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REVIEW PAPER

Neuroethics and Responsibility in Conducting Neuromarketing Research

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Abstract Over the last decade, academics and companies have shown an increased interest in brain studies and human cerebral functions related to consumer's reactions to different stimuli. Therefore neuroethics emerged as a way to draw attention to ethical issues concerning different aspects of brain research. This review explores the environment of neuromarketing research in both business and academic areas from an ethical point of view. The paper focuses on the ethical issues involving subjects participating in neuroimaging studies, consumers that experience the effects of research results and also researchers that conduct such studies. Starting the analysis from the gaps in traditional marketing research, the paper provides information on ethics of neuromarketing research and its challenges and offers perspectives concerning the standards that should be implemented in order to allow the development of both neuroethics and neuromarketing under appropriate conditions.

Keywords Neuroethics · Neuromarketing · Neuroscience · Consumer free will

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Introduction

The disciplines of neuroscience and cognitive psychology advanced and joined forces to provide an entirely new paradigm for understanding the ways in which consumers develop, store, retrieve, and use information. Social cognitive neuroscience is an emerging area of research that can contribute to the development of new theories and the enrichment of the existing ones [1]. Companies increased their interest in neuromarketing studies that measure consumer choices, and therefore commercial, political, philosophical and law implications for the society arise from using these neuroimaging tools. By using technology advances in neuroscience, researchers can obtain information on brain responses to marketing stimuli. Anticipating ethical challenges is crucial in developing methods for effective research, as it also represents the aim of neuroethics. There are associations (Neuromarketing Science & Business Association, The European Society for Opinion and Market Research) and authors [2–10] interested in neuroethics and implications of neuromarketing research and their purpose is to share knowledge and protect social interests related to the discipline.

Neuromarketing researchers are the individuals or organizations that perform neuroscience investigations for marketing purposes. These studies are performed using brain scanning techniques and the use of neuromarketing research nowadays involves parties that have different interests, such as:

- advertising agencies and marketing departments that want to pretest their campaigns, products, packaging design or websites and identify moment-by-moment reactions to persuasion and measure message effectiveness, understanding or attention in order to make adjustments and optimize their budgets and results, or to identify the ease and pleasure when using their products or websites;
- media departments that want to determine the effectiveness of hiring space in television, radio, magazines or digital media and to develop their mix of strategies;
- departments interested in identifying the suitable brand names that resonate with consumers, or how strongly they feel about a brand or product and whether their response to it is cognitive or emotional;
- companies that need to understand the triggers of their customers' preferences;
- political strategists that want to evaluate communications and debates;
- film producers that want to decide between actors to cast in their movies, between alternate endings of a movie, or select sequences to include in the movie trailer in order to maximize the impact.

Therefore neuromarketing can be employed in order to better understand unconscious consumer response and preference for:

- pretest campaigns on TV, radio, online media and film;
- design choice and launch of products, brands, labels or packaging;
- print magazines and outdoor advertising; test taste, texture and smell;
- political campaigns;
- point of sale strategies and position on shelves;
- brand preferences;
- storyboards and movie trailers, all in order to gain the maximum effect.

But in order to act in a responsible manner while employing neuromarketing research for the reasons mentioned above and using the insights provided in order to reach the objectives, each party involved in this process needs to respect guidelines and to make sure that ethics is taken into consideration at each step.

Conceptual Framework

Using brain scans and neuroscience advances in order to understand consumers' decisions and to employ the insights in marketing campaigns, researchers need to be careful with ethical aspects involved in their work. In order to understand neuroethics, we need to study how it reflects on several areas of research because its implications are found at a multidisciplinary level. Levy [1] states that neuroethics exists at the confluence of many disciplines: neuroscience and ethics, most obviously, but also psychology, cognitive science and philosophy of mind. He also claims that the mind is not contained within the skull, but extends beyond it, into the world, and that the mind's location has direct neuroethical relevance.

Neuroethics is positioned as being proactively dealing with ethical issues in pursuing knowledge and manipulation of the human brain and well-positioned to offer guidance for beneficent and non-harmful deployment of neuromarketing techniques [8]. Most employed techniques in neuromarketing research are functional magnetic resonance imaging (fMRI) that measures brain activity by tracking changes in blood flow - when a certain brain area is active, corresponding blood vessels dilate and more blood rushes in, reducing the amount of oxygen-free hemoglobin and producing a change in the magnetic field in the active area, electroencephalography (EEG) that measures variations in brain waves by means of electric activity captured at the scalp level to determine what parts of the brain are activated and whether the stimuli cause positive or negative emotions, or eye tracking devices that identify where a subject is looking at or where exactly he focuses his attention, as they may allow corporations, governments and others to influence decisions and actions regarding consumer preference in natural environments.

This field at the intersection of bioethics and neuroscience is founded on centuries of discussion of ethical issues associated with mind and behaviour. As Illes et al. [11] suggest, neuroethics can be broadly defined as concerned with ethical, legal and social policy implications of neuroscience, and with aspects of neuroscience research itself. Lombera et al. [12] define neuroethics as a discipline that aligns the exploration and discovery of neurobiological knowledge with human value systems and intersects with biomedical ethics, being concerned with ethical, legal, and social implications of neuroscience. Gazzaniga [13] characterizes neuroethics in a

general manner, as the examination of how we want to deal with the social issues of disease, normality, mortality, lifestyle, and philosophy of living informed by our understanding of underlying brain mechanisms.

Levy [14] offers a more specific point of view, stating that neuroethics is concerned with both the nature of the tools it uses and with the problems it seeks to apply. So the interest of this field consists in ensuring that the subjects do not do anything against their will or are physically affected, but also in censoring the use of the information retrieved for unethical or illegal purposes, when results are used for commercial purposes. This dual focus of neuroethics made Roskies [15] distinguish between *the ethics of neuroscience* (1) - ethical problems in neuroscience arising from new forms of intervention into the brain, including informed consent - which is divided into *ethics of practice* and *ethical implications of neuroscience*, and *the neuroscience of ethics* (2) which includes free will, self-control, personal identity, intention and moral judgment. Northoff [16] considers that neither of the terms can be clearly delimited from each other and fits the two terms into a new class: *empirical neuroethics*. He then considers *theoretical neuroethics* as focusing on methodological and conceptual aspects of linking neuroscience with ethical concepts. On the other hand, Macdonald [17] distinguishes between two main categories of ethical issues: those emerging from what humankind can do, meaning ethical problems raised by advances in functional neuroimaging and brain-machine interfaces and those emerging from what humankind knows, i.e. ethical problems raised by humankind's growing understanding of the neural basis of behaviour, personality, consciousness and spiritual states. The ability to scan brains has more profound implications than scanning any other body part, although this does not induce any behaviour or functional change.

Neuromarketing or consumer neuroscience is a discipline that employs advanced technology in order to find a better way to satisfy the consumer [18] and involves the use of neuroimaging in order to measure consumers' desire for a product [17]. In the first issue of the Journal *Neuroethics*, Levy [14] presents the range of issues drawing on neuroethics, including rationality, autonomy and morality. But ethical issues are raised even after finishing a study, and as Murphy et al. [8] remark, not just using scientific technology to advance commercial interests, but findings about the inner workings of the human brain (the neural mechanisms behind thoughts, reasoning, emotions, memory or decision making), beyond the ones divulged by traditional research, raise substantial ethical problems. More precisely, using neuroimaging in an environment in which the ultimate goal is to sell more products to the consumer may bring ethical issues to the table, Ariely et al. [19] note. The responsibility of the people who use the results of neuromarketing studies comes into question, and for the moment there are no regulations that could stop them from using the insights to only serve their financial interests.

According to Morin [20], the first neuromarketing empirical study was conducted in 2003 and published in 2004 by Read Montague. In the experiment, a group of people drank Coca Cola or Pepsi while their brains were scanned using functional magnetic resonance imaging (fMRI). Thus, it was concluded that different brain areas were activated when people knew the brand consumed, as compared to when they did not know it. According to the study, when subjects did not know the brand used, they reported that they preferred Pepsi, and a consistent neural response in the ventromedial prefrontal cortex correlated with subjects' behavioral preferences for these beverages [21]. However, when people knew the brand consumed, they said they preferred Coca Cola over Pepsi (so band knowledge had a dramatic influence on expressed behavioral preferences) and their frontal lobe was activated, an area that coordinates attention, controls short-term memory and directs thinking and planning. This finding reveals that product brands used as emotional stimuli affect cortical activity and can influence purchasing behaviour.

A decade has passed since then and the academic interest in neuroethics and neuromarketing has grown, as shown in Fig. 1. The figure is based on a search performed on December 7, 2014, on Web of Science platform's database, a popular and widely used platform by academic or scientific professionals that offers access to multiple databases which reference research from different disciplines, with indexing coverage from 1900 to present (over 30,000 scholarly books, 12,000 journals and 148,000 conference proceedings). In order to compile the figure, a first search was performed using the keyword "neuroethics alone", and a second search was performed using the keywords "neuromarketing" or "consumer neuroscience" (127 results in total). On a third search performed on the both keywords "neuromarketing" and "neuroethics", only five records of articles published in 2010, 2011, 2013 and 2014

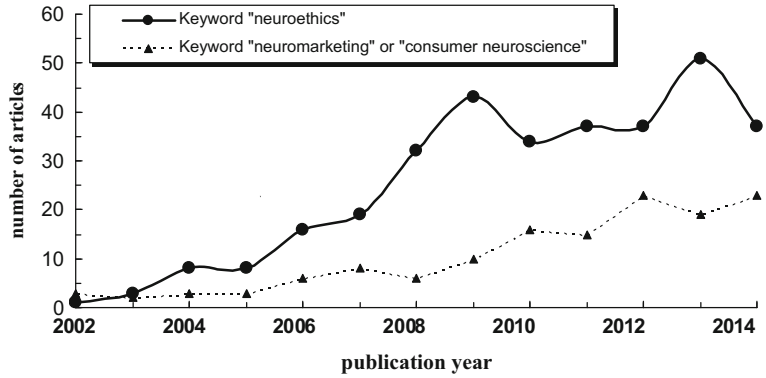

Fig. 1 The evolution of academic interest (number of articles published) in neuroethics and neuromarketing over the last years

[22–26] were found, although there is a need for new regulations to be adopted in order to eliminate any ethical doubts that these studies may bring.

Roskies [15] introduces the idea that the intimate connection between our brains and our behaviours, as well as the relationship between our brains and our selves, generate distinctive questions that beg for the interplay between ethical and neuroscientific thinking. Wilson et al. [27] consider that opportunities to influence consumers without their full awareness may increase significantly as a result of research on brain activity, and when a consumer purchases a product based on a decision in which marketing stimuli unrelated to product characteristics cause affective neural systems to override cognitive processes, the final purchase outcome may not always be in the best interest of the consumer. Ethics regulations should take this into consideration, acting like a balance between companies that advertise their products and consumers' interest. On the other hand, O'Connell et al. [28] suggest that neuroscientists over-emphasize the impact of their research and sometimes fail in considering the limitations of their study. But on the other hand, the authors also consider that increased emphasis on ethical issues involves heavy restrictions on the freedom of neuroscientists in conducting research, also limiting also the results. And although the purpose of neuroethics is to promote public concerns, it should also serve the interests of empirical research. Public receptiveness, press coverage and poor understanding of neuroscience concepts have opened the path for neuroscientists to use brain studies for commercial purposes that push public acceptance for using these techniques. Kenning et al. [24] emphasize that, although investigations in consumer neuroscience theoretically contribute to marketing research, media claimed that marketers desire to control consumer freedoms through unethical research. The author considers that consumer neuroscience is primary basic research used for a better understanding of consumers' behaviour and desires, providing selected practical implications to neuromarketing and consumer policy, but neither completely explaining, nor controlling consumers.

Lee et al. [29] state that consumers may be harmed by a constant assault of marketing campaigns, resulting in over-consumption and purchase addiction. He also emphasizes that by applying neuroscience in marketing we may understand how human beings create, store, recall and relate to information such as brands in everyday life. This may make it possible to discover marketing activities that trigger negative effects such as over-consumption. Moreover, Madan [30] emphasizes the fact that neuromarketing research may actually help some people overcome compulsive behaviour over purchase by examining their brain activity and comparing it to others that maintain an appropriate level of purchasing, followed by the help of clinicians in treating these disorders. The consumer needs a clean environment to live in, to lower the rate of illiteracy, corruption and diseases [18]. Thus, research should be conducted in ethical conditions, respecting the constraints others enforce and exploring the mind of the consumer in order to influence him to adopt a behaviour that is good for the society and for him. So neuroscientists are more and more pressed these days to discuss not only the design of their study, but also the ethical implications they face.

Brief Analysis of Neuroethics in Marketing Research

Ethics in Traditional Marketing Research Tools

Marketing researchers use surveys in order to question consumers on a specific subject, but if the respondent

will experience fear or shame, he won't feel safe and then dishonest behaviour will become acceptable for him. Consumer decisions can be influenced by the environment and the complexity of the options, so there are biases of the survey method that need to be taken into consideration when researchers aim to understand consumer psychology and behavior. In marketing research, questionnaires are used to address a set of questions to a representative sample of the relevant population. This method involves a series of distortions of opinions expressed, and thus a number of problems arise for various reasons, such as the following:

- Respondents may not answer truthfully, either because they do not remember the truth, or they want to present themselves in a socially acceptable manner or stand in a favorable position. Moreover, they may not even be aware of the real reasons underlying their decisions. In some cases, these answers are not sincere (without deliberate intent of lying) and the respondents try to finish the tasks as soon as possible, in order not to lose time. Whatever the cause, after giving wrong answers, respondents' minds create their own arguments in order to support their choice. Thus, those who analyze studies can reach erroneous conclusions caused by misunderstandings or insincere answers offered only at the conscious level.
- Participants of focus groups may influence each other and surveys must cover a large number of respondents to compensate the "noise" in the data or errors in individual responses.
- There is risk of not establishing cause-effect relationships from survey data, as there may be other variables that may have an effect and were not considered in the questionnaire or interview.
- Another barrier is that researchers do not know what is really going on in the minds of consumers, in addition to their lack of self-knowledge. There is no possibility to test whether what people say they do corresponds to what they actually do and therefore their answers are not reliable. Respondents might not be able to articulate or express (willingly or unwillingly) true thoughts and this can divert researchers from the truth.
- Researchers who establish the questions and answers in a questionnaire may miss some options that respondents could have provided. Also, the structure of a questionnaire may reflect the researcher's preconceptions and may force respondents to answer in a way that does not fully correspond to their views. But on the other hand, a less rigorous questionnaire can lead to more bias when it comes to interpretation.
- How scales are built can also influence study results. For example, if a subject responds to a question using as answer the first interval response scale shown (at the left), this can imply (in the mind of the respondent) that he or she is below average (with regards to that particular aspect); if the chosen answer is the last one (right), this can imply (also in the mind of the respondent) that he is above average (or vice versa, depending on the question). Using this knowledge, those who design surveys or forms that present their own views can influence the final decision of the respondent.
- Default values (automatic selections if not specified an alternative) can push us towards a particular choice [31], and respondents' preferences can be significantly influenced by minor variations in how the question is addressed and how the respondent can provide the answer.

So when discussing traditional marketing research tools, it should be emphasized that surveys are not always completed with honesty, participants use answers that fit under certain norms. Traditional research methods are especially useful in capturing the events experienced by participants, rather than proving how they felt in a particular circumstance or when they remember a particular fact. Consumers find it difficult to describe in precise words the emotions they experienced when they were exposed to a stimulus. Therefore, there are doubts concerning the survey method and this encourages researchers to turn their attention to methods that do not involve so much subjectivity. This creates the need for new methods that will change the drawback outlined above and provide accurate information in order to provide better products and services. Neuromarketing can be an additional objective research tool, as using neuroimaging may allow us to identify how people perceive any kind of stimuli and enhance understanding on what engages them at an emotional level, by inferring the probabilities that people adopt a certain behaviour.

Ethics in Neuroimaging Studies With Application in Marketing

In a simplistic manner, neuroethics deals with what is good and bad, or what is right or wrong in using neuroimaging tools in order to understand brain mechanisms. As for neuromarketing, neuroethics is dedicated to protecting human subjects that participate to marketing experiments which use neuroimaging.

Neuroimaging techniques are no longer used for medical purposes only, they are now used more and more in neuroscience research with applications in marketing and advertising. Using data obtained from brain imaging leads to ethical issues for marketers. For example, one of the most used instruments in neuromarketing research, functional magnetic resonance imaging, can isolate systems of neurons that are associated with different brain functions. Usually, researchers perform a scan on the subject's brain without asking the participant to perform a certain task first, and then, during the main study, they record subjects' brain activity during specific tasks; in this way, they can compare changes in the scans and conclude on which brain area is activated during the task.

In advertising, in order to determine what parts of an ad or print engage high or positive emotions, there are tools allow researchers to evaluate mechanisms such as retention (memory), attention and valence of emotions (be they positive or negative). Studies aim to find patterns in brain areas activation through neuromarketing expriments (for example, product preference). So neuromarketing research should bring ethics into discussion through responsibilities towards subjects on the one hand, and towards researchers, on the other hand.

Responsibility Towards Subjects

Neuromarketing researchers should have a clear idea about the criteria for inclusion and exclusion of potential subjects in order to accomplish a relevant study. Subjects should be notified about the proposed research (if this does not damage the results) in a non-technical language, briefed on similar studies that were conducted, provided with the description of the site(s) where the research is to be conducted, including information on the adequacy of facilities for the safe and appropriate conduct of research. Subjects should know which neuroimaging tools will be used, the steps of the procedure and also the risks and foreseen reactions they should take. Moreover, researchers should provide a benefit to the subjects in order to balance the time they give to the research and also for allowing scientists to record their brain activity and to analyze it.

Researchers using neuroimaging techniques should inform subjects on the way the information retrieved is used and on the outcomes before the exposure so as to have a good understanding of the research conducted. This will also allow them to provide feedback. Also, they should obtain the subjects' expressed opinion concerning their participation to the experiments. Moreover, subjects (and media, if it is the case) should be informed by means of a clear statement on the justification of the study, its significance in development and in meeting the needs of the population involved in the research.

The researchers should take into consideration writing down their own views of the ethical issues tackled in the study and a proposal on how they will deal with them. At the end of the study subjects should be informed on the results and findings should be published if they are considered appropriate and do not present risks to the community or population of a defined group of people.

Responsibility Towards Consumers

We are attached to our brain circuits that are connected to certain emotions, and not directly to those emotions. Some brain circuits are accustomed to be activated in certain situations, following a pattern. So, when making a decision, the circuits that are activated are the ones that help us choose, just as a reflex action. This fact allows researchers to use neuroimaging devices and find what triggers us as consumers into choosing a product or service. Respondent's sincerity is always questioned when using surveys, for the reasons mentioned above. In this regard, using neuroimaging tools for market research eliminates this disadvantage and offers information regarding consumers' unconscious reactions to the researched stimuli. Still, respondents need to understand the objectives of the study and act as researchers ask them to, in order to perform the study in a correct manner.

But after completing the study, researchers are responsible for dealing with the results in an appropriate manner, to the benefit of the consumer. As media is one of the most powerful analyzers of neuroethics, scientists should be honest and clear about their work, results and consequences. People look at new sciences with scepticism and therefore media can guide their opinions.

Transparent communication could solve this issue, as the ones that conduct a neuromarketing study are responsible for the information provided to the media, the accuracy of the data used and their implication. Uncertain results should be verified by replicating the study and in order to do so, the steps taken for research must be noted in detail.

Newspapers and magazines publish results of neuromarketing studies in a simplified version, which raises questions about the validity of the latter. Having the power to influence people and their point of view, these newspapers and magazines should refer to scientific reviewers in order to publish such studies, but there is no regulation in this direction. Most people read press releases, not studies that are peer-reviewed, and this can lead to wrong conclusions. In order to avoid these risks when reporting neuroscience papers and to interpret the results in a reliable manner, the opinion formers (such as magazines and newspapers editors or blog authors) should look out for the problem of reverse inference (if a study links activity in one region with a single mental function, readers should check whether this is justified, as many brain regions are involved in multiple psychological processes), the significance thresholds (analysis may contain data that appears due to chance), the number of subjects and relevance of the research groups, for the existence of a control group (if this is the case), the use of statistics in drawing inferences and making comparisons, the use of the rightneuroimaging device in order to answer the research questions. Also, readers should look for overstatements that claim that neuroimaging devices allow "mind reading".

Privacy is defined in terms of a person having control over the extent, timing, and circumstances of sharing oneself (physically, behaviorally, or intellectually) with others [32]. Privacy relates to the research participant's direct disclosure to the researcher to the extent to which the researcher protects the participant's private information. Maintaining confidentiality is a professional obligation for the researchers that deal with information concerning other people. Confidentiality is the process of protecting an individual's privacy, it pertains to treatment of information that an individual has disclosed in a relationship of trust, with the expectation that the information will not be divulged to others without permission [33].

Consumer free will and privacy are the most discussed topics in neuroethics, and philosophy seems to be one of most important components of it. Free will comes with moral responsibility, and people are responsible for their actions only when free will is involved. Regardless of the use of neuromarketing in order to develop advertisements, products or packaging, it is the consumer who must have the final word in choosing a product. The consumer's mind is not altered so as to prefer a product by means of neuroimaging techniques, it is the concept of the product that is designed in a way consumers tend to relate to. Following this line of thought maybe this will eliminate the unwanted products right before they are even designed.

Responsibility Concerning Researchers

As there are still no official guidelines or standards in neuromarketing, neuroethics can either overestimate or underestimate the issues surrounding neuromarketing research. This field in question is mostly developed in private business areas and not so much in academia, this aspect being visible when comparing Fig. 2 with Fig. 3 (the maps were generated using Mapative,[1] an online tool based on Google Maps). The number of neuromarketing research firms has increased significantly in the last few years and this trend continues. This is why it is vital for the correct evolution of this field to discuss ethical issues and establish guidelines for anyone interested in neuromarketing research, either from a scientific point of view (neuromarketing researchers), or from a customer's for neuromarketing services point of view.

While academic researchers discuss, develop or test certain findings in consumer behaviour, companies that use neuromarketing studies are the ones that push the field forward, applying these findings. As each company has its own algorithm and model to use in neuroimaging investigations in marketing, their validity was not verified until present, so there may be ethical issues we are not aware of yet. Arguments in favor or against the idea that neuroimaging studies involve objectivity have been raised, so publishing official standards would eliminate most of the doubts.

Ethical issues are also raised because advertising pursues commercial gain. Marketers are interested in finding more about consumer choice-making and activation patterns that predict consumer behaviour, in order to better understand what consumers need and better predict it in the future. The "game" takes place between the five senses that engage the consumer and

[1] Mapative official website: http://www.maptive.com

Fig. 2 Map of companies that provide neuromarketing research

Fig. 3 Map of academic locations that offer neuromarketing education. As stated by the Neuromarketing Science & Business Association on the official website: http://www.neuromarketing-association.com/education

neuroimaging tools offer the opportunity to examine the social behaviors using knowledge about associated brain functions. So there are questions raised, such as: Should marketers have acces to consumers' unconscious choices? To what use should such information be put? But electroencephalography or functional magnetic resonance imaging are neither able to read subjects' thoughts, nor to manipulate human mind. Businesses that use neuroimaging devices in market research should end public fears such as the ones that they might be able to read the mind of the consumers and solve this issue by being transparent in their steps: notify the subjects on the purpose of the study and offer their customers all the information concerning the way they retrieved the results. Besides understanding the responsibility of using results from neuromarketing studies, researchers should also be careful when analyzing the data gathered. For example, 1 % of the population present abnormal findings [19] that lead to false positives. Also, in case there is information about subjects' preferences that arises outside the scope of the research questions, researchers should be careful with these insights and proceed by always considering the interests of the consumer.

Perspectives

The promises that neuromarketing studies make in our modern world can trigger researchers to take an interest in this field and provide a significant evolution for it. By reporting the ethical implications they face in different studies, researchers not only support their own investigation, but they also help develop neuroethics in a more suitable manner. The real problem may have the roots in the purpose of the research conducted. Universities could be less biased than companies in different stages of conducting a research, as they chose the stimuli and subjects without a particular interest in a product or a brand or a category of consumers.

The Neuromarketing Science & Business Association (NMSBA) was established in February 2012, having the objective to provide professional support to neuromarketing professionals and scientists around the world. This favors a harmonious development for the field, as it will both protect it from ethical issues and foster the social interests involved in the research. The association has developed a code of ethics for the application of neuroscience in business and published it in January 2013. The adoption of this code is a condition of membership to the NMSBA [34]. In the December 2013 issue of Neuromarketing Theory & Practice Magazine, NMSBA announced that their board of advisors was developing a new policy on corporate accreditation in order to verify if the services of these companies were valid, scientifically based and had an appropriate purpose for the field of neuromarketing. This step will ensure that companies provide accurate results and that they are not just blinding their customers with the promises neuroscience can offer to really understand consumers.

There are studies that propose solutions in dealing with this challenging field of ethics in marketing research involving neuroimaging devices used on subjects, since the field develops as fast as technology, these issues must be clarified. Roskies [35] remarks that the mechanistic view on how the brain generates complex thought and behaviour promoted by advances in neuroscience has led some to worry that future advances will make people believe that we are not free agents and, consequently, undermine our views on moral responsibility. The author also suggests that this issue should not be taken into consideration, as our intuitive notions of freedom exist prior to and independently of neuroscientific knowledge and advances. As Garland [36] describes, privacy involves keeping information one does not want to know from being discovered by others, and confidentiality means keeping information that must be disseminated from reaching unintended recipients.

Murphy et al. [8] propose a code of ethics to be adopted by researchers and neuromarketing companies working in the area of neural correlates of decision-making, social behaviour, consumer preferences or neuroethics, in order to prevent accusations of irresponsible behaviour. The authors also bring into discussion subject protection (procedures for informed consent, explicit protocols dealing with incidental findings, advising subjects and reminding them of their right to withdraw), protection of vulnerable populations from marketing exploitation, niche populations exploitation, the need for full disclosure of goals, risks and benefits, accurate information provided to media, and suggest using formal papers as in academic and medical research centers.

Results of a qualitative analysis made by Racine et al. [37] identify ethical issues such as confidentiality and privacy, troubling findings (e.g. tumors) and the protection of human subjects enrolled in research. They also mention that findings regarding how people might act in a given situation might be used for purposes that are not

aligned with consumer well-being. Another problem raised is the interpretation of the data gathered in a study. Although Illes et al. [38] state that there are currently no guidelines that define quality standards for successful decoding of mental states, researchers have distinguished between different areas of the brain corresponding to a certain attitude, mental state or future behaviour, but such results should always be taken into consideration only if they are validated.

In their survey, Wardlaw et al. [39] identify response trends which indicate that the public disagrees the use of neuroimaging in non-medical or scientific settings, especially marketing research, as respondents considered that "private sector does not have the right to that information". In a survey-based research [40], most of the neuroimaging experts (90 %) considered that research ethical boards deal adequately with topics such as informed consent, decision capacity, vulnerable populations, recruitment practices, confidentiality or discrimination. However, authors [40] highlight that some researchers (from both academic and business area) draw too much on these ethical boards for guidance and do not consider the search for solutions to be a sheared responsibility.

Neuromarketing Research Review Principles

Companies might not be primary concerned with the best interests of the consumer, as not always their goals are compatible, and there is a need to set out ethical standards that each neuromarketing practitioner should follow and below are guidelines that should be implemented and followed in any market research that uses brain imaging tools:

1. **Ethics laws and committees**
   Neuromarketing researchers must identify the national and international laws that are relevant for their future study. There are countries that have certain regulations which must be respected. Also, in some cases, there is a national ethics committee whose consent is required, therefore its officials should be contacted and informed about the study in order to proceed with the research.
2. **Commitment to respecting regulations**
   Researchers have to behave ethically during all phases of a research. Any deviation from this principle might damage the reputation of neuromarketing research.
3. **Subjects reruitment**
   When recruiting and using a subject pool, researchers have to identify the vulnerable population who should be protected from neuro research.
4. **Consent of subjects to participate to the study**
   Subjects' cooperation is voluntary and must be confirmed in documents that they sign after being completely informed about the purpose of the research project and the steps to be followed during the study. The subject must be free to leave the study at any moment. The procedures research participants have to comply with must respect their rights as private individuals.
5. **Consent of subjects to be brain scanned**
   As research procedures involve brain activity monitoring, after understanding what the effects of participating to such a study are, subjects need to sign agreement papers if they agree, in order to enter the study and permit researchers to use the neuroimaging devices on them.
6. **Children as subjects**
   Researchers have to respect restrictions when carrying out research on children and any other person contraindicated for medical imaging.
7. **Scientific rigor**
   While there are companies that have their own models and algorithms developed, refined and validated after years of research, there are others that use methods for analyzing the data that may not be reliable. Researchers need to be careful about reverse inference while analyzing the brain regions involved in their research in order to assure internal validity of the study. Although neuromarketing customers look for insights, results and conclusions, researchers should also provide full information about the scientific procedures undertaken in order to be able to externally validate their results and alow others to replicate the study or to generalise the findings to the target population.
8. **Collected personal data**
   The personal data collected during a study shall never be used to any other purpose than the research the subjects agreed to participate to. Also, researchers are not allowed to exploit particular neurological traits found in a subgroup of individuals.

9. **Transparency and objectivity**
   Neuromarketing researchers shall ensure that their project is designed, carried out and documented in a transparent and objective manner. As there is severe information asymmetry between neuromarketing researchers and their clients due to the complex and technical nature of this kind of research, there is a danger of reaching subjective conclusions and blind clients.
10. **Research results and society**
    Neuromarketing practitioners need to identify cases in which their results may be misused and abused and act in order to protect society and vulnerable populations.

All the points stated above require an external control for quality assurance. Neuromarketing Science & Business Association may be the appropriate entity to provide this validity and to identify the degree to which a research study measures what intends.

Conclusions

As marketers design their activity in order to sell more, neuromarketing research suffers from being accused that its aim is just commercial. Neuromarketing does not involve mind control techniques, it is a field that could advance knowledge in decision making more than any other existing science, being able to measure brain responses to marketing stimuli. Using neuroimaging devices, marketers aim to find what triggers the consumer concerning a certain stimuli. They are not entering their subconscious, but providing information on the brain areas activated against a stimuli (a product, ad, print or package design). So they do not invade their private world and their interests, but create a way to find objective answers to questions involving products and services. And as lie detectors are used to distinguish between truth and lie, fMRI and EEG tools are used for predicting success or failure in marketing actions. The real threat of using neuroimaging for a more effective persuasion in marketing and advertising research is the non-informative or even mis-informative content that can trigger a certain response in consumers, as content is the basis of rational purchasing decisions.

Clear regulations must be stated in order to raise credibility and to allow the development of the field. Also, scientists should find a balance between what they want to accomplish and the rules they should obey in order to conduct an ethical study. Neuromarketing could serve the society and the environment, promoting a healthy life for individuals and society. Neuroethics should support consumers' education in making decisions based on their free will in accordance with accurate information provided. Also, neuroimaging technology can be used in a more positive marketing research area: to help consumers find what they want and guide them in living a healthy life, not just giving them what they want. There should be taken into consideration responsibilities towards subjects participating to studies, consumers and researchers.

The paper reviews ethical issues and challenges involving subjects participating to neuroimaging studies, consumers that experience the effects of research results and researchers that conduct such neuromarketing studies, also offering a list of principles that may be implemented in order to allow the development of both neuroethics and neuromarketing under appropriate conditions.

There is still much to investigate on understanding human emotions, self-consciousness, reasoning, moral and free will and we are witnessing an increasing number of neuromarketing studies and growing interest in this area which should bring stability and standardization to research. Ethical issues act like a barrier in the development of neuromarketing, but to a certain extent they are regulatory mechanisms for the progress of the field. This is the main potential benefit of neuroethics in neuromarketing, and the reason for which societies and organizations in neuroscience use it. Of course, ethics also needs to be delineated between its limitations and risks.

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