

TO THE LIMITS OF HUMAN KNOWLEDGE OF THE BRAIN: THE RELEVANCE OF NEUROSCIENCE TOOLS IN MARKETING PRACTICE AND RESEARCH

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Abstract

Considering that the total advertisement expenditure worldwide is forecast around 500 billion dollars annually, the potential of a field that can inform companies about how to target their customers based on their conscious and subconscious needs is inconceivable. Companies are constantly trying to find new sources of competitive advantage and neuromarketing is currently seen as a highly innovative solution with over 300 commercial companies and many academic institutions involved. This paper is intended to provide a comprehensive literature review for marketing professionals and its purpose is to clarify the role of neuromarketing in the current research methods. Important concerns about the use of neuroscience research tools (fMRI, EEG, GSR, Oxytocin levels measurement through blood sampling and one commercial device - Emotiv EPOCH) are discussed in a way that can be understood by the wider public. In conclusion, it is highly improbable that the consumer brain could be well understood without good underlying general models of the human brain, the processes that form and decide human behaviour, advancement of technology, excellent understanding of the measurement methods, and most importantly valid data analysis.

Key words: Neuromarketing, Cognitive processing, Associative network theory, Neuroscientific measures.

JEL Code: M31, D87

Introduction

There are various reasons for ongoing fascination within the field of neuromarketing, or rather consumer neuroscience. Typically, it is the apparent potential of economic attractiveness combined with the direct application of scientific findings in practice. Furthermore, as the depths of most brain processes have yet to be investigated, there is a mysterious touch to the field since the current promising models of the human brain are still lacking a full explanation. Based on this evidence, a much deeper knowledge about cognitive processes occurring in a

human brain combined with an appropriate technology is needed. Alternatively, interest may originate from the ethical issues encompassing the topic, but at the same time it prevents the field from further development.

1 The emergence of neuromarketing science and practice

In order to outline the current state of knowledge, it is necessary to provide some contextual information that appears to be missing in the recent marketing literature. Many projects have been set up by governmental agencies in order to investigate the brain functions and describe the human brain accurately. One of the first projects was the Human Connectome Project launched in 2009 sponsored by American and British institutions. Following this, the Brain Initiative, founded by the American government and the Human Brain Project, have been set up, a project co-funded by the European Union, both launched in 2013. All the projects last over a period of 5 to 10 years. However, despite some published achievements, there still appears to be no ground breaking findings about human brain workings that could revolutionise the field of neuromarketing or cognitive neuroscience. Moreover, the aim of one of the projects is to accelerate the development and application of innovative technologies that might lead to better understanding of cells and neural circuits in the human brain. Based on this, it seems that the development of technology restricts further knowledge.

The term neuromarketing was likely used by Professor Ale Smidts, Professor of Marketing Research at Erasmus University in Rotterdam for the first time in 2002 and it has been employed to describe engagement of various biometric tools such as fMRI and EEG to measure consumer responses to marketing stimuli. Professor Gerry Zaltman from Harvard University was the first one to include neuroscientific methods such as fMRI in his research of consumer behaviour at the end of 1990's. Some organisations (e.g. Neurosense) have found other linguistic forms more appropriate and used the term 'neuroimaging' instead (Schneider & Woolgar 2015).

The problem appeared much later when the term neuromarketing gained significant popularity between both groups - established researchers and commercially driven individuals with less research background. Plassmann et al. (2012) points out that in the year 2000, there was no significant debates or presence of this term. However, in 2004 there were 5000 google hits, and only 6 years later there were already 150 existing neuromarketing companies and 250 published articles about the field. The NMSBA (Neuromarketing Science and Business Association) claims that since January 2016 until February 2017 they have registered a 20%

increase in their company list. This does not mean an actual increase by 20% - however it still indicates that the market might still be growing (Nagel, 2017).

There are some indisputable gaps from the scientific perspective and problems that shadow the field since its creation. Namely, the definition and presentation of neuromarketing agencies might often be misleading, using phrases like “getting straight to brain”. For example Lee et al. (2007) defined neuromarketing as “the application of neuroscience measurement techniques for understanding how consumers respond, both consciously and unconsciously, to marketing”. Schneider & Woolgar (2015) point out that, eye tracking should not be correctly framed by this definition since rather than utilising neurological measures, those tools provide physiological responses to visual stimuli, thus should be marked correctly as biometric. However, considering the following perspective, the definition might not be contradictory: since eye tracking could be also used in neuroscience to measure responses to visual stimuli and it might be possible to detect various neurological problems such as autism (Jones & Klin, 2013) through data analysis, eye tracking may then it may fall into both categories. Another tool, GSR (Galvanic Skin Response) is not under conscious control and can provide information about emotional arousal. GSR is measured by sweat production and as the production of sweat is controlled by the sympathetic nervous system, GSR may be framed under neuromarketing research tools.

This review aims to answer the question whether neuromarketing can overcome certain methodological problems and current limitations in the understanding of the human brain and offer insights to consumer behaviour, compared to the traditional research methods. The purpose of the paper is to critically discuss the relevance of neuroscience tools in marketing practice and research in the light of brain processing theories debated in neuroscience, computer sciences and marketing.

2 The origins of neuromarketing science and practice

Based on numerous studies, the most debated themes in neuromarketing appear to be the following: a) methods related to neuroscientific and physiological measures; b) results obtained mainly through EEG, fMRI, EKG, eye tracking and other less frequently used tools; c) ethical considerations; d) theoretical perspectives.

One of the first studies that involved neuromarketing tools and provided results relevant to marketing practice was the McClure et al. (2004) study. Using fMRI, the study examined the consumers’ response to the Pepsi and Coca-Cola beverages. If a consumer was not aware of the

brand currently consumed, but drank their favourite type of cola, the fMRI showed an increased activity in the ventral putamen which is supposedly associated with reward. However, when the volunteers were told what brand they were drinking, the fMRI showed an increased activity in the prefrontal cortex, which is supposedly associated with higher cognitive processes. The study was conducted on a small sample of participants and thus requires further confirmation. Nevertheless, it showed that sensory information plays only a part in determining consumers' behaviour (McClure et al., 2004), and the difference of brain imaging with a prior knowledge of a brand in contrary to an unknown brand might elucidate the effects of advertising on the brain functions. This study resulted in a great wave of criticism mainly due to ethical reasons.

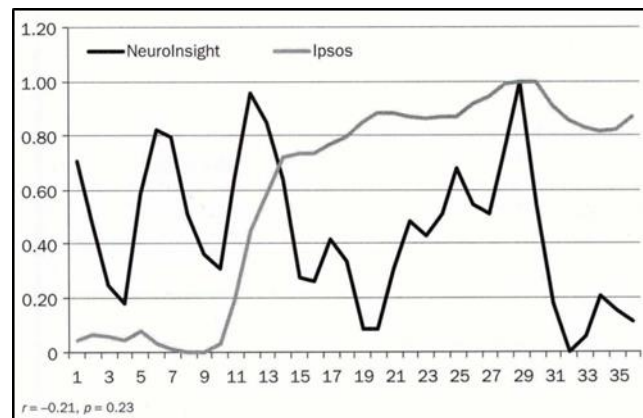
The latest study, conducted by Bosshard et al. (2016), examines the relation of physiological stimuli and affective emotional states between liked or disliked brands. The results showed that both types of brands are connected to affective content, but liked brands correlated with higher motivation levels which might link to increased purchasing intentions when the brand is liked. Other contemporary studies involve the development of new methods of analysis with regards to the use of Emotiv Epoch tool.

Further studies aim to uncover consumer responses by measuring brain activity by means of fMRI. Kühn et al. (2016) claim to have forecast changes in the sales of a popular chocolate bar by testing six different communications placed in a supermarket and compared this to fMRI communication response measures prior to testing in a real environment. Al-Kwif (2016) simply focused on the level of brain activation, which appeared to increase at the ventromedial prefrontal cortex when participants were asked to judge images that reflect brand perceived usefulness compared with judging images that reflect brand pleasure. Shen & Morris (2016) compared the use of fMRI and the traditional self-reporting method in order to investigate which means of measuring advertisements should be regarded as more rigorous. Their recommendation is to use combined methodology until much more research is done into physiological measurements.

Except for studies containing some experimental data, there are also more theoretically approached articles with practical implications. Kennedy & Northover (2016) show how two large agencies use two ways of measures and obtain very different results. The conclusion is that Ipsos' emotion measure may not match a Neuro-Insight's engagement measure based on SteadyState Topography because both devices measure different physiological data (Fig.1). Those might be interpreted in various ways and an explanation of the measured phenomenon should be provided. This might illustrate that the commercial data analysts within neuromarketing agencies might be prone to rather interpretative results, at least in some cases.

The last group of up to date articles is concerned mainly with the ethical dimensions of neuromarketing.

Fig. 1: Same advertisement stimuli comparison – Ipsos vs. Neuro-Insight



Source: Kennedy & Northover (2016)

3 Limitations of application of neuroscientific techniques

The two most frequently used types of neuromarketing devices have been selected for detailed investigation in this review – fMRI and EEG. Other methods, such as GSR, the novel methods for examining the oxytocin levels in blood, and EEG measurements (for example by Emotiv EPOCH device) are also discussed.

A major problem faced by the neuromarketing field is the problem of the interpretability of results and their very high susceptibility to misinterpretation. In reality, the fMRI machine measures changes in oxygen intake levels in the brain, which are indicative of blood flow in soft tissues. When applied to the human brain, it again measures the changes in blood flow throughout the brain. While these changes in the blood flow in the brain are correlated with the local activity in the brain (first noted by William James' *The Principles of Psychology*, published in 1890), they are by no means an accurate reflection or measurement of activity of specific cells. Therefore, the fMRI results do show changes in the brain activity in response to a particular change in environment. However, quantifying the meaning of this change in general, with respect to how the brain perceived the environmental change remains a different question, one not easily answered.

The problems of interpretation of fMRI data can be demonstrated with the following two examples; Bennett et al. (2009) has shown that dead salmon fish brain can be found to process image data using fMRI results and demonstrated that this is the result of a lack of multiple testing correction in typical fMRI experiments, rather than some after-death brain function. The second example comes from Eklund et al. (2016), who have shown that the

commonly used fMRI analysis software solutions SPM, FSL and AFNI result in up to 70% false positives, meaning that up to 70% of brain activity reported as significantly different using these software solutions were in fact not significantly different. Combining these facts, it might elucidate that while fMRI can point out the areas of brain that respond to the environmental stimuli, the data are prone to interpretation errors. Furthermore, it remains to be explained how increased activity in a particular part of the brain relates to the environmental stimulus that caused it. In light of these facts, it seems that fMRI alone cannot satisfy the neuromarketing ambitions vested into it (such as predicting the consumer's reaction to a given advertisement), unless accompanied by more traditional research methods or supported by further research into brain functions.

Similarly to fMRI, skin conductance might provide us with information that certain music gives an individual chills or that a certain part of the advertisement causes increased sweat secretion. Is this a desirable experience? We can identify this by consequently questioning the individual. This might be accompanied by obstacles and subjects' answers might already be dependent on their memory, and hence prone to errors.

Examining oxytocin levels appears to be straight forward, yet only until we realise that many external influences might affect these levels (Prevost, 2014). To ensure validity, it is necessary to average the measures at least three times, and each time blood samples are required (Prevost et al., 2014), making this type of neuromarketing research difficult and also costly to conduct. The participant would have to agree to sample the blood at least six times in order to provide valid results. However, it is possible that there are other methods of sampling oxytocin other than the described one.

EEG can provide information about brain activity in the form of waves. There is a problem with the strength of the signals that are measured through the skull of relatively low conductance. These signals can be affected by electrical activity in the muscles and are sensitive to interference from other electrical devices. To overcome this limitation, neuromarketing companies test their participants in a laboratory environment and use large samples, averaging the results. Moreover, there are also cheaper commercial versions of EEG equipment that have been introduced quite recently such as Emotiv Epoch. The price is usually the deciding factor in choosing such devices, especially in an academic environment. However, multiple studies compared devices that measured brain signals and concluded that the data collected from other systems have shown much more accuracy, concluding that Emotiv EPOCH can provide reliable results only after significant corrections of data. Furthermore, some customer reviews available randomly online suggest that the device is not very user-friendly and it takes a lot of effort to

train an individual to read the signals accurately. On the other hand, there is a potential for further improvements, and this might be a prototype that will lead to better access to neuromarketing devices at a lower cost available commercially, and within academic environment.

4 Emerging theories about brain processing

It is appropriate to describe the current state of knowledge of brain functions in neuroscience and introduce the reader to some established concepts of how cognitive functions process with regards to marketing. One of the theories found in marketing literature and elaborated further is the one described by Stach (2015) that clarifies how the brain functions when exposed to a marketing stimuli and brand concepts in time. To describe the brand and advertising effects, they have adopted a long-established theory of association networks that has its roots in Pavlov's famous experiment. Some trace the origin of the theory even earlier, when the same idea originated from the thoughts of Plato and Aristotle. This theory applies only to memory processing and has been adopted from psychology. Similarly, in computer science, there is a theory called artificial neural network that attempts to simulate the processes in the brain based on mathematics, but applies to all the brain regions. Despite considerable development in this field during recent years, the artificial network has not yet been at the stage of biological perfectionism of the human brain, hence, research has not yet come to a justifiable agreement of how these processes work. Neuromarketing has somewhat adopted an existing theory that our brain is divided into various parts and each of them has specific role, being responsible for various functions.

Today, it is speculated that our higher cognitive functions are probably executed by extensive neural networks in the brain instead of being attributed to specialised areas of the brain, similarly to neural networks theory. Due to limited knowledge about specific human brain processes, the neuromarketing concept may have reached its limits and is operating based on theories and common sense about how the human brain works, at least in some cases.

One of the previously mentioned theories that is relevant for marketing practice is the associative networks theory that simplistically describes brand awareness as dense networks in the minds of consumers. Furthermore, these networks form neural nodes that are able to store any kind of information – such as emotions, visual representation, semantic association and other product aspects or brand characteristics. Information nodes are connected when similar cognitive functions occur (Stach, 2015). The relative strength of such connections depends on various factors – the intensity and frequency of their pairing, already existing networks and

congruence between network, and activation stimuli. Hence, it is possible to theorise that when the brain often perceives some stimuli such as the certain shape of a bottle, it makes a greater connection and forms nodes based on other perceived information. This theory explains the effects of advertising and suggests that the key to success is mainly repetition and usage of various forms of communication with repeated positive stimuli, albeit the theory has not been widely accepted yet. There is no common agreement between the researchers and all the introduced theories have both their supporters and opponents due to the lack of empirical evidence.

Conclusion

A comprehensive literature review on the use of neuromarketing tools with regards to the cognitive processes in the brain appeared to be missing. Based on the review, it is evident that the knowledge about human brain processing has not been uncovered and there are many areas with significant limits. Whilst the general biological construction of the brain has been described, the processes occurring between the environment and the human brain remain relatively unexplored. In conclusion, it is highly improbable that the consumer brain could be well understood (even partially, much less fully) without good underlying general models of the human brain, the processes that form and decide human behaviour, advancement of technology, excellent understanding of the measurement methods, and most importantly a valid data analysis. However, neuromarketing can ascend the development of such technologies, and in some cases can also uncover some important concepts about brain processing if the tools are used to explore some general concepts.

Commercial use of neuroscientific tools appears to be rather progressive, considering the current state of knowledge in the aforementioned areas, and the endless critical discussions within established academic journals. The review discussed the possible limitations of the application of fMRI, EEG, Emotiv Epoch, GSR and oxytocin levels measurement, and described briefly the cognitive theories relevant to marketing in the context of theories from other sciences. The intention of this article is to illustrate where neuromarketing needs to establish further concepts about the workings of the human brain and mind to support the relevance of its findings and consequently apply those in practice.

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