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## NEUROMARKETING UNMASKED: A REVIEW OF CURRENT STATE IN THE FIELD

Neuromarketing razotkriven – pregled trenutnog stanja  
u području

### Abstract

Neuromarketing showed up as a new interdisciplinary field that bridges neuroscience and marketing. A relatively young field that was born within the “neuroculture” matrix is covered with a veil of mystery and often misrepresented in the media as a powerful tool used by corporations to manipulate consumers’ preferences, purchasing behavior, etc. In this paper, we have done an extensive literature review in order to put light on some dilemmas and take off the veil of mystery that surrounds neuromarketing. Firstly, (i) we discussed the definition and context in which neuromarketing emerged, (ii) important brain areas in consumer neuroscience which find their application in neuromarketing research, (iii) techniques used in neuromarketing (neuroimaging and non-neuroimaging), (iv) ethical issues in the field of neuromarketing (a part of neuroethics), and (v) limitations and recommendations for future development of neuromarketing.

**Keywords:** *neuromarketing, neuroimaging, consumer behavior, neuroethics, consumer neuroscience.*

### Sažetak

Neuromarketing se pojavio kao novo interdisciplinarno polje koje povezuje neuronauku i marketing. Relativno mlado polje koje je nastalo unutar matrice „neurokulture“ prekriveno je velom misterije i često pogrešno predstavljeno u medijima kao moćno sredstvo koje korporacije koriste za manipulisanje preferencijama potrošača, ponašanjem u kupovini itd. U ovom radu smo izvršili opsežni pregled literature kako bismo osvetlili neke dileme i skinuli veo misterije koji okružuje neuromarketing. Prvo, (i) diskutovali smo o definiciji i kontekstu u kojem se pojavio neuromarketing, (ii) važna područja mozga u potrošačkoj neuronauci koja pronalaze svoju primenu u istraživanjima iz neuromarketinga, (iii) tehnike korišćene u neuromarketingu (neuroodslikavanja i ne-neuroodslikavanja), (iv) etička pitanja u oblasti neuromarketinga (deo neuroetike) i (v) ograničenja i preporuke za budući razvoj neuromarketinga.

**Ključne reči:** *neuromarketing, neuroodslikavanje, ponašanje potrošača, neuroetika, potrošačka neuronauka.*

## Introduction: What is neuromarketing? Context and definition

Over the last two decades, we are witnessing the rise of “neuroculture” [9]. This is a neologism that refers to the emergence of new scientific disciplines with the prefix neuro. It is not just a matter of making a bridge between neuroscience and social science/humanities in terms of implementing neuroimaging techniques that are used in cognitive neuroscience and neurology, but changing the basic assumptions that we have about ourselves i.e., about self. Neuroculture reinforces a neo-materialistic epistemological standpoint that seeks an explanation for complex human phenomena on the most fundamental biological level [16], [26]. Brain-base narratives which come out from the “neurocultural” matrix increasingly influence our daily lives, social practices, and academic discourse [7].

According to Fisher and colleagues [7], the earliest report that used the word “neuromarketing” appears to be in a June 2002 press release by an Atlanta advertising company, BrightHouse. BrightHouse was the first advertising company that declared using fMRI (abbreviated from Functional Magnetic Resonance Imaging) for marketing research and advertising purposes [7]. The advertising company has been collaborating with people from academia, which led to controversy related to ethical issues [7], [25]. Since then, the number of companies that offer services in the area of neuromarketing has rapidly grown [28].

Neuromarketing is one of such disciplines that emerged within the “neuroculture” matrix. Prefix neuro implies using neuroimaging techniques in the field of marketing. So, it means that neuromarketing is an interdisciplinary field that incorporates knowledge from neuroscience and its methodology to understand and predict consumer behavior [17]. Some authors consider neuromarketing as a subarea within another discipline with the prefix neuro – neuroeconomics [13]. Plassmann and colleagues [28] suggest that neuromarketing can be distinguished from consumer neuroscience by restricting the former to industry applications and the latter to academia. At first glance, it may seem that authors such as Huber and Kenning [13] are using terms such as neuromarketing and

consumer neuroscience interchangeably, but they make clear distinctions between them. Similar to Plassmann et al. [28], Huber and Kenning [13] define neuroscience as a research approach and place it within boundaries of academic discourse, while neuromarketing “designates the application of the findings from consumer neuroscience within the scope of managerial practice” [13, p. 274].

In general, neuromarketing is the implementation of various techniques such as neuroimaging used in other disciplines, which subject is the brain and its activity, in order to understand consumer behavior. Neuroimaging is being used to explore consumers’ preferences avoiding censorship. Therefore, neuroimaging techniques can be said to represent a “royal road” to the consumer’s unconscious mind. With the inauguration of neuroimaging into an area of marketing, the whole field became more controversial than ever.

In the course of this paper, we aim to cover issues related to neuromarketing by doing an extensive literature review. More precisely, we sought to cover important brain areas in consumer neuroscience, techniques used in neuromarketing (both neuroimaging and non-neuroimaging techniques), ethical issues in the field of neuromarketing (a part of neuroethics), and limitations and recommendations for future development of neuromarketing.

## Important brain areas in consumer neuroscience

Research in consumer neuroscience is primarily focused to find out how certain brain areas are activated and what the activation of certain areas of the brain can tell us [12]. Certain brain regions are more important in research in the area of consumer neuroscience than others [12]. Specific brain regions play different roles in cognitive and emotional processes that are relevant in consumer research [4]. In the next few paragraphs, we will describe several areas of the brain that are important for consumer neuroscience.

Firstly, the *striatum* is a striped mass of white and gray matter located in the basal ganglia inside the forebrain [4]. The striatum and its components - *putamen*, *caudate nucleus* (CN), and *nucleus accumbens* (NAc) are most consistently linked to reward processing [4], [17], [18],

[27]. More specifically, the striatum plays a role in the evaluation of one's expectations compared to actual rewards received, and also there is an influence of social factors on this region's reward-related activity. In addition, it is also linked to preference/liking of products, preference of product design, purchasing decision, learning, motivational value, predicted value, etc.

The *insula* or *insular cortex* is one of the regions which plays an important role in emotional processing and (consumer) decision-making [4], [17], [27]. It is related to feelings of pain, frustration, disgust, love, negative emotions, psychological arousal, etc. This area is fundamental in moments of making a decision for which a social or financial risk is expected.

The *amygdala*, a central brain structure located in the temporal lobe, has a crucial role in emotional processing [4], [17]. The amygdala is involved in the processing of negative emotions, unknown stimuli, aversive responses to inequity, positive emotions related to rewarding stimuli, etc. The amygdala appears as an important modulator of the memory system, especially in memory consolidation. It is mostly known as a locus of fear and aversive memory. Thus, it is very relevant in understanding and analyzing marketing stimuli, as well as their position in long-term memory. Situated next and closely related to the amygdala is the *hippocampus*, which plays a major role in generating different forms of memory, but also in memory processing and memory consolidation. Studying memory-related cognitive processes is important for consumer neuroscience because it can provide us with insights into variables that influence consumer behavior such as advertising recall, brand awareness, and product experience.

Another relevant area is the *orbitofrontal cortex* (OFC), located in the frontal lobe and part of the *prefrontal cortex* (PFC), which integrates sensory and affective information from different areas of the brain [4], [17], [18]. Orbitofrontal cortex, as a part of the prefrontal cortex, plays an important role in the underlying processes of human decision-making, by the assessment of the (perceived) value of different options and potential outcomes. This area is critical because one of the main questions in marketing research is how consumers decide between different product alternatives. It is also related to "willingness to

pay (WTP)", experienced value, pleasant experiences, etc. Lesions of this area can have serious consequences on decision-making and emotional processes [12].

Finally, one more area that is significant is the *ventral tegmental area* (VTA), a group of neurons located in the midbrain, which is largely responsible for the transportation of the neurotransmitter dopamine among brain areas [4], [17]. Dopamine enables modulation of the decision-making process and affects goal-seeking behavior. The ventral tegmental area is also a part of the brain's reward system. The modular role of dopamine is of crucial importance in understanding the effect of an advertisement or other stimuli and its sense of reward on consumers, thus determining the success of the stimuli.

It is important to know which brain areas are activated by which marketing stimuli, in the case of both the marketer and the consumer [12]. However, interpretations of activation of certain brain regions and their link to specific psychological processes should be done cautiously, and be theoretically driven [4]. It is difficult to infer a particular psychological process based only on observation of specific brain regions [17]. This is complicated because individual brain areas are usually involved in more than one cognitive function [18]. Therefore, a one-to-one brain activation coordinate to a brain function is rarely possible [27]. We should note, however, that only the most important brain areas for consumer neuroscience were presented in this section, for the sake of being concise. In the next section, techniques with which we can investigate brain areas, but also other physiological indicators relevant for neuromarketing will be presented.

### Neuromarketing techniques: An extensive overview

Neuromarketing techniques are used to observe/measure the responses of participants when exposed to different types of stimuli such as ads/commercials, still pictures, texts, etc. [5]. One practical way of categorizing neuromarketing techniques is into two broad categories – neuroimaging and non-neuroimaging techniques [11]. Neuroimaging techniques can be described as those which are related to the involvement of neurological activity [11]. In contrast,

non-neuroimaging techniques can be described as those which do not involve any neurological activity [11]. Neuroimaging techniques can be further divided into those that measure metabolic activity in the brain or related to it and those that measure electrical activity in the brain [8]. Each of the neuromarketing techniques, which will be described in further detail, has some advantages and disadvantages, and they often measure variables that are complementary in order to better understand a problem in market research [8]. The advantages and disadvantages of neuromarketing techniques depend on the research question being asked [29]. Thus, it is advisable to combine multiple neuromarketing techniques whenever it is possible, to obtain valuable research results [8].

### Neuroimaging techniques

*Functional magnetic resonance imaging* (fMRI) is a non-invasive brain imaging method that measures brain activity based on the changes in the oxygenation level of the blood [29]. fMRI belongs to tools that record metabolic activity in the brain [3]. It functions as a scanner in which a study participant lies during the experiment [29]. It can measure memory encoding, sensory perception, the valence of emotions, cravings, trust, brand loyalty, brand preference, brand recall, etc. [3]. fMRI is used in sensory testing, product choice, testing new campaigns, products, and advertisements, identifying needs, packaging design and prices, celebrity endorsement, positioning of products, identifying video content, etc. [11]. The advantages of fMRI are high spatial resolution (3 mm), measurement covers most brain regions including deeper ones, the method is non-invasive, it is one of the most employed techniques in neuroscience, etc. [3], [8], [11], [29]. The drawbacks of fMRI are relatively low temporal resolution (1-3 s), high costs, the equipment is not portable, the environment makes it difficult to conduct experiments, ethical barriers, etc. [8], [11], [29].

*Electroencephalography* (EEG) is an electrophysiological monitoring method that detects changes in the electric current in the form of brain waves [29]. EEG can be classified as a neuromarketing tool that records electrical activity in the brain [3]. In EEG, electrodes are spread

across the participant's head (commonly there are 64 electrodes) [29]. EEG measures attention, engagement/boredom, excitement, emotional valence, cognition, memory encoding, recognition, approach/withdrawal, etc. [3]. EEG is applied in brand recall, testing new campaigns, testing and developing advertisements, testing design and usability, testing taglines, testing in-store experience, etc. [11]. The advantages of using EEG are high temporal resolution (in milliseconds), equipment costs are relatively low, it is portable, it is a non-invasive method, it has greater validity in the measurement of emotional styles and the detection of psychopathologies compared to fMRI, etc. [3], [8], [11], [29]. The disadvantages of using EEG are that it can only record more superficial electrical signals (i.e., low spatial resolution; around 1 cm, depending on the number of electrodes), it is non-scalable, result normalization is needed, there are ethical implications, etc. [5], [8], [11], [29].

*Magnetoencephalography* (MEG) is a non-invasive medical test that records changes in the magnetic fields produced by electrical currents occurring naturally in the brain [29]. MEG belongs to the group of techniques that record electrical activity in the brain [3]. MEG uses very sensitive detectors set on a helmet placed on the participant's heads (it contains from 100 up to 300 detectors) [29]. It can measure perception, attention, and memory [3]. It can be applied for brand recall, and also for testing design and usability [11]. Good temporal and spatial resolution, as well as non-invasiveness, can be seen as advantages of using MEG [3], [8], [11], [29]. High costs, the need for a room free of the earth's magnetic field, and ethical barriers can be regarded as disadvantages of using MEG [3], [11], [29].

*Positron emission tomography* (PET) is a clinical imaging symptomatic method where researchers inject radioactive ligands into the bloodstream of a participant and track how they accumulate in the brain [5], [11]. PET belongs to the type of neuromarketing tools that record metabolic activity in the brain [3]. PET can measure sensory perception, the valence of emotions, engagement, attention, memory encoding, etc. [3], [11]. It is used in testing new products, testing and developing advertisements, as well as in packaging design and prices [11]. High spatial

resolution and the ability to detect changes in chemical composition or changes in the flow of fluids in the brain, can be perceived as some of its advantages [3], [11]. Poor temporal resolution, expensiveness, negative effects of radioactive material on subjects' health, and ethical barriers can be perceived as some of its disadvantages [3], [8], [11].

*Steady state topography* (SST) is a methodology that records brain electrical activity (previously mentioned EEG) while a sinusoidal visual flicker is presented in the visual periphery [3]. This elicits an oscillatory brain electrical response – the Steady State Visually Evoked Potential (SSVEP), and changes in brain activity are then determined from SSVEP measurements [3]. SST is one of the tools that belong to the category of recording electrical activity in the brain [3]. SST measures sensory perception, valence and intensity of emotions, consumer behavior, video materials' effectiveness, long-term memory encoding, engagement, attention, etc. [3], [11]. Its application can be found in brand recall, testing in-store placement, testing advertisements, testing movie trailers, testing prints and images, testing brand communication, etc. [3], [11]. SST's perceived advantages are tracking rapid changes in the speed of neural processing in different regions of the brain (i.e., high temporal resolution) and high tolerance to noise [3], [11]. SST's perceived disadvantage is low spatial resolution [3], [11].

### Non-neuroimaging techniques

*Facial coding* is a methodology that identifies and measures via video camera micro facial expressions that present non-conscious reactions, based on the activity of the facial muscles [3]. Facial coding is the type of neuromarketing tool that doesn't record brain activity [3]. With facial coding, unconscious reactions, 43 facial muscles, 23 action units, and six basic emotions (i.e., sadness, happiness, fear, anger, surprise, and disgust) can be measured [3], [11]. It can be applied in testing movie trailers, testing new products, testing and developing advertisements, identifying key moments of advertisements, etc. [3], [11]. Real-time data, non-invasiveness, and the spontaneity of facial expressions can be viewed as advantages of facial coding [3], [11]. Subjectivity in deciding when a facial

action has occurred can be viewed as a disadvantage of facial coding [3], [11].

*Eye tracking* is a method that involves the usage of either eyeglasses (mobile) or a stationary tracker that uses infrared cameras in order to detect a subject's gaze [5]. Eye tracking as a method belongs to the methods that don't measure brain activity [3]. With eye tracking, visual search, fixation position, eye movement patterns, spatial resolution, excitement, and pupil dilation can be measured [3], [11]. Eye tracking is used in brand recall, brand perception, testing and developing advertisements, testing design and usability, testing in-store experience, testing layouts, testing new campaigns, etc. [3], [11]. Some advantages of using eye tracking are portability, it is one of the least intrusive techniques, its ability to measure the focus of consumers' attention, the pattern of visual behavior of fixations of the gaze, dilation of the pupils, focus, and microfocus, etc. [3], [8], [11]. Some of its disadvantages are low flexibility, unreliable results, results can depend on subjects' eye conditions, equipment is costly, etc. [3], [11].

*Skin conductance* (SC) is a technique that measures the objective excitation caused by an emotionally relevant stimulus, i.e., it measures subtle change in galvanic skin response (GSP) [8]. SC is the type of technique that doesn't record brain activity [3]. SC measures emotional engagement, as well as valence and arousal of emotions [3], [11]. It can be applied in marketing for testing in-store experience, brand perception, brand recall, testing design and usability, prediction of market performance, etc. [3], [11]. SC's obvious advantages are portability, noninvasiveness, the ability to measure the degree of arousal, there are softwares that allow separating noise from true arousal response, the prediction of market performance is better than with self-report questionnaires, etc. [3], [11]. SC's obvious disadvantages are that it is more informative when combined with neuroimaging techniques and that it cannot distinguish between stress and excitement well enough [3], [11].

*Facial electromyography* (Facial EMG) is a technique that measures and evaluates the intentional and automatic movements of facial muscles [3], [8], [11]. Facial EMG is the type of neuromarketing technique that doesn't record brain activity [3]. EMG can measure unconscious

reactions, subconscious reactions, emotional expressions, social communication, mood state, emotional valence, etc. [3], [11]. Facial EMG is used when testing brand recall, testing consumer reactions to advertisements, testing video materials, testing of content filtering, identifying video content, etc. [3], [11]. The advantages of facial EMG are high accuracy, flexibility of recording, growing credibility for use in the analysis of different affective reactions to visual stimuli, reactions of taste, smell and hearing, human interactions, and behaviors, the ability to measure facial muscle activity even to weak emotional stimuli, the ability to test both voluntary (conscious) and involuntary (unconscious) facial muscle movements, the ability to identify the valence of the mood state/emotion (positive or negative), availability of software to remove artifacts, etc. [3], [8], [11]. The disadvantages of facial EMG are that it doesn't record discrete emotions (i.e., there is double meaning for certain facial expressions), electrodes fixed on the face may inhibit some facial movements, there is noise in data, etc. [3], [8], [11].

*Implicit association test (IAT)* is a psychological test that is designed to measure the implicit attitudes/evaluations of the person by assessing reaction times on two cognitive tasks, in order to identify the speed with which they can associate two different concepts, with two different evaluative anchors/attributes put next to them [3]. IAT belongs to measures that don't record brain activity [3]. As it was described, it measures reaction time and underlying attitudes/evaluations [3], [11]. IAT can be used in the areas of category segmentation, brand positioning, celebrity endorsement, salient packaging features, identifying video content, sensory testing, consumer attitudes, etc. [3], [11]. The pros of using IAT are that it draws a more holistic picture of individual behavior and experience, it allows identifying hierarchies of products, it is less biased by deliberate attempts of the subject to conceal their attitudes, etc. [3], [11]. The con of using IAT is that results depend on willingness of subjects to collaborate [3], [11].

Other commonly used techniques in the area of neuromarketing are transcranial magnetic stimulation (TMS), monitoring heart rate and its variability, blood pressure monitoring, looking into the interaction between

heart beats and pulse transition time, measuring stress hormone (cortisol) from saliva, etc. [3], [8], [11]. All of the described techniques come with ethical implications regarding their usage in neuromarketing, and this will be explained in the next section.

## Neuroethics in neuromarketing

Rapid development in neuroscience and implementation of neuroimaging techniques outside academic and clinical frameworks led to the recognition of the need for neuroethics [6]. Neuroethics deals with ethical, legal, and social aspects related to neuroscience, and with those aspects exclusively restricted to research procedure within the scientific area itself [14]. The emergence of neuroethics on the academic scene happened in the same year (2002) when BrightHouse got media attention for being the first advertising company that declared using neuroimaging techniques for commercial purposes [7]. A conference *Neuroethics: Mapping the Field* organized by Dana Foundation was held on ethical and social implications of neuroscience. The conference gathered experts from different fields such as neuroscience, ethics, law, and journalism to participate in establishing a new interdisciplinary area derived from bioethics. In the next few paragraphs, some of the main aspects of neuroethics related to the field of neuromarketing are going to be presented.

According to Murphy [25], ethical issues in neuromarketing can be classified into two major clusters. The first cluster refers to the protection of parties who can be exploited in the most general sense by those who do neuromarketing research (i.e., companies, research agencies, etc.), and the second cluster implies protection of consumer autonomy if methods in neuromarketing prove their efficiency in terms of manipulating and predicting consumer behavior [24]. Some aspects related to the protection of subjects who participate in neuromarketing research means the implementation of rigorous procedures that will guarantee privacy and confidentiality to these subjects. Researchers in the field of neuromarketing are obliged to provide truthful information i.e., to well inform subjects about the research itself (if possible, expected outcomes of research when it does not interfere with validity, etc.) and potential risks for

health due to methods used in the research (e.g., fMRI's strong magnetic field can have negative health effects)[5]. Along with these "basic" recommendations, researchers in the field of neuromarketing should be very cautious about "vulnerable groups" during the process of "targeting" the niches on the market. These vulnerable groups should be excluded from neuromarketing research. Subjects that can be categorized as vulnerable are children, those with some neurological condition or psychiatric diagnosis [25].

It is said that neuromarketing borrows various neuroimaging techniques from neuroscience for commercial purposes. The dominant motivation of marketers is to find out specific cortical structures responsible for the decision-making process in consumer behavior. If this novel approach proves itself as "key" to a deeper layer of a consumer mind and shows higher predictive power, the autonomy of the consumer comes into question. There is *a priori* attitude that the consumer has autonomy to a certain degree in making decisions, in other words, that he or she is in charge of his/her consumer behavior. Of course, it is partially true. The great advantage of techniques used in neuromarketing, in comparison to a more traditional approach to consumer behavior such as focus groups, surveys, structured interviews, is the possibility of avoiding censorship, social pressure (in the case of a focus group). Additionally, neuromarketing tools provide solutions for the subject's incapability of being absolutely aware of why some product or brand seems to him or her more likable than another. But what if the consumer's autonomy can be manipulated? What if companies can influence consumer's preferences without their conscious knowledge? Can it be treated as an attack on human integrity?

The first neuromarketing research that caught academic attention was conducted by McClure and colleagues [23]. Their research showed how consumers' preferences interact with brand information at the level of brain activity [23]. This study triggered skeptics who were afraid of the potential exploitation of any new technology. This and similar research were quite enough for the media to spread misinformation about the existence of some "magic spot" or "buy button" [7]. These statements have produced legitimate worries and public distrust in

neuromarketing and in some general sense have shaped simplistic, deterministic, reductionist understanding of (consumer) self and behavior. Media are not the only ones to blame, companies that offer services in the area of neuromarketing foster that viewpoint, too. Fisher and colleagues [7] were primarily focused on websites of neuromarketing companies in order to extract their main features that might have an impact on the public image of neuromarketing. They pointed out that there are so often premature and unrealistic claims about the power of neuromarketing that do not get enough support from empirical studies [7]. Furthermore, there is a tendency for over-interpretation of results obtained by neuroimaging techniques. These clarify other relevant ethical aspects related to the creation of an unrealistic image of neuromarketing that leads to public misconceptions about (neuro)science in general. Besides research subjects, ethical concerns should include other parties who pay for services provided by neuromarketing companies. It is proven that showing brain images has a powerful effect even within the scientific community [22]. In addition to scientists, the public shares the same fascination with brain images. Scientific descriptions look more persuasive if they are accompanied by brain images, even though it does not influence the validity of findings [7], [22].

General fascination with brain images reflects the currently dominant attitude and our wish to find out specific places (*loci*) in cortical structures that are responsible for a wide spectrum of the complex human experiencing and behavior. This collective fascination can be abused by neuromarketing companies, so in order to prevent potential ethical issues, some regulations need to be established. Companies that provide neuromarketing services have to be as transparent as possible in terms of the methodology they use in research. Procedures and techniques have to be sufficiently explained, not just listed without any concrete description [7]. Making these aspects clearer should be a good measure in fighting manipulation and violation of ethics in this domain. Related to it is also a question of internal and external validity of the methodology used in neuromarketing [25]. In order to make some improvements in these aspects, more people from academia should participate in testing existing hypotheses in this field and

doing research in order to expand the knowledge that is going to be publicly available. Action of this kind would help to present neuromarketing and its possibilities more realistically and prevent manipulations of corporate clients by neuromarketing companies. One solution for these ethical issues is establishing a more rigorous practice in terms of monitoring and regulating research in consumer neuroscience and its application in neuromarketing. As we can see, damage can be done not just to subjects in research, but to corporate clients so the legal framework has to cover as much as possible those situations in which it is obvious that neuromarketing companies violate ethics by using “fancy” interpretations and brain scan images in order to manipulate their clients.

These ethical issues open up a space for questions such as who can have control and ownership over neuroimaging technologies. Should they be restricted only to academia as it was at the beginning when neuroimaging technologies were used only in clinical and academic purposes? In some countries, e.g., in France, pursuing any commercial research by using brain imaging techniques is banned [30]. Should neuroimaging technologies be democratized? Who could navigate the development and implementation of these technologies? There is no single answer to all potential ethical dilemmas. Farah [6] is an advocate of neuro-literacy, suggesting that as information technologies and environmental science have entered the curriculum of most secondary schools over the past few decades, the same is going to happen with neuroscience in the near future. Therefore, neuro-literacy can be of help for providing necessary knowledge that can guide us when we face some ethical dilemmas considering the implementation of neuroscience in everyday life. In the last paragraphs, we will discuss methodological limitations, as well as recommendations for future research in the field of neuromarketing.

## Conclusions

Neuromarketing is an emerging new way of analyzing and understanding consumer behavior that incorporates methodologies from neuroscience in the field of marketing. Corporations motivated to get an advantage on the market

employ neuromarketing companies to help them achieve their goals related to marketing mix [10], [21]. A great enthusiasm with neuroimaging techniques, brain-based narratives, and fascination with brain scan images which all together blur some limitations in the field that must be taken into consideration if we want to stay objective and improve the state of affairs in the field. Some of the limitations in the field are going to be presented in the next few paragraphs and at the end of the discussion, there will be some recommendations for future research.

Tools used in neuromarketing research such as fMRI, PET, EEG, etc. are much more expensive than instruments used in traditional marketing research. Therefore, the immovability and high costs of these tools are some of the most obvious limitations in neuromarketing research [24]. Implementation of the described tools requires a controlled, laboratory environment. Laboratories are not an adequate representation of the real-world situation in which people are exposed to some advertising stimuli. In numerous situations in which we are exposed to some brands, ads, etc. we are surrounded by other people (e.g., social occasions, joint activities, etc.). These contextual factors give a completely different dimension to our experience of marketing stimuli. In controlled laboratory environments, subjects are completely isolated from these contextual factors. In other words, artificial environments in which neuromarketing research is being conducted show low external validity. Furthermore, simpler experimental designs (like those in fMRI studies) compared to traditional experimental designs in marketing research, difficulties related to subjects' bodies moving during an experimental procedure [19], and a small number of subjects in research have a negative impact on the generalizability of results gained in that way. Lack of reliable empirical findings (i.e., incomplete map of brain functions) is one of the main underlying factors for over-interpretation of results obtained by neuroimaging tools such as fMRI, PET, etc. In most cases, neuromarketing research is based on the implementation of a single tool [24]. Implementation of more than one tool would significantly add to the reliability and (incremental) validity of findings in this field. In other words, the weakness of one tool would be covered by another.



Limitation regarding ethics is tackled in the chapter about neuroethics in neuromarketing. All potential ethical issues are not exhausted in the paper, so it is to be expected that with development in the field new ethical dilemmas will arise, especially those related to consumer autonomy if these neuromarketing tools achieve “high” levels of efficiency in terms of prediction of consumer behavior/preferences as Murphy [25] pointed out. For now, we should be sure that existing technology in the service of neuromarketing does not have an ultimate answer on some specific consumer behavior in terms of accurately identifying brain structures responsible for that behavior.

### Some predictions of the future of neuromarketing and consumer neuroscience

In the next few paragraphs, future avenues for neuromarketing and consumer neuroscience will be discussed. Neuromarketing is a constantly evolving field, both in the area of technology and insights [15]. Still, we should distinguish the neuromarketing hype from the real potential of neuromarketing in the future [2]. The hype can be seen by the fact that there has been tremendous growth in the number of neuromarketing companies in recent years [28]. There are even companies that promote neuromarketing itself [2].

It is expected that there will be more collaborations between researchers who are interested in neuromarketing [20]. More studies will be done in the field in future periods [20]. Thus, more publications about the topic will be present in marketing and consumer research scientific journals, more books, and more topic-relevant Google references [15]. In addition, special issues on neuromarketing are expected in marketing and consumer science journals [1]. An increased number of studies will help us to better understand, analyze, and compare obtained research data [20]. This will open up space for more methodologically correct studies in the field [20]. It can be expected that neuromarketing will integrate itself with traditional market research methods that belong to quantitative and qualitative research [1]. This will allow the marketing discipline to develop theories based on multi-method evidence [1]. In the future, contributions from the disciplines of social and affective neuroscience will be valuable [18]. More

concretely, contributions of social influences and settings, and also interpersonal interactions should be integrated with neuromarketing research [18]. It is also anticipated that an integrated model of information processing in the consumer’s brain will be built [1].

It is also estimated that connectomics, the study of the brain’s structural and functional connections between cells, will play an important role in the future development of neuromarketing and consumer neuroscience [1]. A new frontier for neuromarketing is nanomarketing as well [24]. The term nanomarketing refers to the integration of neuromarketing tools with miniaturized, portable, nonintrusive, and wireless nanotechnology devices (i.e., in the broader sense, nanomarketing technologies) [24]. Mileti and colleagues [24] predict future market research will use a combination of different nanomarketing technologies to test research hypotheses.

However, there is a possible scenario that the hype around neuromarketing will fade out [2]. It is still an open question whether neuromarketing tools will continue to be used in market research, considering their relatively high costs compared to conventional marketing tools [2]. As we have previously mentioned, the rise of neuromarketing is connected to the rise of neuroculture in general, and its popularity depends on neuroculture’s popularity. For example, there was hype around subliminal advertising, which quickly died out even though subliminal priming remained an important research area in social psychology [2]. The future of neuromarketing depends on the academic community and researching deeper questions on how marketing works and not just examination of specific advertisements [2]. In addition, the academic community should take the results from basic (fundamental) research in neuroscience and find its practical application in marketing. Some examples of fundamental neuroscience research that are making breakthrough advancements and could help in advancing consumer neuroscience are European Union’s Human Brain Project (HBP) and the BRAIN (Brain Research through Advancing Innovative Neuro technologies) initiative [1].

It will be beneficial in the future to use neuromarketing to find out what consumers really want and find useful, and not coerce them into consuming products they don’t

like and need [2]. This field can have a promising future if ethical concerns are taken into consideration [20].

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