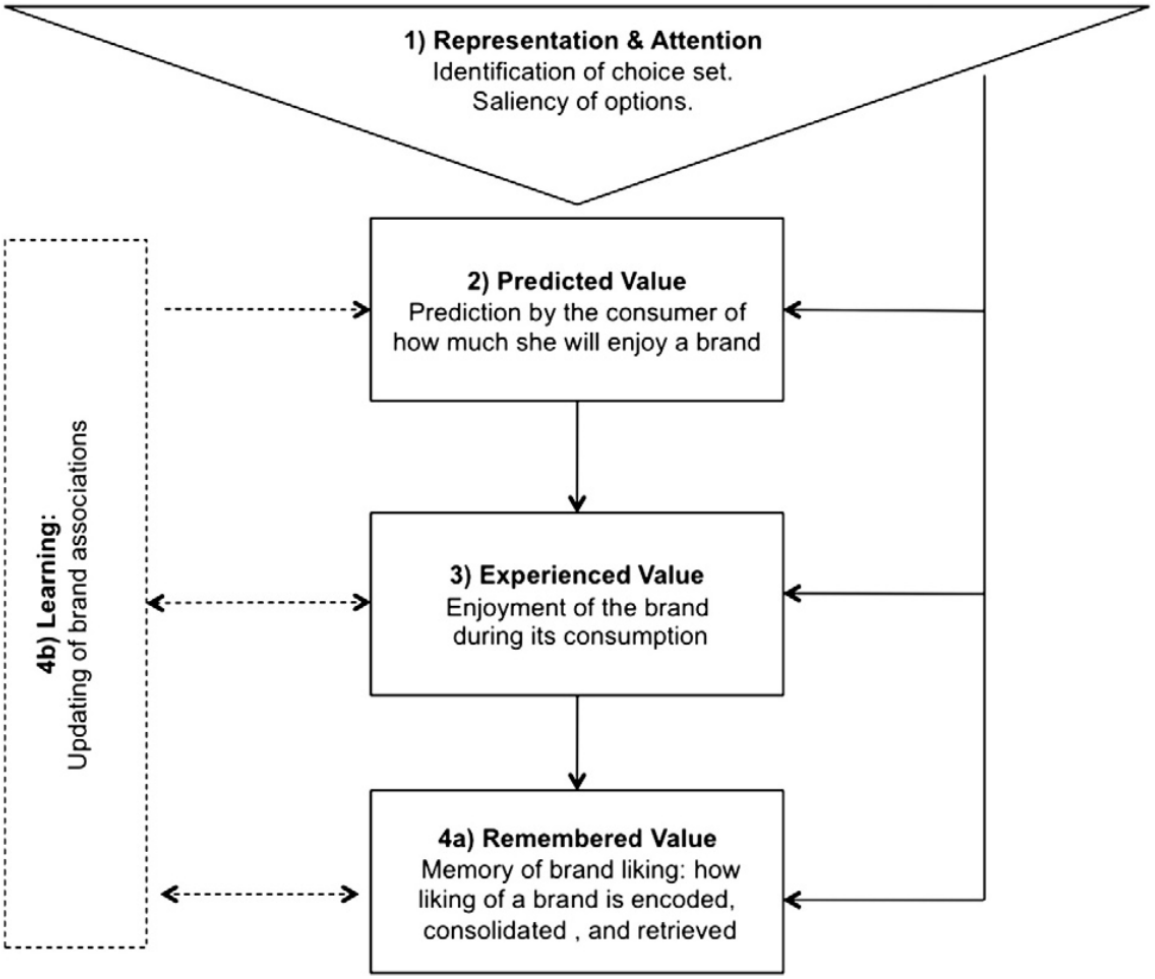

Figure 3: Value Signals important for brand decision Source: (Plassmann et al., 2012)

Starting with Representation & Attention (1), consumers have an absolute overflow of information at all moments of which the mind only processes a fraction. The rest is directly sorted out, why it is important for a brand to pass the threshold into a consumer's mind (Milosavljevic & Cerf, 2008). The first step for a consumer when choosing a brand is to map possible alternatives. Incoming data is analysed, complemented by internal information like hunger or thirst, and external information like time, setting and environment, to create options to choose from. Plassmann et al (2012) call this brand identification (Plassmann et al., 2012).

On a neurological level, the visual stimuli is processed by the visual cortex, located in the occipital lobe and supported by the dorsolateral prefrontal cortex in the frontal lobe involved with predicted value and remembered value (Berns & Ariely, 2010; Plassmann et al., 2012).

The two most important ways of attention, to select and choose from all available information are bottom-up and top-down saliency filters. In easy words, bottom-up attention is everything that automatically grabs the attention of the consumer's mind, even if he or she was not planning on focusing his or her attention to it. This includes contrast, density, brightness, movements, and more.
Again, on a neurological level, the first place in the brain to react to the external stimuli is the thalamus, as part of the diencephalon, i.e. the old brain, before it is sent to the visual cortex. The signal travels from the bottom up to the top of the brain and is therefore being called bottom-up attention (Milosavljevic & Cerf, 2008; Milosavljevic et al., 2012) (Milosavljevic et al., 2011). This attention is automatic and not consciously controlled, which is why it can be assigned to System 1 on a behavioural level. Top-down attention is the opposite, where consumers need to focus to choose between the options. As this process requires mental energy, System 2 executes this saliency filter (Kahneman, 2011). The frontal lobe, together with the primary visual cortex is activated first, hence it is an attention from the top of the brain, down to the other regions (Milosavljevic & Cerf, 2008; Milosavljevic et al., 2011). In terms of influencing consumer decisions, the visual appearance of the product can therefore influence the chances of consumer preference.

The next step in the framework after having chosen a brand or product is the Predicted value of a brand (2). It reflects the perception of a consumer towards the future payoff of choosing a certain brand over another. Loyal customers have shown an increased activity in the striatum (part of basal ganglia and the limbic system) in comparison to an unloyal reference group. The stronger or more desirable a brand is perceived, the more active the insula (between temporal and parietal lobe in the cerebrum). This area is usually responsible for negative emotions, but also arousing emotional experiences.

The third step in the framework is the actual experience of the brand, the so-called Experienced Value (3). It analyses the satisfaction a consumer draws from the brand or the product and it is considered to be the most important value in behavioural economics, for a value-based decision making (Kahneman, 2011). Valence and the intensity both influence the experienced value. Neurons in the orbitofrontal cortex (cerebrum) fire up at the moment the consumer experiences a positive, i.e. a

pleasant or joyful experience. This means that the experienced valuation system is controlled by higher cognitive processes, found in the new brain (Plassmann et al., 2012).
Nevertheless, McClure et al's (2004) Pepsi/Coke study has proven that experienced value is also dependent on brand associations, as the important areas for memory and association (namely the hippocampus as part of the limbic system and the dorsolateral prefrontal cortex among others) were not activated in the blind tasting (McClure et al., 2004).

This has a direct influence on the next step in Plassmann et al's (2012) framework, the Remembered Value (4a) (Plassmann et al., 2012). This is the process by which diverse brand associations are encoded, consolidated, and recalled in the memory of the consumer. Parts of these processes, according to researchers, unfold subconsciously (Plassmann et al., 2012; Ramsøy & Skov, 2010). The term "remembered value" refers to both explicit and implicit memories of previous consumption experiences. Implicit brand memory refers to information about a brand that has a subliminal, or unconscious influence on the decision making result. The unconscious part of the brain (i.e. basal ganglia) shows to be the active area during implicit brand memory (Plassmann et al., 2012; Renvoisé & Morin, 2007).

The final element in the decision making framework is Learning (4b). It is interconnected with experienced value (3) and remembered value (4a). Basically, consumers define their preferences for one brand over another via post-experience behaviour. The presented framework draws the different actions during the decision making process and shows how consumers form preferences. This will be further analysed in combination with insights from Behavioural Economics in the fourth chapter.

2.7 Chapter Summary

This subchapter serves the purpose to sum up all the afore-presented information in a short and understandable overview.
Consumer Neuroscience analyses consumer brains for a better understanding of the decision making process on a neuronal level (Berns & Ariely, 2010). Therefore, the

brain needs to be understood not only from a biological standpoint, but also a psychological one.

There are three parts of the brain that can be distinguished in this context. Beginning with the Cerebrum which carries the cortex, and includes the prefrontal cortex, responsible for the prediction of value, price-evaluation and decision utility (Yoon et al., 2012). From a psychological perspective, it can be said that the Cerebrum carries the parts of the brain, responsible for conscious actions.

The Diencephalon and the brainstem fulfil most of the unconscious functions in the brain. The amygdala is involved in emotion processing and intuitive decision-making. It furthermore takes a big role in the control of body responses like facial expressions, respiration, pulse, sweating and pupil dilation (Ramsøy et al., 2012).

Behavioural Economics aims at a better understanding of decision making and behaviour, while having human mental shortcuts as heuristics and biases in mind.

Neuromarketing and more importantly its techniques, such as fMRI, EEG, and Eye-Tracking, are used to test hypotheses and deduct knowledge and practices for economic and commercial use.

The consumer decision making framework takes a closer look at brand preference formation.

3. Methodology

In the methodology chapter, Niklas explains his point of view and the logical understanding of this thesis. The student has gathered some previous experience and reflections on methodology that have shaped his idea on the role of the researcher, interacting with external sources and bringing old and new insights into the context of this paper (Einarsdottir, Strieder, Tasiopoulos, & Alonso Saavedra, 2020; Einarsdottir, V., Alonso Saavedra, Tasiopoulos, & Strieder, 2021).
The methodological chapter is structured into five subchapters and follows roughly the order of Kuada (2014), starting with the philosophical perspective (3.1), continuing by presenting issues of ontology (3.2), and explaining the epistemological choice (3.3) of Niklas. The methodology closes with a description of the chosen data collection tools (3.4) and a short explanation about validity and reliability (3.5) for this thesis (Kuada, 2014).

3.1 Philosophy of Science

Glattfelder (2019) describes in his book the scarcity of scientists that openly define their beliefs and point of view regarding their scientific approach because "*by definition, this information is non-scientific"* (Glattfelder, 2019) p.325). The student is aware of this paradox, yet tries to describe his scientific thinking with the help of pre-defined classifications that are now presented. The philosophy of science is the school of thought that tries to create a frame for all questions that concern the methods, knowledge and logic of scientific work (Runehov & Oviedo, 2013).

It is further important to present and explain the paradigm used for this thesis. A paradigm should bridge the conception of science (i.e. Philosophy of Science (3.1)) and the conception of reality (i.e. Ontology (3.2.) and Epistemology (3.3)) with the Methods (3.3) to illustrate Niklas' beliefs (Arbnor & Bjerke, 2009).
Niklas point of view is that knowledge is constructed as the result of various factors that affect scientists. Everyone constructs their own knowledge and understanding of the world in interactions with their surroundings and their subjective experience (Glattfelder, 2019). This is called the constructivism paradigm and it is based on the assumption of multiple realities, as every person has individual experiences and their

own way of assessing them (Kuada, 2009). Knowledge is therefore constructed by scientists and not primarily by the research data (Glattfelder, 2019; Kuada, 2014).

To construct knowledge, it is also important to be clear about the own interpretation of thinking and reasoning. It can be said that Aristotle was the first one to frame and use the term of logic as a means of reasoning over 2000 years ago (Glattfelder, 2019). Logic stems from the old Greek word “λογικὴ τέχνη” (“Logike Techne”) that can be translated as the art of thinking (Adler, 1997). It helps the cause of this chapter, yet the whole thesis, to work logically and coherent. Aristotle used deductive reasoning to explain his point of view.

The student also uses deductive reasoning in the spirit of Aristotle as a way of thinking, instead of inductive reasoning. Both concepts are now briefly introduced.

Deductive reasoning refers to the process of arriving at a logical conclusion based on one or more premises. In other words, an assumption or theory is checked on its correctness with the help of specific observations, i.e. testing the formulated assumption (Hyde, 2000). The neuroscientists Prado, Chada & Booth (2011) give the following definition: “*Deductive reasoning is the process of drawing conclusions that are guaranteed to follow from given premises*” (Prado, Chadha, & Booth, 2011), p.3483). An example for deductive reasoning is:

X is to the left of Y.

Y is to the left of Z.

Therefore, X is to the left of Z.

Inductive reasoning is the opposite. It takes specific observations as the core element and formulates a theory, based on the observed examples. Inductive reasoning starts with an observation and derives to a conclusion as this example of inductive generalisation shows:

The A’s I see are bold.

All A’s I have ever seen are bold.

Therefore, all A’s must be bold.

It should be noted that the finding may not be an irrefutable truth based on previous observations (Glattfelder, 2019).

Niklas focuses first on the theoretical background, gathering information and resources about Neuromarketing, Behavioural Economics and related fields that have an interest in decision-making, before analysing the current state of knowledge by interviewing Martin Skov, a renowned Neuroscientist. In consequence, the

student uses deductive reasoning in this thesis by collecting data first and conducting a qualitative interview to compare theory against praxis second (Hyde, 2000).

3.2 Ontology

Ontology supports the constructivism paradigm in the way that it clarifies the conception of reality that is applied to this thesis. This field of study raises questions about the nature of reality, existence, the view on reality and the meaning of being (Kuada, 2014). According to Burrell and Morgan (1979), ontological assumptions are concerned with three major questions about reality:

1. Is reality formed through internal, i.e. individual or external forces?
2. Is reality an objective product of individual consciousness?
3. Is reality an externally determined element or a product of the mind (Burrell & Morgan, 1979)?

These questions should help the researcher to decide on a suitable paradigm for this thesis. As the researcher in charge of this thesis, Niklas sees reality as formed through internal forces and an individual product of the mind. Therefore, the aforementioned constructivism paradigm is applied to this thesis.

The student is further aware of the existence of multiple, socially built realities (Mertens, 2019). This perspective on reality has different names, depending on the researcher, although they all follow the same ontological point of view.
Kuada (2014) calls this view that reality is constructed by individuals the *interpretive approach (Kuada, 2014)*.
Fast and Clark (1998) prefer the term *nominalism* (Fast & Clark, 1998).
Burrell and Morgan (1979) use the term *subjectivist perspective (Burrell & Morgan, 1979)*.
Niklas collects empirical data in the form of an interview with Martin Skov, a Neuroscientific researcher at the Danish Centre for Magnetic Resonance at the Copenhagen University Hospital Hvidovre and professor at CBS, and a written questionnaire, answered by Antonio Rangel Bing professor of Neuroscience, Behavioral Biology and Economics at CalTech to compare it against the gathered academic literature and to validate his view on reality. Jacquette (2014) argues that

this interpretive research cannot be generalised, as it applies to the context of the thesis and the involved individuals as the student and the interview person (Jacquette, 2014).

3.3 Epistemology

Just as Ontology asks the question of what reality is, Epistemology tries to understand how we know what we know. It supports the underlying constructivism paradigm in the way that it gives a frame to the theory of knowledge (Audi, 2011).
Martinich and Stroll (2021) explain the origin of the word epistemology as follows: *“The term is derived from the Greek epistēmē (“knowledge”) and logos (“reason”), and accordingly the field is sometimes referred to as the theory of knowledge”* (Martinich & Stroll, 2021).
Kuada (2014) specifies Epistemology as the intersubjective perspective of a researcher who studies his social environment (Kuada, 2014). To explain this thought construct, an example can simplify Kuada’s (2014) words: When two people stand in front of a blue wall, they can describe the blue wall, but they will always be limited to their own intersubjective perspective. This means, there might be other words in different languages, there are different shades of blue such as marine-blue, turquoise, etcetera, the senses of the two individuals can be developed at a different level, and so on.
As a researcher, studying the analysis of the blue wall by the two men, there are two options. The researcher can either let the two men describe the wall by themselves, without interfering in any way, or interact on some level with the two individuals and therefore influence their behaviour and reality.
Kuada (2014) calls the first approach objectivistic with a positivist epistemology (Kuada, 2014).
This means that the research is gathered objectively without any interaction between researcher and study object. In the case of Neuromarketing, this is impossible, as the researchers always interact with the study subjects, because a permission to monitor the mind is required, as well as to mount the research tool onto the test person. Also in the case of this thesis, Niklas interacts directly with several researchers, such as Antonio Rangel and Martin Skov, to receive answers to a written questionnaire, as well as the semi-structured interview itself, which allows

follow-up questions.
Therefore, Niklas applies Kuadas (2014) subjectivist approach with an anti-positivist epistemology (Kuada, 2014). The student subsequently gains a subjective impression of the study subject and this research displays Niklas perception of reality that has been influenced by other stakeholders such as Antonio Rangel, Martin Skov, and Andreea Bujac as the supervising professor.
The next subsegment, namely Methods (3.4), complements the Methodology and explains primary and secondary data collection, to construct knowledge for this thesis.

3.4 Methods

3.4.1 Primary Data Collection

In an academic context, there are qualitative and quantitative research methods. The quantitative approach collects big sets of data, mostly numerical via questionnaires and quantitative interviews, to evaluate research hypotheses and possible correlations (Kuada, 2014).
Qualitative research, on the other hand, are all methods that cannot be dealt with in any kind of quantification process (Hennink, Hutter, & Bailey, 2020). Qualitative research helps to confirm theories and also generates a better understanding and possible new perspectives. Furthermore, the use of qualitative data enables scientists to become more engaged in the research process. It allows them to gather insights tailored to their research and the individual characteristics of the problem statement. The researcher also interacts on a more individual level with other stakeholders that can have an impact on the collected data (Kuada, 2014).
Interviews are a perfect example for that. Niklas approached nine neuroscientific researchers from institutions such as CalTech, CBS, University of Michigan, Emory University and INSEAD to conduct a semi-structured interview.

There are three types of interviews, namely structured, non-structured and semi-structured interviews. A structured interview has predefined questions and has usually a low rate of interaction between the interviewer and the contestant.
Non-structured interviews are loose discussions between the interviewer and the contestant about a specific topic. There is no predefined outcome, also supported by

the lack of a specific interview layout or pre-formulated questions.

A semi-structured interview lies in between the two extremes and combines aspects from both techniques. It can include pre-determined questions as well as open-ended inquiries. The combination of both allows the researcher to gather knowledge in a non-linear manner, asking follow-up questions, having a closer look at specific details and exploring new issues, while having an overall structure and guidance during the interview (Hennink et al., 2020).

Table 2 shows the blueprint of the semi-structured interviews as conducted with Martin Skov on Tuesday 3rd of May 2022 at 11:00 am via Zoom. The Interview is part of Niklas' primary data collection.

Blueprint of the semi-structured Interview		
Structure	Activity	Approximate Time
Introduction & Set-Up	Short self-introduction Brief the participant Elevator Pitch thesis & interview objectives Explain interview method, use of data, confidentiality	3-6min
Question 1	Topic: Decision Making	2-4min
Question 2	Topic: Future Research	5min
Question 3	Topic: Ethical Regulations	5-7min
Question 4	Topic: Possible Risks	5-7min
Closing comments, Outro	Show appreciation for taking the time Offer help for his research	3min

Table 2: Blueprint of Semi-Structured Interview Source: (Wilson, C., 2013)

The total interview, including the intro and the outro, lasted 35 minutes, until 12:05 pm. The interview started with the introduction of the student and a short presentation of the topic of the thesis.

Niklas explained the perspective of the thesis and linked it to the research of Martin Skov, whose paper and research is cited several times in this thesis. Martin Skov is a Danish Neuroscientist, with over 25 years of experience and more than 80

publications in the field of cognitive neuroscience, neuroeconomics, neuroimaging and decision-making (Skov, 2022). He is a research associate at the Danish Research Centre for Magnetic Resonance, Copenhagen University Hospital Hvidovre and professor at CBS, forming part of the Decision Neuroscience Research Cluster.

After clarifying the semi-structured interview method and the restricted use of the interview for this thesis only, Niklas introduced the four topics Decision Making, Future Research, Ethical Regulations and Possible Risks for the interview. The student shared a powerpoint presentation (Appendix A), with each topic and question being limited to one slide, to prevent seeing all questions together. Martin Skov had not previously received the questionnaire and was answering the questions on the spot, without specific preparation.

The interview closed with appreciation towards Martin Skov, for taking the time and his assurance to provide the student with a newly published paper about neuroscience as well as tips and requirements for a possible future PhD career in that field. The whole interview transcript can be found in Appendix B.

Apart from Martin Skov, Niklas approached eight other researchers that are all Neuroscientists and cited several times throughout this thesis. None of the researchers even replied to the student with the exception of Antonio Rangel, Bing professor of Neuroscience, Behavioral Biology and Economics at CalTech. He answered the same four basic questions that were also answered by Martin Skov, via email in a written questionnaire on Tuesday, 26th of April 2022.

The purpose of interviewing neuroscientists is to collect qualitative data that can be analysed and put into the context of this thesis. More specifically, allowing the student to compare written sources to the real opinion of researchers and practitioners that are most often not visible in academic papers. The following chapter 4, Current State of Knowledge in Neuromarketing Research, examines the statements of the two Neuroscientists Skov and Rangel in regards to consumer decision-making, the application of Neuromarketing techniques in a commercial scenario and the ethical implication of it with the help of further literature. This is connected to the overall topic of a commercial analysis of consumer choices with Neuromarketing techniques.

3.4.2 Secondary Data - Literature Review Process

The secondary data collection in this thesis are peer-reviewed articles and papers, published in academic journals and via higher research institutions. In other words, the methods for this thesis are a semi-structured interview as primary data and a thematic literature review as secondary data source. This thesis contains a theoretical background to introduce the reader to definitions, theories and techniques of the different academic fields related to this thesis, such as Neuroscience, Neuromarketing, Neuroeconomics and Behavioural Economics (Stallwitz, 2012). According to Grant & Booth (2009), a literature review contains published materials that gives an analysis of the literature with a wide range of topics with varying degrees of depth and comprehensiveness. The synthesis, i.e. presentation, is mostly narrative and displayed in either chronological, conceptual or thematic order (Grant & Booth, 2009). The student chooses a thematic order for his research, structured in Neuromarketing research, Neuroscience and Behavioural Economics. The literature is further grouped in decision making, both from a Neuromarketing and a Behavioural Economics perspective, supplemented with primary data. Attention, awareness and consciousness is first presented in a neuroscientific context, to later combine it with the behavioural economical angle about judgement under uncertainty, heuristics, biases and other mental shortcuts. The secondary data should help to present a balanced view from all mentioned academic fields and justify, i.e. explain, the four research questions raised in the introduction. The analysis about intention and effect of Neuromarketing in practice is backed up with literature from well known neuroscientific and behavioural economic researchers and their studies, such as McClure et al (2004), Lee et al (2007), Berns & Ariely (2010), Plassmann et al (2012), and more (Berns & Ariely, 2010; Lee et al., 2007; McClure et al., 2004; Plassmann et al., 2012).

Ethics also play an important role in the thematic literature review and the student analyses this topic with the help of articles about Neuroethics, and malpractice examples in popular-scientific books, but also peer-reviewed and reputed researchers. All in all, the applied literature serves as a guide towards a better understanding of decision making in consumer based research, while simultaneously responding to the research questions. As the presented area of study is broad and contains elements and influences from many other fields, small summaries in

between help to define findings and insights.
The next subchapter deals about the validity and reliability of the used sources and should emphasise the credibility of this research.

3.5 Validity and Reliability

This subchapter serves as a testimony to the attempt of a valid and reliable research. Reliability refers to the replicability and consistency of the data collection process. Are the findings similar to the observations of other researchers? To receive reliability, information and data should be confirmed by more than one other source. Franklin et al (2010) argue that the role of reliability is depending on the epistemological view of the researcher (Franklin, Cody, & Ballan, 2010). Niklas' viewpoint is previously explained in the chapter. The student and his subjective impression is influenced by stakeholders such as Martin Skov and Antonio Rangel. However, Niklas tries to back up the information and data process by several peer-reviewed sources.
In the context of qualitative data, reliability is also referred to as dependability. It means that scholars attempt to adjust for varying conditions in their observations. One example from the topic of this thesis is the fast advance in technology and the evolution of test devices. This is also in line with the epistemological belief that there is no final or absolute truth. Later chapters show that even peer-reviewed articles, published by reputed and well-known academics and scientists cannot guarantee an ultimate validity and reliability.

4. Current State of Knowledge in Decision Making Research

This chapter reviews an extended Neuromarketing and Behavioural Economics literature with a special focus on consumer decision making.
First, a placement of decision making for this analysis, as well as the areas of the brain that take part in it, are given. It is then put into the context of Plassmann et al's (2012) Consumer Decision Making Framework. After showcasing some influential biases, the question of how biases and heuristics affect the decision making is answered by the two responding Neuroscientists Martin Skov and Antonio Rangel.
Academic sources, especially from the field of Behavioural Economics help answering the question by presenting different examples.
This leads to the role and effect of Neuromarketing in practice. Introducing several Neuromarketing companies and their history from the early 2000s until today, the student analyses the requirements for an academic and scientific research, applicable to practice.
The last subchapter deals with the legal and ethical restrictions of Neuromarketing, by letting public media journals and their concerns speak. This is further analysed with the help of peer-reviewed answers about the ethics of Neuromarketing.

4.1 Consumer Decision Making and the Influence of Biases

Up to this moment, the term *decision* has been used over 100 times in this thesis, mostly in combination with an action, as the decision process or decision making. In Neuroscience, the decision making process is analysed on a neuronal level. Researchers analyse what areas in the brain are activated for the different stages of the process, as well as how they interact with each other (Rangel et al., 2008).
Neuroeconomics studies value-based decision making on a neurobiological basis.

As a short digression, value-based decision making is all actions, from simple food related choices by an animal to highly complex human decisions as stock market trading. It is a suite of functional brain processes involved in representing internal and external aspects of the organism, valuing alternative behavioural options, and selecting motor actions based on these valuations (Ramsøy & Skov, 2010; Rangel et al., 2008).

In comparison to Neuroscience, Neuroeconomics takes a closer look at the brain's computations towards a decision. This means, researchers look at cognitive and emotional elements during the choice process (Ramsøy & Skov, 2010). Although Behavioural Economics does not directly analyse the brain as the neuroscientific fields do, it is also involved in the research about human behaviour and decision making. Scientists that do research about decision making from a Behavioural Economics perspective look at the psychological components when someone forms a decision. Most often, they take a closer look at irrational behaviour and especially mental shortcuts such as biases and heuristics during the process (Camerer et al., 2011). Therefore, behavioural economists use System 1 and System 2, i.e. fast thinking and slow thinking, to better distinguish between irrational and rational decision-making processes (Kahneman, 2011).

Korteling et al (2018) describe how humans *"rely on conclusions that are based on limited amounts of readily available information rather than on larger bodies of less consistent data*" when making a decision (Korteling, Brouwer, & Toet, 2018) p.7).

For Martin Skov, neuroscientist in Copenhagen, decision making *"[...] is something the brain is engaged in, which requires inputs from multiple different neural systems"* (Appendix B).

This statement is in line with Plassmann et al's (2012) consumer decision making framework, as seen in chapter 2.6, Figure 3 (Plassmann et al., 2012). In the first step of the framework, Representation and Attention (1), the frontal lobe and primary visual cortex are activated before the striatum becomes active, as the centre for processing predicted value. Skov states that the most important neural system for decision making is the reward system. It drives many kinds of decision making processes and is *"built on the generation of emotional states that could be either positive or negative"* (Appendix B). In the decision making framework, the reward system is active during the Experienced Value (3) (Plassmann et al., 2012).

According to Kahneman (2011), this is also the most important value for decision making from a Behavioural Economics perspective (Kahneman, 2011).

Plassmann et al (2012) note that *""Reward processing" seems rather general"*, which requires the student to properly name the active areas of the brain in regards to the reward system (Plassmann et al., 2012) p.30). In this context, Berns and Ariely (2010) also raise the question if a neural signal at the time of, or shortly before a decision serves as a *"good predictor of the pleasure or reward at the time of*

consumption (the 'experienced utility')" (Berns & Ariely, 2010) p.285) (Kahneman, Wakker, & Sarin, 1997).

Many independent studies have shown a correlation between neural activity in certain areas of the brain and the anticipation of rewarding events (Knutson, Adams, Fong, & Hommer, 2001; O Doherty, Kringelbach, Rolls, Hornak, & Andrews, 2001; O'Doherty, Deichmann, Critchley, & Dolan, 2002).

As a disclaimer, it is important to mention here that one of the biggest risks in Neuromarketing and neuroscientific research is called *reverse inference*. This will be analysed and evaluated in more detail in subchapter 4.2. In short words, reverse inference is the thought that one mental process can be narrowed down to only one brain area (Plassmann et al., 2012).

Berns and Ariely (2010) have determined moderate to strong evidence (odds 9:1) for a causal relationship between the reward system and the following neural regions (Berns & Ariely, 2010). The areas of the brain that have been identified to take part in processing rewards are the striatum (i.e. part of the unconscious brain), the ventromedial prefrontal cortex, medial orbitofrontal cortex and anterior cingulate cortex (i.e. part of the conscious brain) (Erk, Spitzer, Wunderlich, Galley, & Walter, 2002; Knutson et al., 2001; Plassmann et al., 2012).

Martin Skov affirms that the reward system *"encompasses both the basal ganglia, the pallidum and ventral striatum, the nucleus accumbens, the amygdala, the insula, the ventral medial prefrontal cortex."* (Appendix B).

McClure et al (2004) show the activation of all mentioned areas in their Coca-Cola vs. Pepsi study while the participants lie in an fMRI machine. They demonstrate that consumers pick more pleasing stimuli over less pleasing stimuli based on their assessment and comparison that the most satisfying drink (between Pepsi and Coca-Cola) is the one that reportedly tastes better.

However, the scientists also acknowledge that there are more stimuli in a real-world scenario that would be necessary to take into account, as well as other distracting stimuli (i.e. noise) in the research environment. Martin Skov sums this up as *"depending on whether a stimulus elicits pleasure or elicits pain, fear or disgust, the brain thinks of the object as either being positive or negative"* (Appendix B). So the reward system is responsible for the incentive salience, i.e. 'wanting' of something, during the decision making process.

One question that comes up, especially in Behavioural Economics but also in academia from neuroscientific fields, is how biases and heuristics, i.e. mental shortcuts in the consumer brain, affect the decision making process.
Antonio Rangel responds to this question as follows: *"A substantial fraction of our decisions require identifying the outcomes and likelihoods associated with different options, assigning values to those options, and then comparing them to make a choice. Each of those steps are associated with computational processes that are imperfect and can be affected by biases"* (Appendix C). In his own words, he describes the decision making process aligned with Plassmann et al's (2012) framework and the different stages of it, starting with Representation & Attention (1), to Predicted Value (2), Experienced Value (3), Remembered Value (4a) and ending in Learning (4a) (Plassmann et al., 2012).
During the stage of early attention, one of the first biases (i.e. reducing mental energy, so instead of using system 2, system 1 takes over), occurs in the form of salient stimuli. A consumer's attention is usually more drawn towards certain brands or options based on the brightness of the packaging, the location of the product in the upper right visual field, and other cognitive diversions (Durgin, Doyle, & Egan, 2008; Milosavljevic et al., 2012; Plassmann et al., 2012).
Since Tversky and Kahneman published their influential paper in 1974 about judgement under uncertainty and mental shortcuts during decision making, many researchers have detected and analysed more heuristics and biases. The Decision Lab, a behavioural economics research company, lists almost 100 different types of cognitive biases on their website of which some are now being presented in the context of Plassmann et al's (2012) consumer decision framework and their influence on Neuromarketing (Plassmann et al., 2012; The Decision Lab, 2022).

The Availability heuristic is a well-researched mental shortcut that can occur easily in the human mind. Antonio Rangel describes it as follows: *"In assigning probabilities to outcomes, we may overestimate the likelihood of outcomes that are very salient but low probability (e.g., airplane crashes), and this could be worse if experiencing unrelated anxiety."* (Appendix C).
To stick to Antonio Rangel's example of the aeroplane crash, an individual that is about to take a flight and tries to estimate the probability of an accident would

employ a mental shortcut by taking the first information that comes to mind. This can be an article about a crash, including pictures and a catchy headline that results in overrating the chances of such an incident. Because memories may not be a reliable model for anticipating future outcomes, the availability heuristic calls into question the capacity to properly evaluate the probability of particular events (Korteling, Brouwer, & Toet, 2018).
In the introduction, the student mentions a study of Tversky and Kahneman from 1974 about subjects estimating the higher count of words that begin with the letter K against words that have a K in the middle. This is another typical example of the availability heuristic (Tversky & Kahneman, 1974). The availability heuristic occurs because System 1 is employed to solve the task and used to give a fast and low resource-requiring answer, instead of System 2. People might see that their fast estimations of likely outcomes are distorted after further consideration.

Antonio Rangel also mentions the Peak-end rule, that influences consumers in their decision making. He says that *“In evaluating options, we might rely on memories from previous experiences, but these memories might have biases”* (Appendix C).
The Peak-end rule is caused by the representativeness heuristic. This heuristic illustrates why an experience is recalled only on glimpses of memory that elicit an emotional reaction, rather than the complete experience. The worth of an individual's experience is thus dominated by the retained value of such glimpses.
The Peak-end rule describes how humans recall an experience based on their emotional reaction, especially at peak moments, as well as at the end (Kahneman, 2011). In comparison to the Anchoring bias, the Peak-end rule can be detected rather easily. Once cognitively aware of it, the individual can actively focus on ending an event in a positive way, to create positive memories that the mind will activate when evaluating options. Some marketers create customer experiences that end on a high note by giving an unexpected little gift at the end of the purchase, or even simple actions like using the customer’s name, to employ the Peak-end rule to influence the buying decision (Okeke, 2019).

The Anchoring bias occurs when people are influenced by certain information before making a decision (Furnham & Boo, 2011). This mental shortcut leads people to place too much weight on the first piece of information they obtain.

The first information is used as an anchor, or reference point for further information. This can affect judgement and lead to different conclusions. A first explanation to this distractor in decision making was given by Tversky and Kahneman (1974) that argue when individuals try to make estimations or forecasts, they start with some initial value that gets modified from there.

The Anchoring bias arises when the modifications are insufficient and therefore cause an incorrect decision making (Tversky & Kahneman, 1974). All Stimuli that enter the nervous system have an impact on the physical-chemical structure, resulting in new neural connections, even when irrelevant or misleading information is added (Korteling et al., 2018).

This distortion in decision making can range from simple consumer decisions in a supermarket to judges that have to decide about a fair prison sentence for convicts.

The studies by Englich and Mussweiler (2001) about judges behaviour and decision making under the influence of an anchor are now shortly presented:

19 German trial judges were presented to a fictional case of alleged rape, including material about the penal code, brief descriptions of the incident from each of the victim, the defendant, the opinion of medicolegal and psycholegal experts, as well as two witnesses. The anchor was a demand by the attorney of either sentencing the accused to two months or to 34 months. The study subjects decided if the demand was too low, too high, or just right. They then said how long they would sentence someone if they were in charge of the case. The anchor had a significant influence on the length of the sentence. The judges allocated to the higher anchor handed down sentences averaging 28.7 months, while those assigned to the lower anchor handed down sentences averaging 18.78 months (Englich & Mussweiler, 2001).

Englich and Mussweiler (2001) show with their three studies that first, a direct influence exists; the penal decisions are assimilated to the sentence demanded by the attorney (i.e. the anchor), second, the impact is independent of the perceived relevance of the sentencing request, and third, the anchoring bias is independent of the judge’s experience (Englich & Mussweiler, 2001).

This example shows how much influence biases can have and how they affect even analytic and rational decision making.

In fact, being aware of the anchor and detecting it cognitively as a bias, can even reinforce the effect as more anchor-consistent information is provided (The Decision Lab, 2022; Wilson, T. D., Houston, Etling, & Brekke, 1996).

Korteling et al (2018) explain the neurological reason for this kind of bias as *“neural networks are more easily activated by stimulus patterns that are more congruent with their established connectionist properties or their current status.”* (Korteling, Brouwer, & Toet, 2018) p.6).

In other words, humans tend to identify further information that supports existing ideas. When the brain processes a stimulus, future encounters of the same stimulus are handled more rapidly. The neurons in the brain form connections and associations that the brain goes back to at the next activation of the stimulus (Forster & Davis, 1984). This is also the case with the confirmation bias. Humans rely and assign more weight onto data that supports pre-existing beliefs. The mental shortcut appears in the form of collecting evidence that fits the foregoing assumption and drawing wrong conclusions as a result from it. Information that is aligned to the subject’s point of view lets him or her also feel better, because it is confirming their standpoint.

To give a conclusion and short summary to the question posed in the introduction: *How is human consumer decision making influenced and affected by biases?* - Human thinking is influenced a lot by mental shortcuts.

Tversky and Kahneman have laid the foundation for many behavioural economic studies that show how biases and heuristics take advantage of the human fast thinking, i.e. System 1, in many decision-making processes. Especially moments that require quick decisions or have an overload of information (as happening in many purchase situations) are prime to fall victim to heuristic decision making (Kahneman, 2011) (Yoon et al., 2012).

Some researchers argue that the human brain is not designed for making decisions that require the mental energy of System 2 all the time. From an evolutionary perspective, the *“functioning of biological neural networks (‘System 1’ or ‘Type 1’ processing) [...] originally developed to perform more basic physical, perceptual, and motor functions.” (Korteling et al., 2018)* p.8).

Ramsøy et al (2012) also argue that contextual factors play a huge role in preferences and decisions and therefore rational behaviour is limited (Ramsøy et al., 2012).

These contextual factors are also difficult to include in clinical studies about consumer behaviour and decision making.

It also opens the question whether human decision making can be considered as either rational or irrational. Behavioural Economics researchers and Richard Thaler, Nobel Prize laureate in 2011, at the forefront, argue that people are predictably irrational. Thaler is most known for his work on the nudge theory (Thaler & Sunstein, 2008), which the student explains in further detail in the discussion. As this is a fundamental question of rational or irrational human behaviour and work for future research, the student closes this question in relation to this paper by citing neuroscientist Martin Skov from the interview: *"I think bias itself as a term is something that's related to the idea of irrationality"* (Appendix B). However, he also mentions that in his perspective, biases depend on experience and the accompanying stimulus are built into the reward system due to learning. This is also in line with Plassmann et al's (2012) decision framework where learning (4b) and experienced value (3) are interconnected (Plassmann et al., 2012).
The next subchapter analyses the role and effect of Neuromarketing, with a closer look into the commercial application of Neuroscientific techniques for Marketing reasons.

4.2 Intention and Effect of Neuromarketing in Practice

Neuromarketing, its academic classification, its influence from other fields, and its techniques have already been presented throughout this thesis. It has been therefore shown that the birth of Neuromarketing is depending on the particular perspective. It should be therefore understandable that it depends on the particular perspective to determine the birth of Neuromarketing.
The study of McClure et al (i.e. blind Coca-Cola vs. Pepsi Tasting) in 2004 is seen by many researchers as the first well-known application of neuroscientific techniques to understand commercially relevant consumer behaviour on a neurological level that has also been applied to practice by companies (Lee et al., 2007; McClure et al., 2004; Murphy et al., 2008; Ramsøy, T. Z. & Skov, 2014).
Since then, Neuromarketing has gained increasing attention by many scholars and academics, the public and the media, and of course, executives in businesses. Murphy et al (2008) call this the "Neurohype" and list ten companies that have specialised in Neuromarketing by 2008 (Murphy et al., 2008). Plassmann et al (2012)

show the high rise of Neuromarketing in academic and commercial fields until 2010 with an info-diagram, as seen in figure 4:

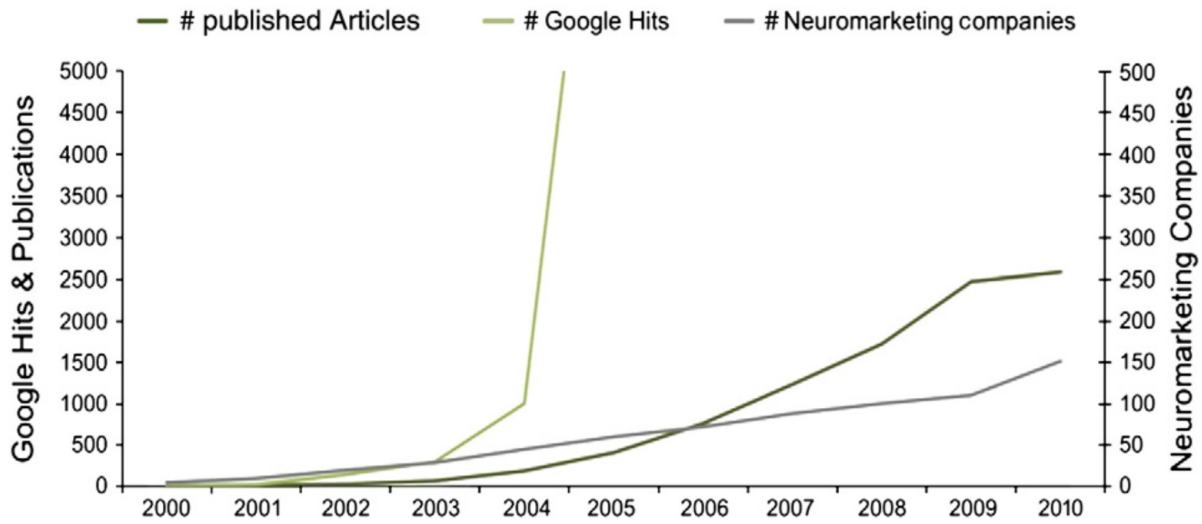

Figure 4: Growth of research applying neuroscience to marketing over time Source: Plassmann et al (2012)

The Neuromarketing Science & Business Association (NMSBA) has 46 members that are involved in Neuromarketing from over 30 countries. The list includes laboratories closely linked to Universities, privately held companies, and big research corporations with up to 44000 employees (NMSBA,).

The student investigated some of the companies mentioned by Murphy et al in 2008, current NMSBA members, as well as Thomas Ramsøy's company Neurons. The following paragraphs give a summary of a selection of companies and their business models, including the development over the last years, whenever publicly available. This is intended to give the reader an idea of the bandwidth of the Neuromarketing market. Niklas uses academic and peer-reviewed sources wherever possible. As a note, some of the now presented information about the companies does not have reliable, objectively confirmed sources, also due to the fact that some companies do not exist anymore, and neither do their websites and other platforms. The following ten companies have been chosen as a cross section of different companies; successful, bankrupt, or accused of fraud, also for a later evaluation of requirements for proper neuroscientific research, which is applicable for commercial practice.

EmSense was a commercial neuroscience company, founded in 2004 by a spin-off of seven researchers from MIT (Massachusetts Institute of Technology). The company collaborated with Microsoft for their Xbox and Coca-Cola to choose the right SuperBowl Ads with the help of their own invention, a special EEG that also promised to measure breathing, head movements, pulse and the skin temperature. According to Roger Dooley, researcher and author of popular-science Neuromarketing books, the company ran out of business around 2011, unable to attract more investors (Burkitt, 2009; Dooley,). Their website seems to be currently offline.

There is very little public information about **Lucid Systems**, other than it is or was a Neuromarketing company from California in the US that promised to deliver *“unimpeachable scientific data—telling you not what people say about your products, but what they truly think about them” (Abi-Rached, 2008)* p.1160). This information stems from an article published in a peer-reviewed scientific journal, citing the website at that time. Although the website still exists in 2022, there is no information about the company, its activities or even its legal status. The website is empty except for a contact formular for *“business inquiries” (Lucid Systems,)*. Based on articles in newspapers from 2008 to 2010, Lucid Systems was involved in monitoring voter’s brain activities via an EEG to monitor emotional responses and predict behaviour (abc News, 2009; Honan, 2009).

Nielsen Holdings is a conglomerate of several companies with in total over 44000 employees, all operating under the Nielsen name. **NielsenIQ** forms part of the NMSBA and has, according to the NMSBA website, offices in France, Germany, India, Italy, Mexico, the UK, and the US (NMSBA,). Nielsen IQ combines neuroscientific research with traditional market research (NielsenIQ,). Despite its size, there is limited public information on current work of the company, apart from the fact that it consults clients, including companies from the Fortune 500 list, on consumer decision making with the help of consumer intelligence. On LinkedIn, this company has almost 450000 followers and over 14000 employees at the time of this thesis (LinkedIn,).

NeuroFocus is the name of the next company, mentioned by Murphy et al (2008) in their paper *Neuroethics of Marketing*, published in the journal of Consumer

Behaviour (Murphy et al., 2008). NeuroFocus was founded in 2005 in California, US and acquired by Nielsen Holdings in 2011. By that time NeuroFocus was subjectively the industry leader, as stated by Penenberg (2011) in an article at Fast Company magazine, a news outlet for business media (Penenberg, 2011). NeuroFocus has been working with companies such as Hyundai, Google, Walt Disney Co., and PepsiCo. Neurofocus analysed consumer's reactions to a Cheetos (i.e. an American crisps brand by PepsiCo) advertisement that showed an immoral prank. Although consumers reacted unfavourably towards the ad in a focus group, EEG tests on the same participants revealed that they found pleasure in seeing the prank of how a woman puts orange cheetos in another washer at a laundromat, implying an orange colouration of the laundry (Burkitt, 2009). Although the list of well-known industry names that partnered with NeuroFocus seem to speak in favour of the company, all found information is quite old and even on the website of Nielsen, the owner of Neurofocus, searching for 'Neuromarketing' only showed three results, from 2011, 2012 and 2017.

Another company that Murphy et al (2008) mention is **Neuroco (Murphy et al., 2008)**. The company was founded in London in 2005, utilising EEG technology to study design, packaging and shopper behaviour of Fast Moving Consumer Goods. Neuroco was acquired by NeuroFocus in 2009 (Crunchbase,). Despite intense research, no more information was found about Neuroco, its business model or details about the acquisition.

Sands Research is a Neuromarketing company, founded in 2008 by Stephen Sands an Adjunct Professor in the department of Electrical Engineering and Computer Engineering at the University of Texas at El Paso and Ron Wright (Sands,). The company has around ten employees. Based on the running website of the company, their activities focus on applied neuroscience for customers, manufacturing and sales of neurophysiological equipment such as caps, gel and amplifiers for EEG, and a patent pending software called 'Neuromedia' to analyse group engagement and emotions via media (Sands Research,).

NeuroSense Limited was established in 1999 in the United Kingdom as one of the earliest Neuromarketing agencies before the spike in 2004. In a 2004 article published in nature neuroscience, a peer-reviewed journal by Springer, the chairman

Michael Brammer defended his company against allegations of conducting unethical and unscientific research for commercial exploitation. The accusations were formed by other researchers and published in *Nature*, *Science*, *Nature Neuroscience* and other academic journals (Brammer, 2004). The company was later acquired by Truthsayers, a British enterprise that sells SaaS-based technology with a neuroscientific background to measure and analyse employers and their satisfaction levels (Truthsayers,).

OTOInsights, or also ‘One to One Interactive’ was a company, founded in 2002, that tried to become the leading human experience firm. A company presentation from 2012 shows that they had offices in Boston, Baltimore, Salt Lake City, Reno-Tahoe, London and Singapore with over 140 employees and clients such as DIAGEO, Mercedes-Benz, Bentley, easyjet, Nokia, and even Greenpeace (Slideshare,). The company advertised its Neuromarketing research by using EEG as well as a vest, equipped with sensors to measure different body functions. The company filed for bankruptcy in 2010, also due to internal disputes (Justia,). All of their former website domains are for sale by domain sellers.

Neurons is a Danish Neuromarketing agency, founded by Thomas Ramsøy who is a professor at Copenhagen Business School, author of many of the cited articles in this research and colleague of Martin Skov. Neurons is an NMSBA member. Apart from its headquarters in Taastrup, Denmark, the company has offices in the US, Guatemala, India, Japan, Turkey and Brazil. Among its customers are Nintendo, Visa, Twitter, IKEA, Coca-Cola, TikTok and Google. Based on their website, Neurons offers three types of products to its customers: ‘Predict’, ‘Explore’ and ‘Research’. The first one claims to predict consumer behaviour by offering an AI-powered heatmap that simulates the user’s attention towards certain objects on a digital screen with 90% precision. ‘Explore’ lets customers create online panel studies to analyse customer attention, emotion, and cognition for TV and social media advertising, or static images. Neurons promises to recruit study subjects based on the customer’s target group and to deliver insights for customer motivation and linked behavioural associations based on standardised tests. The last offering from Neurons is ‘Research’ and ensures to provide real customer responses via EEGs

and Eye-trackers. This solution can be applied in stores, homes and on mobile devices (Neurons,).

The next company seems to be inactive, as their website is offline. **FKF Applied Research** was founded as a lab, closely linked to UCLA (University of California, Los Angeles) by three partners. One of them is Tom Freedman, who served as senior advisor to the president during the Clinton administration, and his brother Joshua Freedman, a psychiatrist, former UCLA neuroscientist and author of books about emotional intelligence (Wikipedia, 2022a; Wikipedia, 2022b). The company focused on fMRI scans to study decision making processes and to understand from a neurological level how the brain responds to leadership qualities. FKF put special emphasis on political campaigns in the US, to possibly predict voters' choices. Lindstrøm (2010) describes one of FKF's studies to analyse public response to campaign advertisements for the Bush-Kerry presidential campaign in 2004 (Lindstrøm, 2010). These predictions were also published in an opinion-editorial article in the New York Times, claiming scientific standards by using fMRI. Three days later, the New York Times published a letter from 17 neuroscientists that disagreed with the conclusions and questioned the scientific standards (Abi-Rached, 2008).
The research seems to have produced reverse-inferenced results, as the cited lead researcher for the study, Marco Iacoboni, drew most of his conclusions from the activation of the amygdala and the as negative perceived reactions to that.
At this point, it makes sense to explain the aforementioned reverse inference with the direct example of the FKF study. The researchers examined the neurological reaction of each ten democrats and ten republicans in an fMRI machine by showing them pictures of the US politicians George Bush, John Kerry, and Ralph Nader during the 2004 presidential campaign (Kaplan, Freedman, & Iacoboni, 2007). Statements, such as *"greater habituation of amygdala activity during the presentation of in-group faces, leading to greater amygdala activity over time in response to out-group faces. This change in amygdala activity may be a correlate of a perceived threat posed by out-group faces."* (Kaplan et al., 2007) p.56), show the problem of using a given brain activation for a *"one-to-one relationship between the brain activity and the mental process of such interest"*, i.e. reverse inference (Plassmann et al., 2012) p.22).

Martin Skov explains this as follows in the interview, conducted in May 2022: *“So I don't think that anyone today would say that the amygdala complex is specifically encoding negative emotions or negative effects. In fact, we know that the nuclei are, you know, little groups of neurons within the amygdala that encode both positive effect and negative affect and also encode both a positive motivational stance and negative motivational stance.”* (Appendix B).
Berns and Ariely (2010) confirm this view and say that it is not possible to take whole cognitive processes like decisions and reduce them to *“a single area of activation”* (Berns & Ariely, 2010) p.286). Martin Skov explains this further: *“So what actually happens in any concrete situation when you respond to a stimulus is that all these systems are collectively engaged and probably the actual outcome, whether you, for instance, find a given object attractive, if you want to acquire it, if you want to spend money on it, is a result of a coordination of activity, neural activity across all these neural systems.”* (Appendix C).

All of the reviewed information about reverse inference, combined with the presentation of different Neuromarketing agencies, some successful, some bankrupt, and some charged with accusations of fraud, let two question from the introduction come back to mind:

1. *What are the requirements to conduct a proper academic and scientific Neuromarketing research that is also applicable to a commercial scenario?*
2. *What are the legal and ethical implication of Neuromarketing and what are, or should be the regulations for practitioners?*

The first question is answered in the following paragraphs and also taken into the discussion chapter. The second question is answered in the next subchapter, 4.3 The View upon Neuromarketing, the attempt to influence Decision Making, and its Ethical Implication.

One way of understanding the success of some Neuromarketing agencies and the failure of others is looking at their research methods (as much as publicly available) and see with what kind of academic and scientific standards they work.
FKF has been a prime example for a research with flaws and noise that influenced the validity of the studies and hence the reputation of the reliability and seriousness

of the company. Ten Neuromarketing companies have been presented in this chapter, to give the reader a representative overview of the bandwidth of commercial offers.

Four companies are either listed as bankrupt, have their website offline, are generally not available anymore, or all former combined (i.e. EmSense, Lucid Systems, OTOInsights, FKF Applied Research).

Three companies have been acquired or merged with other Consumer Research companies (i.e. NeuroCo, NeuroFocus, Neurosense).

Three companies are still existing and operate until today:

- Sands Research, which is closely linked to the University of Texas at El Paso. They also sell EEG equipment to other laboratories;
- NielsenIQ, which forms part of a big corporation for consumer and market research. They focus on consumer intelligence, but not specifically Neuromarketing;
- Neurons, the company by Thomas Ramsøy, who sells software to predict consumer responses and specially designed studies for customers by using EEG and Eye-tracking (Neurons, ; NielsenIQ, ; Sands Research,).

By taking a closer look at the offerings of the operating Neuromarketing companies, it shows that none of them seem to work with fMRI anymore. This has several reasons.

In the 2000s, fMRI was praised as the best machine to look into the human brain and see the different areal activations due to the tracked increase in oxygenated blood (Berns & Ariely, 2010).

However, there are not many fMRI scanners due to the high costs of purchasing and maintenance, the requirement of having skilled professionals who can use the fMRI, and the fact that the machines are very big in size. Furthermore, fMRI machines are a highly artificial test environment, with a lot of loud sounds coming from the scanner, the requirement to the study subjects of lying completely quiet in a narrow iron tube and the clinical setting around the machine. All of this is considered to be very noisy, i.e. "*Irrelevant or meaningless data or output occurring along with desired information"* (Merriam Webster,).

It therefore leads to a different behaviour of the study subjects that would not act the same way in a real situation, without all the surrounding distractions. As there is a

different behaviour, the decision making also changes which leads to a lower validity of the study or even wrong assumptions and conclusions. Lee, Amir and Ariely (2009) call this the lack of ‘ecological validity’ which means that a study is not able to claim that the responses that people give are comparable to choices in a real life situation (Lee, L., Amir, & Ariely, 2009).

In summary, the first requirement for a neuroscientific research that can be applied for companies in a realistic commercial scenario is the reduction of artificial noise and the ecological validity of the study.
Neuromarketing tools that are less invasive and intrusive during tests are EEGs and Eye-Tracking devices. Due to the technological progress in the last years, these devices have become smaller and mobile now, i.e. wearable, and have therefore a better applicability to in-store testing like in supermarkets or other environments (Gaskin et al., 2017). This is a big aid for reducing noise and impulse distortion. On top of that, EEGs and Eye-tracking wearables track data also more reliable while being less expensive to previous models and especially in comparison to fMRI scanners.
More requirements for valid research which fulfils academic standards and that can be used for commercial purposes alike are shown in a practical example now.
As a disclaimer, this research was done by Neurons and it was not possible for the student to confirm its authenticity and reliability, due to the fact that no further sources were given. The example stems from a case of Neurons in cooperation with Lowe’s, an American retail and home improvement company, made public in a Neurons Youtube video from October 2020 where Thomas Ramsøy, CEO and researcher, explains the study. This is the only publicly available information that was found, as there are no further sources in the description, nor on the company website, Google Scholar or the AAU library. The only validity comes from a logical explanation and the ‘reputation’ of Thomas Ramsøy as a professor at CBS in Denmark and him being a well known researcher in that field (Ramsøy, T. Z., 2020).

Neurons did a study for Lowe’s in the US to test to what extent consumers, which are exposed to an ad previously, would change in-store behaviour. To conduct this experiment, Neurons created three groups of test subjects that were all set up with Eye Tracking and EEG devices. Eye Tracking to measure the attention and to create

a heat map, based on the focus and the time that the subjects spend on one detail in the store, as seen in figure 5. The EEG measured the emotional responses, such as motivation.

Figure 5: Eye Tracking & EEG Neuromarketing Study for Lowe's Source: (Ramsøy, 2020)

All three groups were set up and calibrated in a different room, before going into the store, while watching different ads. The task was, among other purchases, to buy some paint for their house. The control group only saw ads without the specific paint brand that was part of the experiment. The second group saw the ad for the specific paint brand among others, and the third group had a longer exposure of commercials for the given paint brand. After the participants went through the store and bought all required materials for the experiment, they were asked a couple of questions towards their choices. Although most test subjects remembered seeing an advertisement about paint, they denied having been influenced by it. However, the results, as seen in figure 5, show a different result. The groups that were exposed to the commercial had a stronger attentional response. The EEGs tracked furthermore an increase in motivational response, in comparison to the control group that stayed rather neutral.

According to Thomas Ramsøy, the data was analysed and interpreted by neuroscientists, and denoised, to avoid false assumptions. Unfortunately, he does

not specify the analysis of the data and the techniques to do so, nor the denoising process.

Berns & Ariely (2010) have described some of their ideas about standard criteria for hiring Neuromarketing companies. They argue that independent of the simplicity of the study, the sample size should be at least 30, preferably more, to avoid wrong assumptions based on individual behaviour. The researchers also advise to ask for a *"'bootstrap' — for example, testing on a 'fresh' subsample of data"*, to check the robustness of data (Berns & Ariely, 2010) p.290). They name some further criterias which are mostly of specific technological nature and do not apply anymore, due to the article's release in 2010 and the technological advances.

Ironically, Dan Ariely, who specifically writes about *"the hope and hype of neuroimaging in business"* and *"the ethics of Neuromarketing"* (Berns & Ariely, 2010) p.289) has been accused of data fraud and academic misconduct in August 2021 (O'Grady, 2021). He allegedly changed data sets for his studies, one even about honesty (The Economist, 2021). This behaviour demonstrates the importance of an analysis and open discussion about morale and ethics in neuroscientific and behavioural research, not only in this thesis but also on a higher level at universities and research institutions.

In conclusion, it can be said that there are different requirements for a reliable commercial application of Neuromarketing. Signs for proper conducting and testing are:

- The reduction of noise,
- Ecological validity, a control group on top of the study subjects,
- A calibration procedure of the tracking devices,
- Neuroscientists that are able to read out and interpret the data in the right context,
- The avoidance of reverse inference.

After the presentation of different Neuromarketing agencies, their development and the deduction of standards for an academic Neuromarketing application, the previously formulated question about the image and ethical implication of Neuromarketing is answered in the following chapter.

4.3. The View upon Neuromarketing, the attempt to influence Decision Making and its Ethical Implication

Neuromarketing has created a lot of debates, not only in academic circles but also in the public media, due to the many promised opportunities,- sometimes serious, sometimes not. Together with the public attention, the spotlight has also always been on the ethical and moral implication of applying neuroimaging techniques for a commercial output.

However, there have been claims about influencing consumer decisions through conscious or unconscious messages long before the rise of neuroimaging techniques. One of the best known ‘studies’ that received a lot of attention, not only by researchers but especially by marketers and the public was in 1957. A marketing clerk announced that he had increased sales of popcorn and Coca-Cola in a US cinema by manipulating filmgoers’ minds to consume more. He claimed his success on flashing short messages, not visible to the human eye, in between the frames of movies. The signs read ‘Drink Coca-Cola’ and ‘Eat Popcorn’ (Murphy et al., 2008). This statement sparked a lot of furious and concerned reactions by the public at that time, drawing parallels to ‘Brave New World’ and ‘1984’. Moore (1982) cites two articles from The Nation and The New Yorker, saying that this case of subliminal advertising was *“the most alarming invention since Mr. Gatling invented his gun”*, and that *“minds had been entered and broken”* (Moore, 1982) p.38). Without any scientific proof, neither from the inventor nor from researchers trying to reconstruct the experiment, this was rapidly debunked as a marketing gag in academic circles. However, the myth about simple, successful and subconscious consumer priming lived on for a long time in the public media.

With the beginning of the 2000’s and the advances in technology that let researchers conduct more studies about the human brain, especially in a consumer context, these old fears about manipulation, consciously and unconsciously, have come up again. Especially the hype about the *“Buy Button in the Brain”* in the early 2000’s has put new fuel to this decade-old debate (Berns & Ariely, 2010) p.286). The ‘Buy Button’ was advertised by authors of pseudoscientific and popular scientific authors, such as Renvoisé & Morin (2007) in their book ‘Neuromarketing - Understanding the “Buy Buttons” in your Customer’s brain’, Martin Lindstrøm (2010) with his book

‘Buyology’ and indirectly by Robert B. Cialdini in ‘Influence’ (Cialdini, 2014; Lindstrøm, 2010; Renvoisé & Morin, 2007).

This has been scientifically disproven by many researchers by now, foremost because reducing cognitive purchase decisions to one single area of the brain is a classic example for the aforementioned reverse inference (Plassmann et al., 2012). Nevertheless, even well reputed and respected researchers have been tempted, for different motives, *“to provide simplistic answers to what in reality are highly nuanced questions”* regarding possible neurological explanations for consumer behaviour (Murphy et al., 2008) p.297). Murphy et al (2008) continue to argue about the image of Neuromarketing. The following paragraphs present the opinion and ideas towards the ethics of Neuromarketing of some accredited and accepted researchers in the academic community, including even the written statements of Dan Ariely due to his ongoing popularity and reach.

Antonio Rangel answers to the question about ethical regulations in an email to the student by saying *”Same principles as in other domains: consumer protection and social welfare should drive regulatory decisions. Problems are similar than, with say, data collection by tech companies.”* (Appendix C). Martin Skov goes into the same direction when being asked in the interview: *“There's general data protection laws that should be applied. So whenever you measure the brain in terms of activity, certainly there should be rules about how, what kind of information you acquire, how you use it, how it can be related back to individual brains and so on.”* (Appendix B).

Berns & Ariely (2010) represent the opinion that the study subjects have to be previously informed about the research, and the data should only be applied within the context of the research (Berns & Ariely, 2010).

Murphy et al (2008) agree with the claim to protect groups and individuals alike, who might be hurt, harmed, damaged or exploited by Neuromarketing (Murphy et al., 2008).

There are two specific groups of people that have to be protected. The first group are the test subjects of the individual neuroscientific studies. Their data has to be anonymised and the findings should not be applied back specifically to the analysed subjects. The second group includes all especially vulnerable people, like the

psychological or neurological ill, pathological gamblers, drug addicts, and children. Berns & Ariely (2010) call this the exploitation of *“a biological ‘weakness’ that only exists in some people.”* (Berns & Ariely, 2010) p.289).

Furthermore, there should be a *“full disclosure of goals, risks, and benefits”*, according to Murphy et al (Murphy et al., 2008) p299). Lee et al (2007) raise the concern that some people might put too much trust in neuroscience information, as they do not fully comprehend the given information (Lee et al., 2007). Weisberg and her team of researchers conducted a study at Yale University in 2008 that shows people trusting a statement containing a neuroscientific explanation, even when the information is clearly irrelevant to the argument. They write: “*The presence of neuroscience information may be seen as a strong marker of a good explanation, regardless of the actual status of that information within the explanation. That is, something about seeing neuroscience information may encourage people to believe they have received a scientific explanation when they have not.” (Weisberg, Keil, Goodstein, Rawson, & Gray, 2008)* p.2).

The legal situation for using fMRI scanners in studies, at least in the UK, is summed up by Michael Brammer (2004), the chairman of NeuroSense at that time. As he is defending his company and himself against accusations of unethical behaviour, he argues that there are no machines in the UK, which are free from ethical control and all experiments with fMRIs, whether commercial or not, must receive ethical approval (Brammer, 2004). However, the use of fMRIs has been drastically declined, due to the aforementioned reasons of noisy data and the technological advance of other neuroscientific tools like EEG and Eye-Tracking.

As some basic principles for ethical standards have been presented now, the student would like to introduce the reader to the personal opinion of Martin Skov, co-author of many articles and colleague of Thomas Ramsøy, as well as reputed neuroscientist himself. This statement is a bit longer and Niklas will elaborate and comment on it in the discussion chapter. The whole Interview can be read again in Appendix B.

“Well, I would just quickly say to you on this topic that for me personally, I do not believe a lot in Neuromarketing. I could see… I'm sorry… I have to say, I think that a lot of it is like a kind of intellectual fraud. So, for instance, the idea that there's like a

buy button and you can set up a company that can promise to marketers so that you can design specific marketing actions that will, you know, elicit buyer behaviour. I think that is baloney. One of the big reasons for this is just said that there's a huge variation in how individual brains compute hedonic liking for stimulus. So it's impossible to design anything, any like visual design or a brand or whatever that will persuade all people that they should like it more or should, you know, be more willing to buy a specific product.

This is simply not possible.

And for this reason, I also think that the idea that you can sort of describe the brain as endowed with specific tendencies to do specific things is baloney. I don't believe in that. I also want to just, you know, suggest another thing to you, which is that what people do in neuroscience is something that's already being done by marketers without using fancy technology. So they are already manipulating people just using words and intuitions about, for instance, if you boost people's mood by showing them nice pictures, you know, happy children of people laughing, they will eventually like whatever they see associated with that better. So this is, I think, something that's already well understood by marketing people. You don't need any scanner to tell you this. And it is also, I think, simply words to some degree. Otherwise, I don't think people spend billions of dollars on marketing campaigns. So you might just ask, should we even allow marketing? I mean, it's certainly a type of manipulation. However, you come up with your campaigns and what you think is happening in the brain. So that's sort of my off the cuff remark about this." (Appendix B).

5. Discussion

The statement of Martin Skov about Neuromarketing and its effectiveness is without a doubt a very honest and strong opinion on many levels. The student would like to use the discussion chapter as a place to give a chronological account of the student's own creation of knowledge and opinion building throughout the writing process.
Niklas explains the idea behind the thesis, the initial image he had on the topic and how it shifted over time and with more exposure to the topic, via academic sources, popular-scientific books, personal statements such as of Martin Skov, statements of scientists and researchers in conferences, videos, blogs and more. Niklas also elaborates further on the increasing influence of Behavioural Economics in the thesis, from the beginning of the writing process until this moment.

Prior to the beginning of this summer semester in 2022, the student was looking for possible research topics for his master thesis in Marketing at Aalborg University. By coincidence he stumbled upon a TED Talk on Youtube where Patrick Renvoisé explained the basic idea of a "Buy Button" inside the brain. Fascinated by the idea, Niklas started to watch more TED Talks by other speakers about Neuromarketing and ordered the book of Patrick Renvoisé and Christophe Morin, about "Understanding the "Buy Buttons" in Your Customer's Brain" (Renvoisé & Morin, 2007). The initial idea for the thesis was to apply Neuromarketing to a practical scenario such as the gambling industry. Niklas was in contact with the Gauselmann group, a German gambling corporation with brands such as Merkur. As the company could not see a match between a thesis about Neuromarketing and their own corporate strategy, the student decided to write about Neuromarketing on a more descriptive level and to discover throughout the writing process of the thesis the bigger picture of the science of consumer decisions. The first and second draft of the introduction were still written without much scientific knowledge, but with a huge personal interest and a fascination with the idea of a "Buy Button" in the brain. After reading further popular scientific literature such as "Buyology" by Martin Lindstrøm (Lindstrøm, 2010) and "Influence" by Robert P. Cialdini (Cialdini, 2014), the student was disillusioned and questioned the effectiveness of Neuromarketing for the first time. At that time, Niklas enrolled in an online course about Neuromarketing at

coursera, an open online course provider. The lecturing professor was Thomas Ramsøy, recorded from the premises at Copenhagen Business School. The student got influenced by that course and especially the provided compendium of scientific, peer-reviewed literature and started to get an idea on what Neuromarketing is, i.e. on what other fields and influences it is founded. At the same time, Niklas started reading more of the book “Thinking, Fast and Slow” (Kahneman, 2011). The four proposed research questions were Niklas honest questions and at the same time the guideline, to approach the topic of consumer decisions from a neuroscientific background. During the assembly of the theoretical background, the student first started to understand the huge bandwidth of Neuromarketing and that he could only scratch on the surface of many interesting topics due to the sheer size and depth of all the related scientific fields. The decision making process and particularly the way that marketers could influence this process ignited Niklas huge personal interest again. Especially heuristics, biases and mental shortcuts seemed to be an interesting topic, as they inflict with rational decision making. As the student had already decided to write a thesis about Neuromarketing and the neuronal processes in the brain, the theoretical background introduces Behavioural Economics just as one of the influences for Neuromarketing. However, due to the personal development of Niklas opinion about Neuromarketing and further supported by the revelations of Martin Skov in the interview, Niklas started to have an increasing interest in the psychological factors and less in the neurological interpretation of decision making processes.

The analysis chapter is the attempt to reconcile Neuromarketing with Behavioural Economics, based on the same focus of understanding and influencing a consumer decision.

While analysing the different Neuromarketing companies, it showed that there are a lot of fraudulent offers in the market, just as Martin Skov says in the interview with the student. Even well-known researchers such as Dan Ariely have been accused of fraud and having worked closely with the white house like Tom Freedman from FKF is also no guarantee for a flawless and accurate practice.

This leads to the question if Neuromarketing really is *‘baloney’*?

The conclusion for Niklas is not completely clear and definitely ambivalent. In general, the student does not see a higher success-rate with Neuromarketing than

with traditional Marketing approaches. This is in line with Martin Skov's statement. However, Neuroscientific consumer research can do important fundamental research. One example is a study by Knutson et al (2007) that shows via fMRI scans how a choice in the human brain is done 8-12 seconds before the person is consciously aware of it (Knutson, Rick, Wimmer, Prelec, & Loewenstein, 2007). Nevertheless, taking these basic studies and exploiting them commercially, just with a minor calibration for the exact business case does not seem to make Neuromarketing companies automatically successful. The presentation of ten companies from that field have shown how much Marketing and how little Neuroscience some contain.
On the other hand, the student also introduced Behavioural Economic research, such as biases and heuristics. The student is of the opinion that insights and empirical tests in the psychological field of Behavioural Economics are not only valuable basic research, but also better applicable in commercial environments.
A good example for this is provided by Richard Thaler, beside Daniel Kahneman one of the other five Nobel laureates within Behavioural Economics (The Nobel Prize,).

Thaler is most known for the nudge theory, a concept to take advantage of judgemental heuristics of people. A nudge, i.e. an asymmetric intervention, should *"motivate choices with positive environmental outcomes"* via heuristics, so whenever the fast thinking System 1 is used (Campbell-Arvai, Arvai, & Kalof, 2014) p.453). As decision making often happens in situations that require a quick choice due to time pressure, an overload of information, and cognitive capacity limitations, consumers often choose suboptimal outcomes (Yoon et al., 2012).
The idea behind *nudging* is that whenever a choice has to be made, as for example in a cafeteria between different food options, judgemental heuristics can be used to guide the decision maker towards a choice with a positive outcome. Thaler & Sunstein (2008) explain the cafeteria example in their book as follows: The cafeteria has to decide over a structure or layout in which they organise the food. The responsible person for such a plan is called a 'Choice Architect'. A choice architect has the responsibility for organising the context in which people make decisions, as to what kind of food the cafeteria customers are exposed to first upon entering. As a choice between food is inevitable for a hungry customer in that scenario, Thaler & Sunstein (2008) raise the question why the choice architecture should not lead to a

good decision making (Thaler & Sunstein, 2008). They make the case that installing a salad bar at the entrance and moving the unhealthy food options such as junk food to a less visible area guides, i.e. nudges, people towards the healthier option.
However, it is important to point out the freedom of choice by the customer between healthy or unhealthy food. The junk food is not banned from the cafeteria and customers can avoid the positive nudge by just walking around the salad bar. Nudges are therefore not mandated. Campbell-Arvai et al (2014) have tested Thaler's & Sunstein's (2008) assumptions about healthy and sustainable food choices in a real life study at a campus cafeteria at an American university. In their study they try to nudge cafeteria visitors towards a vegetarian food choice. Their findings show *"a significant influence on participants's choice of a meat-free menu option"* and conform to Thaler & Sunstein's (2008) theory (Campbell-Arvai et al., 2014) p.465). Another well-known example for the effectiveness of a nudge are the installations of a fly-image in the urinals at Schiphol Airport in Amsterdam. The airport staff found that *"etchings reduce spillage by 80 percent"* in comparison to urinals without a printed fly for which men can aim at (Thaler & Sunstein, 2008) p.9).

Because of the aforementioned examples and further studies which are not displayed and elaborated here due to the limited size of the thesis, the student sees more commercial potential in Behavioural Economical techniques than in Neuromarketing. As Martin Skov describes it, every kind of Marketing, whether on a psychological or on a neurological level tries to manipulate, i.e. influence the consumer in its opinion (Appendix B). Based on the gathered information throughout the process of conducting this thesis, the student does not see the superiority of Neuromarketing techniques for a broad consumer audience. Nevertheless, consumer scientific research on the basis of behavioural economic models, such as the different biases, combined with EEG and Eye-tracking might be interesting in the future, especially as technological advances allow more and more real-life and instant cognitive tracking.
Future applications might include virtual reality (VR) technology for example, to test and adjust situations that are prime to judgements under uncertainty. Attention towards food choices in a virtual cafeteria or a supermarket could be measured with the help of VR glasses and the environment could be adapted to different scenarios without the real cost and time of rearranging the test area.

6. Conclusion

This thesis tries to give the reader an overview of Neuromarketing and its techniques under the light of consumer decision making. In addition to Neuromarketing literature, the student also presents a first introduction into Behavioural Economics and the psychological view on consumer behaviour. Both fields are intertwined, together with further academic fields such as Neuroeconomics. Consumer decision making can be explained in many ways, depending on the specific view and research angle. This thesis is an attempt to show different decision making research and examples from studies, combined with an analysis of commercial applicability of Neuromarketing and Behavioural Economic concepts.

The student raises four questions in the introduction that are investigated throughout the chapter of the paper.

The first question regards theoretical and practical Neuromarketing methods and their functionality. The student presents the theoretical Consumer Decision Making Framework by Plassmann et al (2012), and fMRI, EEG and Eye Tracking as practical tools and techniques. This is further supplemented by Behavioural Economic theory such as heuristics and biases. fMRI scans are most often not anymore applied in consumer research, due to the distracting stimuli and a different consumer behaviour. EEG and Eye Tracking have been further developed and are applied in neuroscientific consumer research, due to their better mobility, decreased costs and higher reliability. Heuristics and biases describe consumer behaviour from a psychological standpoint and have been proven in empirical studies. One practical application from it is nudging people towards a decision outcome by taking advantage of mental shortcuts.

The second question concerns the different requirements for a reliable commercial application of consumer based neuroscientific research. By showcasing ten Neuromarketing companies, their services and development since the 2000’s, the student deduced the following signs for legitimate conducting and testing: A reduction of noise, ecological validity, control groups, proper calibration of test devices, employment of experts and the prevention of reverse inferences results.

In answering the third research question about the ethical implication of Neuromarketing, Niklas identifies some popular myths about the effectiveness of

Neuromarketing, proposals of ethical standards by researchers and their own shortcomings sometimes.

The fourth question about the influence and effect of biases is answered by a presentation of common heuristics and mental shortcuts and how the human mind prefers employing System 1, as the fast thinking entity.

In conclusion, it can be said that Neuromarketing is a very interesting field of research, especially when taking the bigger picture of behavioural decision making into account. There are certain limitations to the commercial exploitation of Neuromarketing as mentioned before. However, future developments in technology like virtual reality might require a new evaluation of consumer based neuroscientific research.

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