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NEUROMARKETING

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Abstract

Neuromarketing is an interdisciplinary field merging neuroscience and marketing, holds great promise for understanding consumer behaviour. This paper provides a concise overview of the historical foundations of neuromarketing, the brain areas that affect decision-making, and major techniques or methodologies to measure brain responses to marketing stimuli (the most common being Functional Magnetic Resonance Imaging, fMRI or Electroencephalography, EEG). It also aims to display some real examples of applied neuromarketing in the business environment (Procter & Gamble, CocaCola, Pepsi...), and key findings from substantial neuroimaging studies, while analysing its challenges, such as limited empirical documentation or ethical considerations. To further picture the overall context of neuromarketing, potential opportunities for businesses in the technological era, among other fields, are presented.

El neuromarketing es un ámbito interdisciplinario que combina la neurociencia y el marketing, presenta ventajas prometedoras a la hora de comprender el comportamiento del consumidor. Este documento introduce la historia y fundación del neuromarketing, así como las partes del cerebro que afectan a la toma de decisiones, y las técnicas más significativas utilizadas para medir las respuestas neuronales frente a estímulos de marketing (como la Resonancia Magnética Funcional, o la Electroencefalografía). También expone algunos de los ejemplos reales de marcas e industrias que han utilizado neuromarketing (Procter & Gamble, Pepsi y Coca Cola), así como sus descubrimientos más importantes. Cabe mencionar que esta disciplina, como todas, se enfrenta a retos, como su escasa documentación o consideraciones éticas. Con intención de establecer un marco global acerca del neuromarketing, se explican algunas oportunidades para el futuro, como el auge de las tecnologías y la inteligencia artificial, y su relación con la publicidad, entre otros.

1. NEUROMARKETING

1.1. THE CONCEPT OF NEUROMARKETING

The most optimum way to introduce neuromarketing, following its name formation, would be to present an academic definition of its core basis: marketing. "Marketing is an organisational function and a set of processes for creating, communicating, and delivering value to customers and for managing customer relationships in ways that benefit the organisation and its stakeholders" (Kotler et al., 2012). Understanding customers' data is crucial for every business willing to thrive in the market, gathering both quantitative and qualitative information about their lifestyle, preferences, personality, and feelings to better create innovative strategies, attract potential consumers and adapt in today's highly competitive landscape. Traditional data collection is suffering from limitations when obtaining accurate results. "In some studies, the failure rate of new products is set at 90%" (Iloka & Onyeke, 2020, p. 30). Occasionally, survey participants have not given precise answers due to multiple reasons, such as the level of personalisation of the experiment, the reliability and honesty of their verbal responses or the surrounding conditions (comfort, motivation, peer pressure...).

With time, neuroscientific research has experienced promising results which have led to a common interest, especially in the economic sector. Neuromarketing has emerged as a rapidly growing field that combines psychology, economics, neuroscience, biology, marketing and many other disciplines, to obtain efficient results, as it targets subconscious processes underlying consumer behaviour and decision-making. It is known that around 90% of purchase decisions are made subconsciously, with difficult logical or verbal explanations (London, 2017). Businesses have been gifted with a tool that, if used correctly, can be used to adapt and create marketing projects that better target their customers and lower the risks of wasting valuable efforts (economic, normally). Is it possible for neuromarketing to uncover concealed insights that are not readily visible through other methods? Does neuromarketing offer a more efficient cost-benefit ratio than other marketing research methods? Can neuromarketing furnish preliminary feedback regarding product design? (Ariely & Berns, 2011).

According to Harrell (2019), neuromarketing refers to the measurement of physiological and neural signals to gain insight into customers' motivations, preferences, and decisions, which can help inform creative advertising, product development, pricing, and other marketing areas.

As a consequence, it is possible to conceive the effect a high price has on our brain activity (which, curiously, creates the same feeling as getting pinched) (Dooley, 2011), adjust prices to the appeal and enjoyment of customers, benefit from detailed knowledge to advertising emotional engagement by measuring an audience's neural activation while being exposed to it or determine in-store emotions at brick-and-mortar shops (Ramsøy, 2019). Neuromarketing studies have even proved that audiences feel much more connected to brand ambassadors rather than brands themselves (Ariely & Berns, 2011). Marketing has become multidimensional, going beyond the visual perception, but the subconscious, affected from all senses (Harvard Business Review, 2015).

Still not being fully established, the use of neuroscientific techniques (which will be explained in depth in the following pages), like neuronal responses, brain activity or physiological examination (such as eye movement or heart rate) to optimise marketing results has come with a strong foundation and interest. Nonetheless, how efficient is neuromarketing for a business alongside its performance in time and its resources? Is it viable to get ahead of consumers' subconsciousness and predict their purchase decisions? What are the limitations of neuromarketing practices? Should there really be a concern regarding consumer influence and its ethical implications?

According to Hill + Knowlton Strategies "Neuromarketing works for one reason: People don't always know what they want or what exactly they like about something. What's more, brains don't lie, and they don't get embarrassed. Sometimes, if you want to know whether an ad campaign or messaging plan will resonate, it's best to go straight to the source" (2017).

1.2. NEUROSCIENCE

The School of Neuroscience at the King's College London defines neuroscience as the exploration of the nervous system, mainly centred in the brain and its structure, function, growth and the neuronal connections shaping behaviour (2023). Consumer neuroscience is a rapidly growing field that focuses on understanding the subconscious processes that drive consumer decision-making.

Research has shown that a staggering 95% of purchase decisions are made subconsciously (Mahoney, 2003), highlighting the importance of this field for marketers and businesses. Cognitive neuroscience plays a crucial role, as it provides insights into the biological foundations of human behaviour. While neurology focuses on clinical research on patients with nervous system disorders, consumer neuroscience concentrates on assessing the responses of consumers (Iloka & Onyeke, 2020). It is considered to be part of the

NeuroPsychoEconomics research (Harris et al., 2018), along with neuromarketing, although it would be adequate to make a distinction between the two.

Another distinction to understand would be that of neuroscience and neuromarketing: the first referring to the academic research itself, as stated above, and the second targeting business practice through the application of the results of such research (Kenning & Hubert, 2008).

Consumer neuroscience has not only been useful for the development of neuromarketing; but for consumer psychology, finding patterns of behaviour in decision-making and strengthening prediction theories, complementing other research methods in the field; and customers themselves, “by being presented with products that they actually desire” (Karmarkar & Plassmann, 2019, p.288)

1.3. NEUROECONOMICS

The field of neuroscience has brought about tremendous advancements in understanding of the human brain and its functions, notably analysing human decision-making. However, when it comes to understanding the complex relationship between brain activity and economic decision-making, it is crucial for neuroscience researchers to collaborate with economists.

Neuroeconomics, stands for “an emerging transdisciplinary field that uses neuroscientific measurement techniques to identify the neural substrates associated with economic decisions” (Zak, 2004, p. 1737). In this sense, it plays a crucial role in the study of neuromarketing, as economics is the study of decision-making essentially, an effective distribution of limited resources, in an environment of unlimited necessities. It springs from the study of bioeconomics, which submit frameworks for the analysis of human behaviour.

This collaboration between neuroscience and economics can help provide a more comprehensive understanding of the underlying mechanisms for researchers and economic agents, leading to more effective marketing strategies and improved economic policies thanks to the extensive knowledge on how the brain influences consumer behaviour. On the one hand, neuroeconomics has offered economics the prediction of economic and social behaviour thanks to established patterns, leading to the ability to address undetermined questions in the field. Regarding neuroscience, neuroeconomics brings multiple demands related to decision-making with their corresponding scientific analyses and studies.

Some of the most relevant research applications and findings of neuroeconomics include: reward acquisition, certainty, ambiguity, and gratification delay, learning and

strategy, and cooperation. “Neuroeconomics provides a unified framework to measure neurophysiological activity during the process of choice, and in doing so opens a window into human nature” (Zak, 2004, p. 1746).

Correspondingly, as marketing in economics, neuromarketing is included in the scope of neuroeconomics, focusing on the private sector and marketers’ interests to promote a product, brand or service in the most efficient way.

1.4. HISTORY, INTRODUCTION AND EVOLUTION OF NEUROMARKETING

Despite being a relatively new concept, the birth and evolution of neuromarketing should be considered when presenting an overall analysis of the term, bearing with the limited quantity and availability of works explaining its development. The first time this discipline was mentioned in academic papers and studied in its very nature was in 2002 by Dutch professor and Nobel Prize winner in Economics Ale Smidts, in his article “Kijken in het brein” (“Looking into the brain”) (Smidts, 2002). The paper was later translated into English with the name “Looking into Neuromarketing”, which gave insight into the application of neuroscience methods by professionals working in the marketing industry (Cenizo, 2022).

It “developed in close relation to the more general research on the neuroscientific basis of decision-making, commonly referred to as neuroeconomics or decision neuroscience” (Levallois et al., 2021, p. 2). It is important to differentiate neuromarketing with applied, consumer, or advertising psychology. The first consideration of psychology in marketing dates back to 1895 by Harlow Gale, interested in the effect persuasion, memory, and attention from consumers have in advertising (Brooke, 2022). To be more specific, Iloka and Onyeke (2020, p. 29) state “neuromarketing is a branch of study that was previously communicated to focus on the application of consumer neuroscience in the marketplace by employing neurophysiological tools (such as functional magnetic resonance imaging, eye tracking, and electroencephalography) to conduct specific researches with particular focuses on the market.”.

1.4.1. Neuromarketing techniques in the 20th century

The use of brain-analysing techniques with business purposes began much earlier, before they were gathered into the idea of neuromarketing. As a matter of fact, the late 1960s inaugurated this process with several studies analysing an audience’s pupil dilation effects while watching multiple commercials (Krugman, 1965), although subsequent studies

debunked the common thought of pupils dilating to enjoyable advertising, but for the single reason of processing information (Arch, 1979). During these years, galvanic skin response and eye-tracking were also analysed by academic researchers (Levallois et al., 2021).

A decade later, Michael Rothschild, Professor of Business at the University of Wisconsin-Madison published a series of papers evaluating subjects' responses to television promotions through electroencephalogram (EEG), and seeing significant changes in neurological patterns according to the observed imagery. Well-known companies like Coca-Cola, Ford or Levi-Strauss requested pioneer centres in the field for market research based on neurotechnology and biometric testing. However, as many business-scientific works of the time, were kept confidentially (Márquez, 2017).

Thereon, thanks to the rapid advances in neuropsychology and neuroimaging in the 1990s, techniques such as positron emission tomography (PET) were used by Harvard Professor Gerald Zaltman studying "consumer responses to alternative retail environments" (Kosslyn et al., 1999) who, together with cognitive neuroscientist Stephen M. Kosslyn, launched a patent for "Neuroimaging as a marketing tool" in 1999 (#6099319). (Zaltman & Kosslyn, 1999). This patent was acquired by the organisation Neurofocus in 2008.

1.4.2. Expansion of neuromarketing in the 21st century

Primary neuromarketing-specialised consulting firms in history are Joe Rezman's Brighthouse Company (Brighthouse Institute for Thought Sciences), founded in 2002, using functional magnetic resonance imaging (fMRI) in market studies for the first time (Teboul, 2016, p. 73) and associated to Emory University (Fernández, 2014); along with SalesBrain, a still-functioning business with its patented model called Neuromap, "a proprietary persuasion model to improve sales and marketing results applying cutting edge neuroscience and media psychology" (SalesBrain & Morin, 2002).

Neuromarketing achieved greater recognition in 2003 stemming from the Forbes cover page titled "In Search of the Buy Button" (Wells, 2003), which described real-life cases, testimonials and general information about the discipline. This article made substantial noise in the industry and created a wave of both positive and negative opinions about neuromarketing effectiveness and ethics. From that year until 2008, the term was mentioned in an archive of more than 1278 English-language publications, according to Levallois et al. (2021), in their paper "The emergence of neuromarketing investigated through online public communications (2002-2008)".

On the one hand, Fugate (2007) stated some practical applications of neuromarketing practices (such as media selection, celebrity endorsement or product appeal), exposing both sides of public attitudes towards them and offering clear statements to what should be considered to exploit the full potential of neuromarketing, beware of its limitations (primarily ethical, legal, and scientific), resulting in an enrichment of traditional marketing strategies and ultimate consumer satisfaction. Neuromarketing was seen as a unique, powerful and reliable solution to measure consumer behaviour and limit the risks of launching undesired products. Nonetheless, sceptics can see it as a “brain scam”, not only for its costs, but for its scarce documentation and proof of qualified results (Nature Neuroscience, 2004). The fear of finding consumers’ “buy button” aroused rapidly, with testimonials declaring neuromarketing could “exceed the limits of legality” (Lee et al., 2006).

These testimonials paved the way for the foundation of the Neuromarketing Science and Business Association (NMSBA) in 2012, now based as an international association for global neuromarketing professionals. The institution created a code of ethics addressing “the confidence of the public in the legitimacy and integrity of neuromarketers, ensuring neuromarketers protect the privacy of research participants and the buyers of neuromarketing services”. This code is of obligatory subscription to its members and has established the standards for the neuromarketing research industry (*NMSBA Code of Ethics*, 2012).

Despite this, there has been an increasing curiosity in various facets of neuromarketing, always including its ethical implications. A case in point is the publication authored by Stanton et al. (2017), which delves into moral hazards coming from the methods and applications of brain analysis for business purposes and tries to offer an overview towards an objectification and transparency of the discipline.

An important landmark in neuromarketing history was its implementation as a separate section in specialised companies with acknowledgement in the marketing industry, like Nielsen or Millward Brown. Such techniques began to take part in their clients’ modern marketing strategies (Cenizo, 2022).

Thus far, there have been five established research centres dedicated to the field of neuromarketing. These centres focus on a variety of goals, including enhancing brand preference, improving the memorization of advertising messages, maximising the impact of advertisements, improving television commercials, and operationalizing branding strategies. They employ various techniques and technologies to study consumer behaviour, such as brain imaging and physiological measurements, to gain insights into the subconscious processes that influence consumer decision-making (Boricean, 2009).

What almost all papers related to the subject have confirmed and agreed upon are the drawbacks to the proliferation of neuromarketing: Lee, Chamberlain, and Brandes recognize that the significant division in past studies, the deficiency of high-quality user-oriented methodologies, and the nonexistence of a proper guideline to differentiate proper neuromarketing research are restricting the possible expansion of this field, as stated in their work published in 2018.

Neuromarketing has lately been applied to the digital realm. Researchers have explored the connection between neuromarketing and the Internet, finding that it can positively influence brand-consumer loyalty by measuring real-time verbal and non-verbal responses to new products, prices, and advertising promotions (Cenizo, 2022).

In recent years, there has been a shift in the way neuromarketing is reported. Stanton et al. (2017) and Hsu (2017), retrieved from Cenizo (Neuromarketing: concept, historical evolution and challenges, 2022) suggest a moderated view of neuromarketing, which regards it as an additional tool alongside traditional methods of market research, rather than a replacement for them.

2. ESSENTIAL BRAIN STRUCTURE FOR NEUROMARKETING

The research for a “buy button” in our brains as the main target for neuromarketing could be somewhat restricting. Evidence has proven that there are multiple sections affecting the decision processes of consumers and cannot be reduced to a single area of study (Ariely & Berns, 2011). Understanding which functions and stimuli are being processed by which section is exceptional in order to analyse the results of a neuromarketing study, resulting in successful campaigns or a possibility to adapt to those intakes.

2.1. PARTS OF A BRAIN

The brain is a complex organ, a prime part of a much larger system defined as the central nervous system, along with the spinal cord. Functional messages are communicated from the brain to target cells via neurons, activated electrically and chemically. These stimuli are then studied by “neuroimaging tools, providing images of the activated areas” (Glaenger & Colby College, 2016). Decision-making involves many brain regions and networks working together, different types of decisions may rely more heavily on certain brain regions or networks, depending on the nature of the decision and the context in which it is made.

The brain is mainly divided into four sections: frontal, temporal, parietal and occipital lobes, each involved in specific tasks and connected through what is known as projections (Zak, 2004). One of the key sections involved in decision-making is the prefrontal cortex, located at the front of the brain, especially in long-term goals requiring deep recognition of advantages and disadvantages of the various options (Wells, 2003). It is also implicated in actions related to working memory, attention, cognitive control, and personality. This region starts developing during the teenage years, so decisions are much more impulsive among the younger population. Some brands take advantage of this, positioning their products in the lower shelves at stores so they will get noticed by kids (Sorter, 2019) or adapting their promotions to the age of their target segment. In Figure 1 below, there is a clearer picture of these brain areas and their locations.

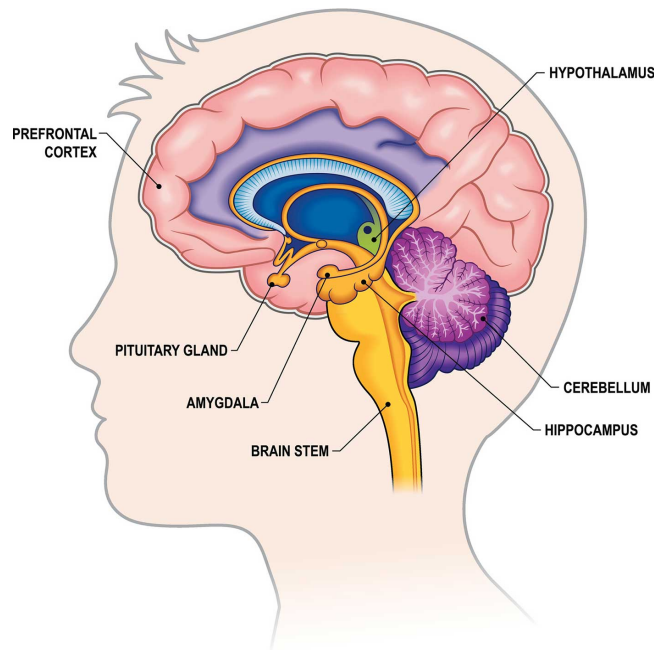
The rational area of our brain does not come alone in the purchasing process of a person, especially when being exposed to an ad. The limbic system constitutes an indispensable for marketers, as it is in charge of emotional perception and learning, composed by the hypothalamus, the hippocampus (a contributor to humour, training, and conscious memory) and the amygdala, which is directly involved in the acquisition and storage of memories (precisely, the basolateral amygdala, BLA). Hence, commercials evoking emotions are much easier to remember by consumers. This almond-shape structure responds to pleasure, rewards, and social attachments, but also fear or anxiety. It can also recognize unpleasant situations, sometimes used in some industries to enhance the advantages of their products (insurance companies, for example), but still greatly useful for humans to avoid “unfair offers, monetary losses, and high prices” (Kenning & Hubert, 2008, p. 16).

The basal ganglia, a group of nuclei deep in the brain, is involved in the selection and initiation of motor movements, but also in decision making processes. They work together with the prefrontal cortex to evaluate options and select the most appropriate one (Cleveland Clinic, 2022). It is closely related to the amygdala, as it affects the way our brains handle reward, evaluated through emotional activations and dopamine release, “which motivates subjects to acquire resources”, one of the main (Zak, 2004, p. 6).

These activations have to be painstakingly estimated. An interesting example related to the business world is the measurement of brain activity in individuals looking at their phones (Lindstrom, 2011), focused on the insular cortex, an inner part of the brain processing sensory data, autonomic regulation, perception of one's own self, and emotional control of social behaviour (Benarroch, 2019), which could directly mean consumers were feeling the same as if they were in love when using these devices. Contrarily, studies have found that activation does not necessarily mean positive reactions; subjects could be also

experiencing rejection to their smartphones and present similar brain images. This is why neuromarketing results can sometimes be difficult to interpret and decode into advertising strategies (Glaenger & Colby College, 2016).

Figure 1. Parts of the brain from Johns Hopkins Medicine.



Source: Brain Anatomy and How the Brain Works, n.d.

2.2. THE TRIUNE BRAIN MYTH

Neuromarketing's most relevant sections of the brain have been structured into what is known as the "three brains of neuromarketing": the neocortex or rational brain, the limbic or sensory brain, and the reptilian system, working independently for our behaviour, emotions, and reflections. This theory was based on neurological evolution throughout history, although it has been rejected by many scientists who prefer to refer to cerebral areas as single sections interacting and functioning together (Teboul, 2016). Zoëga Ramsøy states that "while many of these mythical narratives can serve as attention grabbers and selling points, they are even to become obstacles to valid metrics" (Ramsøy, 2019, p. 7).

The triune brain statement, on the other hand, could simplify the evaluation of brain activity for marketers. Starting with the reptilian system or the archicortex (primitive cortex), the most ancient of the three (formed 400 million years ago), which constitutes the central nervous system, evolving from species like fishes or reptiles, hence its name. It manages survival instincts such as conservation, territory, aggressiveness, etc. and evades learning

abilities, as it is completely guided by rigid and stereotyped patterns. Marketing campaigns showing fearful, or FOMO (Fear Of Missing Out) situations try to provoke this part of the brain (Crisol Translation Services, n.d.).

Secondly, the limbic system or paleocortex (formed 65 million years ago), mentioned above, is in charge of pleasure, affection, relationships, but also of fear, failure and with so, learning. It appeared progressively on mammals, in order to provide meaning to their surroundings and their position as social animals. Advertising that displays positive feelings, happy individuals, loved personally and by their group, are designed to attract the attention of consumers through this part of their brains.

Last but not least, the most recently-adapted section: the neocortex, found in big mammals, primates and humans. The brain developed amazingly, reaching a wider mass and being able to create imagination, consciousness, and symbolic thinking. It takes part in the functioning of reasoning, memory and language. This is activated, for example, when consumers watch commercials that “explain how a product works or the benefits of a service, based on logic and rationality”.

Figure 2. The Triune Brain structure.

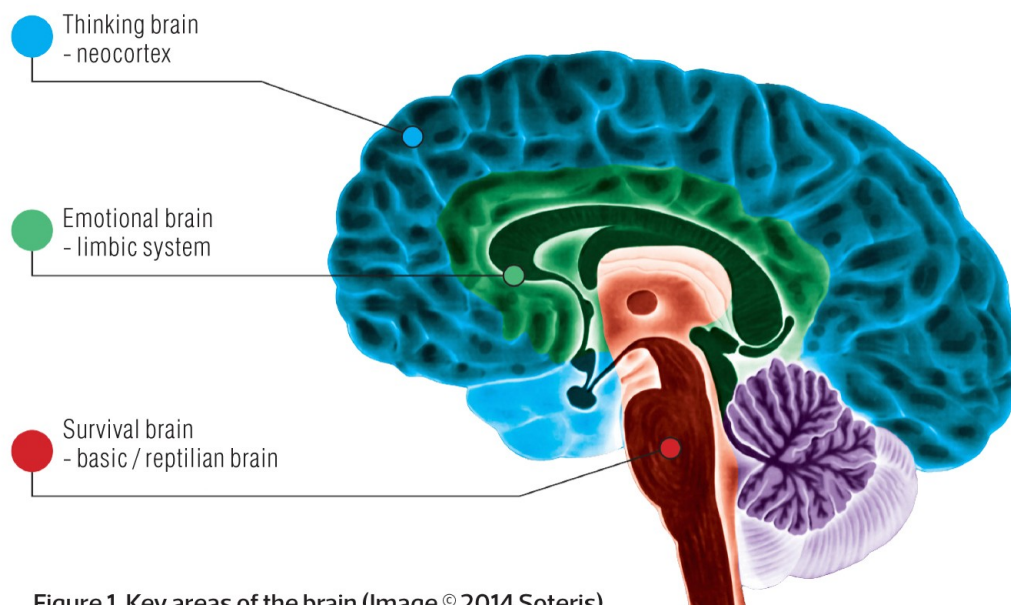


Figure 1. Key areas of the brain (Image © 2014 Soteris).

Source: 3 Brains (And how to use them in marketing), Saini, 2019.

Human brain evolution has not been the cause of the aggregation of brain structures, but the reorganisation of those structures thanks to neural plasticity. New functions have

been added to our brain patterns, improving our ability to perform new tasks and develop further competences (Alonso, 2021).

In conclusion, the theory of the triune brain proposed by Paul MacLean in the 1960s has been both praised and criticised. Supporters of the theory highlight its potential to explain the evolution and development of human behaviour and cognition through the three distinct regions of the brain. However, opponents argue that the theory oversimplifies the complexity of the brain and human behaviour and fails to account for the interconnectedness of brain regions and their functions. While the triune brain theory may offer some insight into certain aspects of human behaviour, it is important to approach it with caution and acknowledge its limitations as an explanatory framework for the workings of the brain (MacLean, 1977).

2.3. RAMSOY'S TYPES OF CEREBRAL ATTENTION

Understanding the effect that each brain section has on consumer behaviour can be easily done through one of the most important focuses of business: gaining consumers' attention. In cognitive psychology and neuropsychology, attention has been extensively studied and is known to be a complex and multi-dimensional process. It is generally agreed that it can be divided into several forms: bottom-up attention, top-down attention, emotion-driven attention, and cognition-driven attention. In his paper "A foundation for consumer neuroscience and neuromarketing", Ramsøy (2019) describes the multiple types of attention and its relation with the marketing world.

Bottom-up attention refers to the fast, automatic, and non-volitional way that attention is captured by sensory stimuli. This type of attention is driven by the senses, which respond to specific features of the object of attention. In visual attention, aspects such as contrast, density, angles, movement, and colour composition can all operate as indices of "visual salience" and affect the likelihood that an item is seen.

On the other hand, top-down attention is a slower, effortful, and volitional mobilisation of one's mind to an object of interest. Unlike bottom-up attention, which is automatic, top-down attention requires time to be mobilised and is often equated with "concentration".

Emotion-driven attention happens when something triggers an emotional response, which immediately boosts attention towards the item being shown. From neuroscience, it is known that "emotional" brain regions (like the amygdala) send more signals back to the visual cortex than they receive from it. This leads to a brain-based boost in activity, as well as other behaviours such as stronger pupil dilation and longer fixation to the product of

interest. In terms of advertising, emotional stories can be effective at capturing attention, although some studies suggest that strong emotional responses can lead to lower ad attention (Heath et al., 2009).

Finally, cognition-driven attention is when items that are attended, even briefly, can lead to automatic cognitive responses. This is particularly notable when it comes to reading, as it is practically impossible not to read text that is in front of us. Different aspects of visual complexity can also drive attention, with higher creative complexity leading to attention that is more dedicated to relevant information such as product, text, and brand.

Understanding the different forms of attention can be useful for marketers and advertisers, as it can inform strategies for capturing and sustaining attention towards products and brands. By taking into account the different drivers of attention, it may be possible to create more effective and engaging advertising campaigns.

3. MEASURING TECHNIQUES USED IN NEUROMARKETING

Neuromarketing aims to understand individuals' reactions to marketing stimuli through their cerebral activity. That is why it uses technological and medical tools to obtain the "neural conditions and processes that underlie consumption, their psychological meaning, and their behavioural consequences" (Bercea, 2012, p. 2). According to Ariely & Berns (2011, p. 2), going beyond traditional research methods could establish "an efficient trade-off between costs and benefits" for marketers, leaving the questionable verbal experimentation behind. Theories standing for neuromarketing practices believe in the possibility to obtain accurate audience attraction information about a product or service before implementing them into the market, which could advantageously save costs if a tested good with unpromising future results could be eliminated early in the process.

Other studies' opinions conversely declare that the employment of these techniques is significantly costly and unreliable due to the unnatural experimentation process, as well as invasive to the subjects' privacy of thoughts (Bercea, 2012)

Bercea (2012) offers a clear outline of the multiple methodologies used in neuromarketing research, dividing them into three main categories: techniques measuring metabolic activity in the brain (Functional Magnetic Resonance Imaging 'fMRI', Positron Emission Tomography 'PET'), tools recording electrical activity (Electroencephalography 'EEG', Magnetoencephalography 'MEG', Steady State Topography 'SST', Transcranial Magnetic Stimulation 'TMS'), as well as those not measuring brain activity but which also

support neuromarketing research, like facial coding, skin conductance, implicit association testing, eye tracking, facial electromyography along with the measurement of physiological responses.

Neuromarketing studies have stemmed from neurobiology of reward, resulting in techniques focused on evaluation processes and responses of dopamine-brain regions (Ariely & Berns, 2011).

3.1. TOOLS MEASURING BRAIN ACTIVITY

3.1.1. Functional magnetic resonance imaging (fMRI)

Functional magnetic resonance imaging (fMRI) is a powerful neuroimaging technique that has revolutionised the study of brain function. With electroencephalography, it is one of the most used techniques in neuromarketing (Fortunato & MacroThink Institute, 2014). By measuring changes in blood flow in the brain, fMRI can provide insights into how different marketing stimuli, such as advertisements, packaging, and product design, affect the brain and ultimately influence consumer choices.

This technique measures brain activity of a subject when being static and lying down, combining magnetic field and radio waves. The magnet surrounding the subject's head detects the protons, changing depending on the blood circulation patterns influenced by the activation of the brain sections being used at that specific moment. When we experience brain activity, neurons start "consuming" oxygen, provided through the red blood cells containing haemoglobin. This protein contains iron, allowing the magnets to identify it easily and measure its patterns.

The fMRI results are analysed through a computer screen where those areas being activated by the exposure to different marketing stimuli present different colours every 2 to 5 seconds. These signals are called BOLD (Blood Oxygen Level Dependent signal) and can also be seen in 3D.

Through the use of this technique, it is possible to measure consumers' "memory encoding, sensory perception, valence of emotions, craving, trust, brand loyalty, brand preferences, and brand recall" among others (Bercea, 2012, p. 4).

Such valuable information comes along with advantages on precision, being one of the best in detecting fine features within the brain (Ariely & Berns, 2011), in addition to the capability to extrapolate psychological processes, and obtaining valid measurements for cognitive and metabolic changes. Nonetheless, it must be noted that state-of-the-art fMRI scanners can cost between \$800,000 and \$1 million, with operating costs of

\$100,000-\$300,000. Another burden to this technique would be the subjects' need to remain motionless in order for it to function properly, which would not favour a comfortable and natural environment to analyse real-life situations. Likewise, decoding fMRI collected data requires a high level of knowledge in the domain, results that manifest in low temporal resolution (experiencing a delay in measuring neural activity) and might be subject to ethical concerns regarding the subject's invasion of privacy.

This technique has helped in the field of neuromarketing to test new products (such as packaging, design or sensory perceptions), new campaigns or advertisements, as well as perfecting a brand's positioning, knowing price considerations and even identifying needs. Recently, measurements such as willingness to pay (WTP) have been only examined through functional MRI (fMRI). Interestingly, similar activity in the orbitofrontal cortex has been observed when subjects anticipate a pleasant taste, view attractive faces, listen to pleasant music, receive money, and experience social rewards.

3.1.2. Positron emission tomography (PET)

The process of positron emission tomography (PET) involves capturing the radiation (gamma rays) emitted by positrons from the radioactive substance that has primarily been given to the subject through its bloodstream. The subject's head is surrounded by a set of detectors that identify the radiation signals, but do not accurately pinpoint the source location. Like the functional magnetic resonance imaging, it demands high costs for the businesses utilising them, but it gives remarkable insight into sensory perceptions and emotions of consumers when exposed to certain marketing stimuli. It can be used to test new products, advertisements or packaging designs, among others, with a high spatial resolution (Bercea, 2012).

It is normally used in oncology (cancer treatment), neurology and cardiology, but its accurate results have moved its use to other areas, such as neuromarketing itself (*Positron Emission Tomography (PET)*, n.d.).

Among its disadvantages, it is important to highlight the short functioning life of PET machinery and the subjects' exposure to radiation for a poor temporal resolution. For this reason, this technique is considered "highly invasive and sometimes hard to use in neuromarketing" (Fortunato & MacroThink Institute, 2014, p. 212).

3.1.3. Electroencephalography (EEG)

Electroencephalography (EEG) is a portable neuroimaging technique that measures the electrical activity of the brain using a set of electrodes placed on the scalp. The variations in neuronal brainwaves and their ranges of those changes all correspond to certain mental states (Bercea, 2012). These states could be wakefulness, relaxation, calmness or sleep, among others, and can easily offer differentiated analysis between left and right hemispheres of the brain and personality traits (Plassmann et al., 2011), although this last one is still debated on (Ariely & Berns, 2011). EEG is also a relatively inexpensive and non-invasive technique, making it a more practical option for marketing research compared to other neuroimaging methods such as fMRI (EEG is the most common tool for neuromarketing research after fMRI offering also an easier use) or PET scans. It requires a much lower economic investment on machinery, of around €7,500, operational and analysis costs.

One of the main advantages of EEG for neuromarketing is its high temporal resolution, which means that it can capture changes in brain activity that occur in real-time. This allows researchers to measure immediate responses to stimuli, such as product images or advertisements, and identify patterns of brain activity that correspond to specific cognitive or emotional processes. Conversely, this technique offers a very low spatial resolution, which makes it difficult to find the exact neurons that are being activated, limited to the outer layers of the cortex. Through electroencephalography imaging, consumers' levels of attention, engagement against boredom, excitement, recognition or memory encoding are accessible to infer marketing data.

Additionally, EEG can be used in a variety of settings, such as in the process of developing advertisements, testing new campaigns, website design and usability, or even in-store experience, allowing researchers to study consumer behaviour in real-world scenarios.

However, there are also some limitations to using EEG for neuromarketing. One of the main challenges is interpreting the complex data generated by EEG, as the patterns of brain activity can be difficult to decode and may not always be directly linked to specific cognitive or emotional processes. Moreover, EEG only measures activity in the outer layers of the brain, meaning that deeper brain structures and networks may not be fully captured or located. Also, researchers handling EEG machinery should be aware of external and moving changes that could influence the experiment's setting. Conversely, it offers a much lower cost and practicality, as its devices can be wearable and are relatively less robust than other techniques (Vecchiato et al., 2011).

Overall, EEG has the potential to be a valuable tool for understanding consumer behaviour and decision-making in the context of marketing, but it should be used in conjunction with other research methods to provide a more comprehensive understanding of consumer psychology.

3.1.3.1. Steady State Topography (SST)

The steady state topography (SST) is the measurement of electric activity in the brain as a response to a visual stimulus, using EEG as a tool. Instead of analysing the cerebral situation in a specific moment, it does so throughout a determined period of time, allowing a continuous evaluation of real-time responses. According to some studies, SST is a unique tool when it comes to understanding customers' perception of advertising (such as imagery, advertisements or panels) and offers reliable results of subconscious actions, being "the only neuromarketing technology in the world to have both scientific and commercial validation" (Cruz, 2018).

According to Bercea (2012), this tool can measure consumer behaviour, attention, engagement and emotional intensity, as well as visuals' effectiveness to achieve the expected results. Despite its low spatial resolution, SST can track rapid changes in brain processing in different parts of the brain, even within noisy or inference-affected environments (such as head movements, muscle tension, blinks or eye motions).

This option could be used to measure the strength of advertisements, movie trailers, printed commercials and other types of brand communication.

3.1.4. Magnetoencephalography

Magnetoencephalography (MEG) uses magnet power to measure brain activity through a helmet placed on the subject's head, which detects the magnetic fields generated by such activity. Unlike EEG, MEG is not influenced by the type of tissue (blood, brain matter, bones) (Bercea, 2012) but it requires a room completely free of earth's magnetic power to function properly, which makes the process much more sophisticated and delicate (Alonso, 2019).

Among MEG main advantages lies its great temporal resolution, as well as its reliability for cognitive and affective responses (Bercea, 2012). Thanks to this method, researchers can get information about the brain's pattern happening in rapid decision-making situations. Hansel et al. (2010) describe MEG as a tool that "combines the localization of brain areas with reasonable spatial accuracy, together with the extraction of

the time courses of action in those areas with excellent temporal accuracy". Nevertheless, as EEG methodology, it is not possible to obtain a detailed pattern of the brain's shape. It is also a non-invasive method and can recognize variations in the brain's fluid flow or chemical structure, according to Wang et al. (2018). Although it does not produce a brain image itself, like fMRI, it is normally contrasted with magnetic resonances, fMRI or EEG. In addition, MEG measures activity in deeper areas of the brain, compared to EEG.

Separately, MEG is an expensive method compared to EEG, as its equipment costs can rise up to €150.000 or €400/hour for renting. While it has a better spatial resolution than electroencephalography (EEG), it is still limited. MEG is a non-scalable method, making it less practical and easy to analyse studies on large populations. Ethical concerns have also been raised about the potential invasion of privacy due to the technique's ability to measure brain activity in real time. Finally, MEG data decoding is relatively complex, which requires specialised experts to interpret it. (Hansen et al., 2010). All these factors contribute to its minimal use in market research (Alonso, 2021).

MEG allows marketers to gather research by showing new product tests to the subjects, advertisements, packaging designs, but also identifying their potential needs and sensory perceptions. Mainly, it can measure consumers' memory, perception, and attention.

3.2. OTHER TECHNIQUES NOT RECORDING BRAIN ACTIVITY

Traditional neuroimaging techniques like fMRI and PET have provided valuable insights into the neural correlates of consumer responses. However, in addition to measuring brain activity, several other techniques have emerged as indispensable tools in the arsenal of neuromarketing researchers. These non-brain activity techniques complement and enhance our understanding of consumer behaviour by diving into other physiological and psychological factors that influence decision-making. In this segment, we will explore some of them, which offer a great support to pure neuromarketing research, but lay outside of neuromarketing's strict definition.

3.2.1. Eye tracking

Marketing researchers can also use eye tracking tools to understand how consumers process visual information and how factors such as the position of certain elements or typographies grab their attention better than others. Throughout this technique, it is possible to track eyeball motions, pupil dilation (pupillometry) and blinking, among others (Alonso,

2021). Research studies have also analysed how buyers perceive visual stimuli through time, showing the sequence and shape of the subjects' eye focus.

This technique is especially useful as it is not as expensive as the ones stated above and its equipment is portable, allowing researchers to obtain relevant evaluations of in-store reactions (product, packaging designs, shelf placement), website usability, or print media and advertising effectiveness (Bercea, 2012).

Eye tracking analysis is represented on heat maps and colours, displaying the distribution of visual attention through a colour-coded scheme (*Eye Tracking in Neuromarketing Research*, 2016), with red tones on the zones that have had a higher focus, then yellow, then green (see Figure 3).

The disadvantages of eye tracking by not measuring brain activity rely on the incapacity to infer the quality and association of emotions related to the visual stimuli. Its results are not as reliable as with other techniques, as they depend on the subject's eye conditions.

Nevertheless, it can give answer to questions such as what is capturing consumers' attention, where should the main value proposition be placed, how difficult is it for the target audience to find the information they are looking for, or which elements are 'louder' to the buyers' mind (Romero, n.d.).

Figure 3. Eye tracking heat map of an advertisement.



Source: Eye tracking in practice, Ergomania. Herendy, 2018.

As seen in the picture above, people seem to connect more with eyes and faces in advertisements. If those features are from a baby, the attention becomes even more noteworthy. In this example, the baby is directing the audience towards the textual

information in the commercial: the curiosity to find out what the baby is looking at plays an important role. This is continuously repeated in many other advertisements, where the models or the people announcing it always face the product (Alonso, 2021).

3.2.2. Facial coding

Facial coding techniques allow researchers to understand customers' emotions towards determined marketing activities based on their facial muscles. The evaluation is immediate, as these movements are completely spontaneous, non-conscious and in real-time. A high-quality camera will record the participant's expressions, that will be then analysed using sophisticated software in alignment with the studied stimuli.

According to Bercea (2012), these studies can track up to 23 action units in the subjects' face, representing a human's 43 muscles and showing six different types of emotions: anger, dislike, envy, fear, sadness, surprise, and smile).

For this non-invasive tool to work properly, researchers need clear lightning which does not influence the correct reading of the subjects' facial expressions. In some cases, onsite experimentation could be negatively affected, as these conditions cannot be always ensured. Moreover, the software used may also be subject to error and miss the context or subtle emotional cues in the results (*Getting to Know Neuromarketing: Facial Coding*, 2019).

An example of a real use of facial coding is Disney, which tracked an audience's facial expressions while watching nine of their movies, therefore inferring the key points of the stories and establishing a strategy to hit the right emotions on the desired moments.

3.2.3. Facial electromyography

Facial electromyography represents a different way of measuring emotions through facial expressions, particularly the electrical movements of facial muscles (Ciragan & Guan, 2016). These areas are activated by brain activity and then transmitted through nerves, showing a specific configuration or pattern related to each feeling. As specified by Ree et al. (2019), it is an "objective, quantitative, and non-invasive method to measure facial muscle activity [...] without the need for verbal communication". It can be used to evaluate consumer reactions to advertising, videos, or brand recognition.

Electrodes are placed on the participants' faces, detecting electrical signals generated by the corresponding muscles, which are then being sent to a measuring tool. The cost of facial EEG ranges between €10.000 and €20.000.

It is much more effective and precise than facial coding, identifying voluntary and involuntary movements. However, as with similar techniques, it is subject to context influences and other factors related to the cause of emotions (Bercea, 2012).

3.2.4. Electrocardiography (ECG)

Electrocardiography (ECG) is a non-invasive biometric which measures the heart's electric current produced by blood flow impulses, through electrodes placed on the skin's surface (normally arms, chest, and legs).

This method is relatively simple and fast, compared to the ones mentioned above. It does not cause any harm to the subjects, although its results are often contrasted with EEG or other techniques (Ciragan & Guan, 2016).

3.2.5. Implicit association test (IAT)

In this type of measurement, researchers can obtain accurate information about the associations formed in the subjects' brains by displaying different stimuli in relation to diverse feelings or attributes about them (Bercea, 2012). The bias in the results is relatively eliminated through time limitations, so the participants' answers are immediate and subconscious.

Cristina Ocejo from BritBrain defines IAT as "a psychological test whose objective is to reveal unconscious attitudes, automatic preferences, and hidden biases by measuring the time that takes an individual to classify concepts into two categories" (Ocejo, 2020). Marketing agents could especially benefit from this tool and its potential to understand how brands, products or advertisements are perceived by the audience, throughout their reaction time and underlying attitude or evaluation of such stimuli. Examples of areas of use could be segmentation, brand positioning, or packaging choices.

3.2.6. Other techniques measuring physiological responses

From heart rate analysis, skin responses (Galvanic Skin Response or Electrodermal activity) or blood pressure, these types of methods can also be used in neuromarketing studies. However, researchers need to bear with the influences of other biological factors affecting the results to be obtained, as they might not reflect the subject's response to the marketing stimuli uniquely.

Emotional assessments can be deduced from biometrical research, such as skin responses (using a sensitive device on the participant's wrist), showing interest, attention or anxiety against relaxation or boredom (Ciragan & Guan, 2016).

4. RELEVANT STUDIES AND CASES IN NEUROMARKETING RESEARCH

4.1. PEPSI AND COKE COMPARISON: CONSUMERS' PREFERENCES AND BRAND IDENTITY

One of the most relevant studies in neuromarketing research has been the comparison of Pepsi and Coke preferences by consumers, held by Montague in 2004 and stemming from the campaign called "Pepsi Challenge" of 1970. In this marketing program, PepsiCo representatives across shopping centres and other public locations in the United States organised blind tests with Pepsi and CocaCola and asked buyers to choose their favourite flavour. The consensus showed that their beverage (Pepsi), was most Americans' choice of taste (*Blindsided by the Pepsi Challenge*, 2019).

Montague's experiment, whose results were based on fMRI analytics, grabbed the attention of many marketers and media at the time (McCLure et al., 2004). The paper "Neural correlates of behavioral preference for culturally familiar drinks", investigates the correlations for choices on simple and recognisable drinks to understand the level of influence that brand positioning would have on consumer subconscious options. At first, subjects were given a sample of both drinks without a brand cue (placed in neutral glasses), to which Pepsi came out as the strongest product flavour wise. This result was reversed when the tasters were informed of the brand they were drinking beforehand: the strong brand image of Coca-Cola influenced the declared preference and thus overrode the taste. During blind taste tests, imaging revealed activation of the prefrontal cortex: the activation of this brain region was much more evident for Pepsi. When the subject was informed of the brand, an additional brain area was activated, the medial prefrontal cortex. This latter area is generally activated when people make value judgments and reasoning. The excellent brand image of a product, in this case, Coca-Cola, would thus generate more satisfaction in the brain than the sensations directly conveyed by its taste qualities (Teboul, 2016). Thanks to these results, Pepsi modified its communication approach, basing it henceforth on the product's taste, as it was its most paramount feature to their audience.

4.2. THE AUTOMOBILE INDUSTRY: CULTURAL ARTIFICIAL PRODUCTS IN RELATION TO NEURAL REWARD PROCESSES

One study that stands out is the work of Shaefer and Rotte (2007), which examined the link between sports cars and social rewards and relationships. The researchers presented 21 logos of car manufacturers to participants and recorded their brain activity using fMRI scanning. They then asked the participants to evaluate the elements shown according to different characteristics.

The results of the study were intriguing, to say the least. The researchers found that when high-range sports cars were shown to the participants, there was an activation of the orbital frontal cortex, which is responsible for reward and dopamine reinforcement. This suggests that sports cars are normally perceived as highly desirable and rewarding.

The researchers went on to evaluate the correlations between brain activity and the participants' assessments of the car logos. They inferred that "cultural objects like sports cars demonstrate high social rank, dominance, and wealth," which may function as social boosters. This implies that owning a high-end sports car can not only be a status symbol but can also improve one's social standing. Neuromarketing helped verify the effect theory of the positive association between products with high social status, as well as detecting the specific brain areas that activate interacting with those brands and evaluating consumers' cognitive and emotional processes.

Furthermore, the use of neuromarketing in the car industry has other implications as well. For instance, car manufacturers can use this technique to design cars that appeal to the consumer's subconscious desires.

In conclusion, the use of neuromarketing in the car industry has opened up a new realm of possibilities. By tapping into the consumer's subconscious desires, car manufacturers can create products that are not only appealing but also emotionally satisfying.

4.3. PROCTER & GAMBLE'S ADVERTISING EFFECTIVENESS

Procter & Gamble, brand group of Pantene or Ariel, among others, invested in neuromarketing research and ensured *Febreze* to become one of their top sold products. The annual numbers supporting their brands' advertising campaigns rise up to USD \$4 billion, to which each one (they own over 20 different brands) generates over a billion USD in later sales. Neurensics has discovered P&G's formula to having effective advertising campaigns by measuring potential customers' brain responses while watching the *Febreze*

commercial: dramatically setting up the problem, showing an immediate solution thanks to the product, comparing the old and new situation, and presenting familiar, happy people after using it.

According to their fMRI analysis, the signals showing effectiveness were high, conversely to those of annoyance, implicating the advertising was perceived as interesting, not irritating. The utility of the product was one of the most relevant elements of the ad, as stated in the subconscious findings (*The Secret of Procter & Gamble - Amsterdam*, n.d.).

The giant has also shown interest in cognitive psychology to measure customers' feelings towards food (for example, the cereal brand *Special K* using the silhouette of a thin woman to enhance its low-calorie benefits) (Wells, 2003).

4.4. NEUROMARKETING IN THE TOURISM INDUSTRY

By harnessing insights directly from travellers in their journeys (hotels, planes, museums...) or in pre organised labs, neuromarketing enables tourism businesses to delve into the intricacies of emotional engagement, decision-making processes, and personalised experiences.

On the one hand, hotels can measure any type of service, communication, processes or people taking part in the experience, such as websites, leisure activities, food or comfort. The Spanish hotel firms NH and Barceló carried out eye mapping studies in 2020 to evaluate their online services, and Swiss Hotel or Disney are known for developing their own corporate smells for their establishments (sensorial marketing).

Travel agencies can also benefit from neuromarketing research. One relevant study found that clients present positive impulses when reading past consumers' reviews. Cognitively, they might not fully trust them, but subconsciously, they awaken a favourable impact in the purchase decision. In this investigation, pricing importance on tourist services was also measured, as it can be a paramount factor to travellers due to the intangibility of a product such as a vacation plan. The results of this research were very powerful and precise, as agents used four different techniques: EEG, skin conductance, eye tracking and heart rate measurement (Alonso, 2021). They targeted their analysis towards the perception of prices "in holiday advertisements in terms of design features, positioning, and content", giving precise explanations on their findings for future marketing uses (Boz et al., 2017, p. 119).

4.5. BRAND FAMILIARITY THROUGH CELEBRITY ENDORSEMENT

Brands have been using endorsers to connect personally with their customers. In general, people feel much more attracted to others' faces and eyes than to mere products, texts, or simple images.

When marketers use endorsers in their advertisements, they are grabbing the attention of their audiences, who feel attached and focused especially to others' eyes: when a product is displayed beside a lay endorser, expert or celebrity, eye-tracking studies have shown that their sight orientation can guide consumers to look directly to the product. People tend to feel curiosity towards what the person in the ad is facing.

Our brains are filled with dopamine and phenylethylamine when we see a familiar face, or celebrity, triggering positive emotional states and establishing a friendly association with those faces or brands (Fugate, 2007).

According to Ramsøy (2017), feelings such as recall and recognition can be perceived in the public's brains when perceiving endorsers in a commercial. Nevertheless, it is substantial to choose the most suitable endorser for each brand, as issues such as having an overuse of celebrities in campaigns, masking what is truly important in the advertisement (the product) or not failing to determine a coherent relation between the brand and the endorser. A study done in Brazil, participants' perception of several ads were analysed through eye-tracking techniques. They used commercials with well-known celebrities and compared them to similar advertisements with non-famous endorsers, resulting in a much greater visual attention to the first ones (Falsarella et al., 2017)

4.6. OTHER NEUROMARKETING APPLICATIONS

Neuromarketing's broad scope is undeniable, from products to services, to experiences, it allows marketers to establish efficiency into their practices. The snack brand Cheetos also took advantage of EEG technology to evaluate one of their commercials: *in a laundry shop, someone has changed the clothes of a woman out of the machine to put theirs inside. As an act of revenge, she throws a package of Cheetos into the other person's machine.* During focus group dynamics, the audience showed feelings of discontent and judged the woman's actions as dishonest and disrespectful. However, EEG results showed they clearly enjoyed the advertisement (TEDx Talks - Kristina Centnere, 2022).

The payment platform Paypal also used neuromarketing to understand the drives of their clients and update their brand identity, realising that what they appreciated the most was speed and convenience, not security as many would have thought. They did this

through EEG scans, analysing word-association (words like “fast” were much more resonated in their clients’ brains than “safe”) and feelings towards their service, which evoked positive emotions when experiencing rapid payments. Thanks to neuromarketing, Paypal response and click-through rates increased up to 400% (Hilt+Knowlton Strategies, 2017).

It has also taken part in research studies and marketing campaigns of industries like insurance, retail, democracy, health, and many more, revolutionising the way marketers understand and connect with their target audiences.

5. CHALLENGES AND LIMITATIONS OF NEUROMARKETING RESEARCH

5.1. EXPERIMENTATION

Neuromarketing research, as explained above, is a costly experience that not all brands can afford. Not only in monetary terms, but the techniques require specialised equipment and expertise. In the United States, for example, magnetic resonance technology rents between \$500 and \$1,000 for an hour of use, which could easily rise up to \$50,000 for a single experiment with an average of 12 subjects (Wells, 2003). In Spain, a fMRI session could cost around 300 euros.

5.1.1. Lack of standardisation and documentation in neuromarketing experimentation

One of the main limitations for the growth of neuromarketing research is the limited amount of practical standardisation (possibly stemming from the fact it is a relatively new field), leading to a sense of “uncertainty in terms of the methods and metrics”, as reported by Ramsøy (2019, p. 5). Lately, with the rise in the use of techniques such as fMRI, EEG, or facial coding, for advertising and other business purposes, the industry has started to face a determination to ensure the proper manipulation, documentation, and assessment of these types of experimentation. The improvements in technology come along with regulations, although there is still some mistrust among commercial participants and minimal scientific record of neuromarketing analyses made until now. Regulatory concerns stand upon the necessities for neuromarketing practices to thrive. According to Ariely and Berns (2011, p. 10), conventional marketing approaches, as they are generally not perceived as experimental, have not undergone analyses by institutional review boards (IRBs), “MRI

scans are approved by the US Food and Drug Administration (FDA) for clinical use". Neuromarketing techniques, as they do not result in medical diagnoses for clients, can sometimes avoid being subject to some requirements. The NMSBA (Neuromarketing Science and Business Administration) has published the above mentioned Code of Ethics, an independent standard is certainly needed.

Being a relatively new approach in marketing, published papers are limited, some lacking empirical present evidence rather reliant on past reviews, personal opinions or experiments that cannot "achieve real or extrapolated progress, except to awaken interest in future research" (Cenizo, 2022).

Prioritising consumers' safety from unethical neuromarketing practices is key, as Wieckowski highlights (Harvard Business Review, 2019), companies should keep those protections into account so as to reinforce informed consent in the business industry (something standard in the academic world). As techniques evolve and become more and more sophisticated, it should be of extreme precaution "any kind of data collected in the field without any awareness by consumers".

5.1.2. Research results' interpretations

Experimentation could also face issues when interpreting results. Understanding the complex relationship between brain activity and consumer behaviour is a significant challenge in neuromarketing, as neural responses are highly context-dependent (as mentioned above, many of the techniques require unaltered and calm environments to achieve an accurate functioning). Tiredness, sounds, and other environmental conditions can have a substantial impact on the subjects' brain activity, and therefore interfere with the results of the research.

Neuromarketing research needs scientific and literate staff to ensure its correct use, so that the interpretations are relevant and legitimate to be extrapolated to wider populations or market segments with similar behavioural patterns. Unluckily, some academic papers have been rejected due to unclear interpretations. Martin Lindstrom partnered with MindSign Neuromarketing (now obsolete), to carry out a fMRI study to analyse brain patterns in relation to iPhone ringtones, which activated the subjects' insular cortex (Pedersen & Murray, 2019). This area is known for managing multiple functions, including sensory processing, experiential consciousness or emotion evaluation. Lidnstrom concluded that the subjects' emotions were "love and compassion" when listening to the phone sounds, meaning they would be feeling some kind of passionate attachment to their devices, the same kind as they would do to their relatives or friends. His conclusion was defined as a

“reverse inference”, lacking enough scientific explanation and prior hypotheses, thus resulting in a response letter by more than 40 neuroscience academics to the New York Times questioning the validity of the evaluation. The subjects’ brain activity towards the iPhone could have been the cause of diverse effects, such as attraction to music, or sensitivity to digital devices.

Some researchers find neuromarketing a limited tool with a scarce scope when it comes to extrapolation of results from small lab samples to diverse populations, as well as its poor relationship with other areas of study, like peer pressure or personal motivations. Cultural differences affect neural patterns when exposed to marketing stimuli. For example, studies have come up with multiple reports of humour in the USA, Canada, and the UK (Fugate, 2007).

In addition, it is also important to mention the long-term impact assessment of neuromarketing experimentation results: as it focuses on immediate responses and outcomes from consumers, it can often face challenging evaluations of marketing campaign’s durability or behavioural changes over time.

5.2. THE ETHICAL AND MORAL PERSPECTIVES OF NEUROMARKETING

The ethical implications of neuromarketing research were first displayed by Murphy et al. (2008) in *Neuroethics of Neuromarketing*, focusing on three main aspects:

- Protection of potentially harmed or exploited parties by the field’s application, such as those with neurological diseases or psychological disorders, children and other vulnerable groups.
- Stealth marketing, referring to the tools that could “provide sufficient insight into human neural function to allow manipulation of the brain such that the consumer cannot detect the subterfuge” (Murphy et al., 2008, p. 297).
- Consumer autonomy.

It is rather curious to notice the existence of multiple policies for the protection of participants of neuroscience studies, but limited numbers of them when it comes to marketing purposes.

Murphy presented various recommendations incentivising and highlighting the importance of establishing a neuroethics framework so as to avoid the proliferation of fear, anxiety, or mistrust to neuromarketing practices among the general public:

- Creation of responsible policies for clinical research subjects' protection, informed consent and explicit protocols, especially in the case of abnormal findings.
- Strengthening vulnerable populations' freedom towards marketing exploitation.
- Determination of reliable communications: truthful and fair media representation when benefiting from neuromarketing techniques.

This study was the forerunner for the NMSBA Code of Ethics and its twelve articles for a neuromarketing application: core principles, integrity, credibility, transparency, consent, privacy, participant rights, children and young people, subcontracting, publication, commitment and implementation (*NMSBA Code of Ethics*, 2012).

5.2.1. Consumers' privacy and freedom of choice

One of the major issues surrounding neuromarketing is the potential invasion of consumer privacy. Collecting and analysing brain data raises ethical questions about informed consent, data storage, and potential manipulation of individuals' thoughts and emotions for commercial gain. Striking a balance between research objectives and ethical considerations is crucial at this point.

Privacy and freedom of choice has certainly been on top of neuromarketing's concerns by the general public. Brain scanning is often perceived as highly invasive, a powerful tool to be used by marketers to manipulate customers to enhance profit and consumerism, thus violating human rights, such as freedom of choice, mental privacy, or cognitive liberty (Antoniak, 2020), defined as the rights to control one's own mental processes, without interference and allowing full self-determination. For instance, a consumer protection consortium lodged a complaint against Frito-Lay in 2011, alleging the use of neuromarketing to promote unhealthy snacks to teenagers (Gutiérrez Cárdenas, 2019). It could also be implemented to influence political campaigns, evaluating individuals' brain responses to certain candidates, or even create candidates 'from scratch'. Ariely (2011) has noted that political feelings like reputation, fairness, or uncertainty, directly correlate with measurable activity in the brain. These cases highlight the ethical challenges associated with conducting such research, urging marketing professionals to carefully consider the consequences of using untrustful neuromarketing practices.

Counterarguments state that the subjects' being studied for further extrapolation are only small samples, who have been previously informed about the research's procedures: customers do not suffer brain scanning in their daily lives, so there would not be any direct privacy violation for the average consumer (Wieckowski, 2019).

Other academics envision neuromarketing as an instrument capable of making powerful advertising which could turn mediocre or low-quality products into desired items, incline customers towards purchases they would not be able to afford, or even subconsciously accentuate addictions for those who have struggled with them in the past (Nemorin & Gandy Jr., 2017).

Neuromarketing is a promising technique that can offer great improvements for value propositions, making them more interesting for consumers or communicating them in a more efficient way. These have been the goals of traditional marketing

6. POTENTIAL FUTURE APPLICATIONS

6.1. Neuromarketing in the technological era

In the present technological revolution, neuromarketing could face substantial improvements in better clinical instrumentation, such as brain imaging techniques and wearable devices, resulting in more precise and real-time data collection on consumer responses. These tools could also benefit marketers in terms of on-site experimentation and lower the influences of external variables, as well as cost-benefit relationships.

If those variables are still not easily controlled, virtual reality or the metaverse open up new possibilities for immersive and interactive marketing experiences. By leveraging virtual reality technology, marketers can create virtual environments that simulate real-world scenarios, eliciting genuine emotional responses and allowing for realistic product testing.

Additionally, social media platforms and the popularity of video games offer avenues for neuromarketing to tap into. Integrating neuromarketing techniques within video games can enhance user engagement, optimise product placements, and provide valuable data on players' responses and decision-making processes. The book *Neuromarketing: Exploring the Brain of the Consumer* by Leon Zurawicki (2010) explains multiple examples of how the video game industry has taken advantage of neuroimaging tools to detect players' attention to in-game ads, as well as their localisation and the level of engagement and recall of those advertisements. It has been noticed that brand prior knowledge is not as important for their impact, but positioning in crucial points (such as finish lines or menus), and dynamic versions in captivating games perform much better than static ones. Another interesting experiment made by Emotiv systems (an Australian innovation company which builds portable EEG devices) was measuring users' feelings and adjusting the game to improve the experience to achieve maximum satisfaction. These findings could easily be applied to a wider array of multimedia contexts (social media campaigns, corporate website browsing...).

An outstanding factor of the future technological landscape, and probably the actual one already, is artificial intelligence (AI). The integration of AI in neuromarketing amplifies neuromarketing's capabilities by automating data analysis, pattern recognition, and predictive modelling. AI algorithms can efficiently process vast amounts of neurophysiological data, uncovering hidden patterns and providing valuable predictive insights. But not only objective processing: emotional marketing analytics and optimisation can also be generated by artificial intelligence technology, called Emotion AI. This tool is able to build "uniquely interactive digital experiences that read and respond to human emotions, changing the conversation in real time, calibrating your messaging and calls-to-action based on their reactions" (Shapiro & Hughes, 2017).

6.2. Business opportunities with neuromarketing

Neuromarketing, as explained throughout this paper, will offer businesses the opportunity to perfect their marketing strategy, not only in terms of advertising (targeted ads, emotion analysis, attention enhancement...), but also towards product improvements (prototype testing, packaging and colour psychology, design adaptability...). Future research will bring technological and result precision and eventually become cheaper and faster than other marketing research methods. Businesses will have to face upcoming challenges while integrating these practices into their processes.

Thus far, neuromarketing approaches have only targeted post-design applications, like advertising campaigns' effectiveness and sales boosting. But, what if it could be implemented even before a product exists? In this case, prototyping could save substantial costs, allow a more efficient allocation of resources and establish valuable trade-offs between costs and benefits, as unpromising offerings could be eliminated in the first stages of the process (Ariely & Berns, 2011).

Neuromarketing holds significant potential for shaping the future landscape of business and sustainability. One key advantage is its ability to unravel how diverse segments of the population learn and process information, empowering companies to tailor their messaging and interventions accordingly, not only for product purchasing, but to shed light on how different countries perceive sustainability, uncovering whether it is viewed as a luxury or a necessity. This knowledge allows companies to design targeted campaigns and initiatives that resonate with specific cultural values and aspirations. Additionally, neuromarketing can play a crucial role in identifying genuinely sustainable products, ultimately encouraging more people to actively participate in sustainable practices and make informed buying decisions. By decoding consumer preferences and incorporating

neuroscientific insights, businesses can not only drive their growth but also contribute to a more sustainable future (TEDx Talks - Kristina Centnere, 2022).

7. CONCLUSION

This paper has explored the fascinating field of neuromarketing, starting with its introduction to the business world, the parts of the brain involved in decision making, as well as important techniques and tools used in its research. In addition, some real cases have been presented, with the corresponding challenges and limitations, and potential future scope for neuromarketing application.

The history of neuromarketing, despite being quite recent, reveals a gradual evolution from traditional marketing strategies to a deeper understanding of consumer behaviour through neuroscience. By studying the brain, researchers have identified specific areas responsible for decision making, such as the prefrontal cortex or the amygdala. These regions play crucial roles in processing emotions, evaluating rewards, and forming preferences, offering valuable insights into consumer decision making.

Neuromarketing research employs a variety of techniques and tools to capture neural responses and behavioural data. These include functional magnetic resonance imaging (fMRI), electroencephalography (EEG), measuring brain activity; or eye-tracking, facial expression analysis, and biometric measurements, focusing on physiologic responses. Through these methods, researchers can decode subconscious responses and gain a more comprehensive understanding of consumer preferences and motivations.

Numerous brands have successfully implemented neuromarketing principles to enhance their marketing strategies. Coca-Cola and Pepsi, Procter & Gamble, or Disney have utilised neuromarketing research to optimise their advertising campaigns, packaging designs, and product placements. By aligning their marketing efforts with the neuroscientific findings, these brands have achieved higher consumer engagement and increased sales. As I see it, they have also settled a motivational base for other companies to invest in neuromarketing techniques and upgrade their performance.

Despite its promising potential, neuromarketing faces limitations and challenges. In my opinion, ethical concerns, such as privacy and informed consent, must be addressed to ensure the responsible use of consumer data. Marketing potential starts within the customers, and it is the firm's duty to protect and respect them. Neuromarketing's potential must not be hidden by unfair practices and, as any other marketing tool, should be subject to regulations that ensure its favourable benefits, not only for the business world, but for

consumers, as they will have access to offerings that adjust perfectly to their subconscious preferences. Additionally, not enough documentation and standardisation of research findings, sample size limitations, and the complexity of interpreting neural data pose challenges to the field. It is crucial to acknowledge and navigate these obstacles to maintain the credibility and integrity of neuromarketing research.

Looking ahead, I must say neuromarketing holds exciting prospects. With advancements in technology, personalised marketing experiences can be tailored based on individuals' unique neural responses. Virtual and augmented reality applications can provide immersive and highly engaging consumer experiences. Furthermore, and one of the things that moved me the most, is the potential contribution to social causes, such as promoting sustainable consumerism and industrial practices. There is an outstanding need to re-evaluate mass production and excessive product waste. Neuromarketing precedes effective strategies to offer consumers what they will actually find useful, which is key for building a sustainable environment. I like to think about it as understanding the subconscious to buy consciously.

In conclusion, neuromarketing has proven itself as a potent tool for comprehending consumer behaviour. By harnessing the insights provided by neuroscience, it uncovers the subtle motivations and preferences that cannot be perceived through traditional marketing research. This profound understanding has paved the way for a new era, empowering businesses to better connect with their target audience and make informed decisions. Neuromarketing's impact is undeniable, leaving an uplifting mark on the way we understand and approach consumer behaviour. Ultimately, marketing's key objective is creating value for customers, and neuromarketing is a magnificent tool to achieve it in the best possible way for both parties: brands and end consumers.

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