Neuromarketing and the advances in the consumer behaviour studies: a systematic review of the literature

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Abstract: This study aimed to perform a systematic literature review in order to identify the advances in consumer behaviour research using neuromarketing. Therefore, the methodology proposed by Margarey (2001) was used; later the results were analysed using correspondence techniques. Theoretically, by evaluating the articles selected for the development of this study, it may be stated that academic research has made important contributions regarding neuromarketing, mainly researches performed on the fields of neuroscience and psychology. Analysing the selected sample of articles, it was possible to group the main contributions into, fundamentally, three great dimensions: 1) studies that seek to conceptualise neuromarketing, as well as to describe its applications and methodological possibilities in the development of field studies; 2) studies that seek to map the brain regions involved in decision making processes of buyers; 3) studies that map how information is processed by the brain.

Keywords: neuromarketing; neuroscience; psychology; consumer behaviour; neurology; business administration; brain research; purchase behaviour; neural research; marketing; functional magnetic resonance imaging; FMRI; emotions; management; information processing; brain regions.

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1 Introduction

Neuromarketing – or consumer neuroscience – resorts to methods and research insights regarding the human brain, seeking to learn and solve problems in the marketing field. By means of advanced neurology techniques applied in the field of consumer neuroscience, a more direct understanding and view of the consumer's 'black box' is possible (Solomon, 2008).

When neuromarketing communicates with the fields of psychology, neuroscience, and marketing, it reveals the interdisciplinary face of scientific knowledge. Studies about this subject started in different areas of knowledge in order to explore memory distortions, learning and plasticity of the brain, the impact of society over the brain's development, among others. This branch of neuroscience seeks to understand the complex neural mechanisms underlying thoughts, such as reasoning, decision-making, object representation, emotion and memory, which overlap marketing notions, such as positioning, the hierarchy of effects, brand loyalty, and consumer's responses to marketing (Perrachione and Perrachione, 2008).

It is worth noting that the application of neuroscience to marketing strategies, and particularly, to consumer psychology of brands, experienced significant growth throughout the last decade, both in the academic context and in the corporate world (Plassmann et al., 2011).

In this context, the advances in brain science have enabled the development of innovative models and techniques for understanding the consumers' unconscious experiences. These novelties are related to neuroimaging techniques, such as the functional magnetic resonance imaging (fMRI), for instance. These brain-imaging techniques produce images of the structure or the functioning of neurons. Through

neuroimaging, researchers are able to directly observe brain activities while individuals engage in several mental tasks, that is, images of the consumers' brains are registered and the areas of the mind that are activated when people are exposed to brands, images, videos, products or advertisements are identified.

By means of neuroimaging techniques, for example, it is possible to explore the perceptions and unconscious responses of consumers' thoughts and experiences, providing important readings of such thoughts and experiences. Thus, these techniques may improve the efficacy or even substitute traditional qualitative researches, interviews, and questionnaires, which may present flaws if guided exclusively by the belief that consumers think and expose their emotions and feelings in a linear and rational manner. Information resulting from the application of techniques such as neuroimaging is already being used in strategies and commercials of vehicle manufacturers (Lee et al., 2007). Besides neuroimaging, a variety of psychophysiological techniques have been used for measuring consumers' reactions to marketing stimuli since the 1960s (Wang and Minor, 2008).

Considering the aspects mentioned, this study aimed to perform a systematic literature review in order to identify the advances in consumer behaviour research using neuromarketing. Since new research instruments emerge, allowing the understanding of people's minds regarding their motivations, emotions, thoughts, preferences, ambitions, expectations, and consumption needs, the current brain imaging methods enable a better understanding of the relationship among brain structure, neuronal functions, and human behaviour. Thus, neuromarketing widens the possibilities to qualify marketing studies.

After this brief introduction to the subject focused in this research, the method used in this systematic literature review is presented. Then, neuromarketing and the advances in consumer behaviour study are contextualised, highlighting the analytical result of the selected sample of articles that comprise the scope of the research, emphasising the grouping of main contributions in three great dimensions, further discussed. Finally, an agenda with possibilities for future researches about the theme concludes the paper.

2 Method

In order to monitor the advances in consumer behaviour research, specifically concerning the 'neuromarketing' theme, a systematic literature review was performed. Since the method enables a high degree of objectivity, as well as procedural and analytical replicability, systematic reviews are increasingly being employed in management literature (Hallinger, 2013).

The methodology used for the literature review included two main steps: selection and analysis. The selection step concerns the gathering of a vast set of publications in the desired areas, whereas the analysis step refers to the performance of a critical and careful examination of the publications to identify patterns and recurring themes. In this study, the systematic review followed a five-step design, based on the recommendations of Margarey (2001), which included:

1 definition of the problem

2 selection of journals

3 selection of studies

4 critical assessment

5 data synthesis.

Next, the description of these steps is presented.

First, in alignment with the general objective of the research, the systematic review aimed to identify the advances in consumer behaviour research using 'neuromarketing'. With a clear guiding objective for the research, the selection of journals was subsequently performed. As for criteria, the researchers initially defined that the search for articles would be performed in databases from AMA, Elsevier, Emerald, Inderscience Publishers, Taylor Francis Online, and Wiley Online Library. Such definition occurred considering these databases are internationally recognised and widely used as a source of research for distinct post-graduate programs. Afterwards, to include the journals indexed in databases as sources of research, their titles and scopes were considered. That means the alignment between the focus stated for each publication and its relation to the objective of this research was observed by the researchers. Thus, a total of 20 journals about consumer behaviour, marketing, psychology, and neuroscience were included in the source of key data (Table 1).

Table 1 Number of articles found, by journal and search

Journals	*Search 1 neuromarketing*	*Search 2 neuroscience*	*Articles selected*
AJOB Neuroscience	4	203	1
Cognitive, Affective & Behavioral Neuroscience E	0	715	1
European Journal of Marketing	2	6	0
Harvard Review of Psychiatry	1	98	1
International Journal of Consumer Studies	0	5	1
International Journal of Research in Marketing	1	4	0
International Journal of Technology Marketing	0	0	0
International Journal of Psychology	4	1,121	1
International Marketing Review	1	1	0
Journal of Computational Neuroscience	0	938	0
Journal of Consumer Affairs	1	7	1
Journal of Consumer Behaviour	15	21	14
Journal of Consumer Marketing	12	15	2
Journal of Consumer Psychology	7	51	6
Journal of Consumer Research	0	32	4
Journal of International Marketing	0	1	0
Journal of Marketing	0	1	0
Journal of Marketing Management	0	0	0
Journal of Marketing Research	4	28	12
Psychology & Marketing	4	43	5
Total	56	3,290	49

Source: Prepared by the authors (2015)

For the next step – selection of studies – a research in 20 journals was performed with the keyword 'neuromarketing'. The keyword was used as selection criteria for the title, keywords, abstract, and the body of the text. The type of document included in the research was 'articles', and time limits were not established. Hence, the first research resulted in a sample of 56 publications. An additional research was performed with the keyword 'neuroscience' to validate the strength of the research. The additional research produced a total of 3,290 papers. After the exclusion of duplicated articles, the abstracts of all the remaining articles were individually analysed by five researchers, which were instructed to select articles in which the research issues and results were only directly related to the advances in the studies of consumer behaviour regarding neuromarketing. The entire sample was divided among the five researchers. By the end of this step, the set of publications to be used for the systematic review was reduced to 49 articles that effectively addressed the main issue. This set of publications underwent critical analysis and evaluation of researchers.

Finally, for the data synthesis step, an aggregative approach was used to summarise the conclusions of the studies reviewed. Such approach highly depends on the subjective interpretation of researchers concerning the reviewed articles, considering a certain degree of subjective latitude should be given to researchers so to enable them to consider and compare distinct studies, with the purpose of extracting shared meanings and abstracting the approaches that do not concern the purposes stated for the review (Tanfield et al., 2003). Furthermore, since the objective of the research was to provide a mapping of the advances of consumer behaviour research regarding the use of 'neuromarketing', the results were analysed using the techniques of pattern correspondence (Tharenou et al., 2007).

3 Neuromarketing and the advances in consumer behaviour studies

A series of researches developed on consumer behaviour allow stating that emotional factors play an important role in the purchase decision process, as well as in the development and maintenance of consumer preference for certain products, whether they are goods or services. However, the amount of existing theories to explain and conceptualise emotions, as well as the inherent subjectivity of the theme, hinders the categorical selection of one single definition. Currently, three theoretical currents are commonly addressed in consumer behaviour to defend the origin of emotions: one that favours the cognitive-affective processing (cognitive theory), another one that proposes that affection and cognition may be separately developed (theory of independence), and a third one that focuses on identifying so-called primary and universal emotions, which may be recognised in any culture and result in another range of emotions (evolutionary theory) (Lazarus, 1991; Erevelles, 1998; Zaltman, 2000; Shiv, 2007; Kenrick et al., 2013).

Focusing on the evolutionary theory, it explains the mechanics of thoughts and emotions in terms of information and computation, as well as considering the complex adaptive design of human beings in terms of selection between replicators (Reimann et al., 2010). Studies performed by its principles understand human behaviour as a product of evolved psychological mechanisms that depend on internal and environmental inputs for its development, activation, and expression on the manifested behaviour (Kenrick et al., 2013; Saad, 2013). In light of what has been exposed, it is worth noting

that the use of neuroscience in studies related to consumer behaviour is grounded on the evolutionary theory.

Theoretically, by assessing the articles selected to develop the present study, it is possible to state that academic research has brought important contributions regarding the 'neuromarketing' topic. By analysing the selected sample of articles, it is possible to group the main contributions, fundamentally, into three great dimensions:

1 studies that seek to conceptualise neuromarketing, as well as to describe its applications and methodological possibilities for the development of field studies

2 studies that seek to map the brain regions involved in the decision processes of consumers

3 studies that map how information processing occurs in the brain.

Thus, with the purpose of following research advances in consumer behaviour, this study presents a systematic review as its general objective, specifically referring to the 'neuromarketing' theme. Next, Table 2 presents the dimensions of studies on neuromarketing.

Table 2 – Dimensions of the studies on neuromarketing

Dimensions	*Authors*
Dimension 1: concepts, applications, and methods	Williamson (2002), Lee et al. (2007), Fugate (2007), Wilson et al. (2008), Wang and Minor (2008), Hubert and Kenning (2008), Perrachione and Perrachione (2008), Butler (2008), Garcia and Saad (2008), Foxall (2008), Murphy et al. (2008), Dietvorst et al. (2009), Vale (2009), Fisher et al. (2010), Reimann et al. (2011, 2012), Chancellor and Chatterjee (2011), Plassmann et al. (2011, 2015), Shiv and Yoon (2012), Booth and Freeman (2014), Cerf et al. (2015), Plassmann and Weber (2015) and Venkatraman et al. (2015)
Dimension 2: brain regions involved in the purchase decision process	Ambler et al. (2004), Yoon et al. (2006), Plassmann et al. (2008), Klapproth (2008), Hedgcock and Rao (2009), Huettel et al. (2009), Elder and Krishna (2010), Tanner and Maeng (2012), Berns and Moore (2012), Venkatraman et al. (2012), Karmarkar et al. (2015), Jai et al. (2014), Hubert et al. (2013) and Telpaz et al. (2015)
Dimension 3: brain information process	Gordon (2001), Gakhal and Senior (2008), Stoll et al. (2008), Bar and Neta (2008), Vance and Virtue (2011), Fraser and Bradford (2012), Elder and Krishna (2012), Craig et al. (2012), Krishna and Schwarz (2014), Cascio et al. (2015) and Boksem and Smidts (2015)

Source: Prepared by the authors (2015)

3.1 Dimension 1: Concepts, applications, and methods

Neurologists and academics that research the neuroscience field have provided new insights showing how the mind works and how it may have an impact on behaviour. The main contribution by Hubert and Kenning (2008) was suggesting a distinct definition of neuroscience as the scientific process, and neuromarketing as the application of these findings under the management practice through the review of researches that used distinct methods, such as fMRI, electroencephalogram (EEG), magnetoencephalography (MEG), and lesion study. Furthermore, they affirm that the fundamental comprehension of this field abandons the assumption that neuroscience is simply finding the 'buy' button on the consumer's brain. The authors base the research on the traditional marketing mix components: product, price, communication and distribution policies, and brand research.

However, neuromarketing studies have recently generated controversies over the participation of medical professionals in these researches, and many fundamental issues have potentially important implications to the field of psychiatry. Particularly relevant for psychiatry, neuromarketing may be seen as the extension of the search for quantification and certainty in previously indefinite aspects of human behaviour (Fisher et al., 2010).

Garcia and Saad (2008) present neuromarketing studies as evolutionary, they claim that neural activation patterns associated with numerous marketing-related phenomena may be mapped onto the latest so-called Darwinian modules, therefore, providing a unifying meta-theory to this emerging subject with the help of the evolution theory.

There are different fields interested in studying human behaviour, such as marketing researchers and professionals, aiming to perceive the development and the application of neuromarketing knowledge in different ways. The existence of different perceptions of knowledge is not a new issue, but finding new interconnections among these perceptions is beneficial for the creation and spreading of knowledge. Butler (2008) proposes an analysis model called neuromarketing research model. It interconnects basic and applied research reports, social communication, and the processes involving neuromarketing. This model intends to connect the different perceptions of neuromarketing knowledge.

Thinking about the studies of neuromarketing, Lee et al. (2007) provide and academic perspective on this field. By doing so, they define a series of key issues for neuromarketing research and insert neuroimaging as a likely way to help provide insights about issues on the non-consumption level. Special attention was given to the non-consumption level, in an attempt to broaden the scope of the debate regarding the application of neuroimaging techniques to marketing research. Therefore, neuroimaging is susceptible in the sense of offering considerable vision (insights) about reliability, price, and negotiation. To the authors aforementioned, neuromarketing itself may be a valid field of study and a rich source of issues to be investigated by neuroimaging.

Following the same idea, Perrachione and Perrachione (2008) state that the advances on neuroimaging technology have led to a significant number of studies that investigate the living human brain, aiming to understand its structure and function. With the increasing use of brain imaging techniques, both by science and popular media, researchers from other areas of social and behavioural sciences become naturally interested in the applicability of neuroimaging techniques in their researches.

The effort proposed by Plassmann and Weber (2015) consists of a novel automated structural brain imaging approach to determine individual differences, combined with traditional behavioural experimental approaches. The investigation aimed to analyse individual differences in marketing placebo effects. Results evidenced that consumers

with high rates of reward-seeking and cognition-seeking behaviours, but low in somatosensory awareness, are more responsive to marketing placebo effects.

On the other hand, Williamson (2002) presented a way of thinking about the issues of emotion, reasoning, and behaviour through a method called Innervision. The method uses interventions in groups of people, enabling this group to reflect about what is proposed. The study provides a brief description of a qualitative research methodology that reveals the emotional drivers and specially those who exert their influence in the liminal zone of the mind.

To Reimann et al. (2011), although the psychology field is going through a massive change towards the use of fMRI, the application of this methodology on consumer behaviour research is relatively new. The research developed by the authors highlights the characteristics that make fMRI an interesting method to consumer and marketing research. Moreover, the advantages and limitations of illustrating the proposed procedures are discussed with an applied study, which investigates loss aversion when buying and selling of regular products. The results reveal a significantly stronger activation in the amygdala, as consumers seek to estimate selling price in relation to the purchase price, suggesting that loss aversion is associated with the processing of negative emotions.

Yet, Dietvorst et al. (2009) developed a new scale theory to measure the interpersonal mentalising skills of salespeople – that is, the ability salespeople have to 'read the consumer's mind' in the sense of recognising customer intentionality and processing interpersonal subtle cues, thus adjusting volitions accordingly. Derived from researches about autism and neuroscience, the authors developed a model of brain functioning that shows the differences between interpersonal mentalists (salespeople that read the mind) with more skills and the ones with less skills. The authors establish convergent, discriminant, concurrent, predictive, and nomological validation measures of the scale using four methods in four separate studies: confirmatory factor analysis, structural equation models, multitrait-multimethod matrix procedures, and fMRI. The study is innovative for testing the validity of measures of a scale using procedures from neuroscience, and not only traditional ones.

Venkatraman et al. (2015) state that the last decade has seen a huge increase in the use of neurophysiological methods to better understand marketing phenomena among academics and professionals. However, the value of these methods on predicting advertising success remains underexplored. Using a single experimental protocol to evaluate subjects' responses to 30-second TV ads, the authors used methods of traditional and implicit self-reports, eye tracking, biometrics, EEG, and fMRI. As a result, they observed that the activity in the ventral striatum is the strongest real world predictor.

Reimann et al. (2012), in three experiments, provide new clues about brand by studying the psychological and physiological mechanisms of how consumers relate to their preferred brands. The authors used three different methods to measure the relationship between consumers and brands, such as experimental studies, skin conductance responses, and fMRI. The results propose that emotional arousal decreases as the consumer uses the brand over time, in comparison with the relationship the consumer has with another brand that is not of their preference. In addition, the authors discuss that the integration of psychological and neuropsychological measures and concepts sheds new light on the unique characteristics of the relationship between consumers and brands.

Cerf et al. (2015) present a recording method for single-neuron reading using electrodes in human beings, to be used in marketing and consumer researches. The application of the study shows that the firing rates of neurons, which were previously shown to selectively respond to content related to fear, increased with the emotion enhancement instructions.

The approaches of Shiv and Yoon (2012), and Wang and Minor (2008) are similar. To Shiv and Yoon, the neurophysiological and psychological approaches may help advancing the insights of a brand. Wang and Minor (2008) show the strengths and weaknesses of ten main psychophysiological techniques. The authors address the need for marketing research to establish validity and reliability, and to emphasise the applicability of the psychophysiological techniques used. Psychophysiology is an interdisciplinary subject that combines physiology, biology, and psychology research. It has been defined as the study of the relations between psychological manipulation and the resulting physiological responses, measured on living organisms to promote understanding of the relation between mental and physical health. Consequently, marketing researchers are capable of using physiological indicators to monitor hidden psychological processes. The methodology applied was an evaluation of ten psychophysiological techniques and the abstracts of 67 previous studies using these techniques in marketing research; subsequently, strengths and weaknesses of each psychophysiological technique are discussed based on the review. The results of the study emphasise that the environment contains stimuli that may influence the inner body, which in turn, stimulates the consumer and behavioural results. In market research, the psychophysiological process may be better understood by examining the consumers' inner body. The relationship between psychological background and physiological consequences present in the inner body comprehends the model of psychophysiological relationship, and describes detailed patterns of psychological processes and physiological indicators.

On the other hand, Fugate (2007) briefly discusses the origins of neuromarketing, explains the process in layman's terms, enumerates some of the findings, and suggests some directions on consumer behaviour research based on these findings, through a discussion based both on theoretical and practical reports of neuromarketing application. The authors also summarise the content of the reports and elucidate their contribution to the discussion by displaying how these reports relate to the traditional approaches of marketing research. Therefore, although there are no concrete findings, preliminary evaluations suggest that the combination of neural activity imaging with conventional tools may produce more efficient marketing practices.

However, Booth and Freeman (2014) reaffirm the importance of mapping the mental processes of each consumer in a market-relevant context through an experimental approach. Thus, they state that mental maps provide operational insights that may not be achieved by physical methods, such as brain scanning. These personal cognitive characteristics were included in secondary panels of maps of market demand from consumers who bought by their senses and the ones who bought by attribute.

In addition, it is worth noting the debate of behaviour studies by the economic perspective, such as discussions by Vale (2009) and Foxall (2008). Thus, Vale (2009) challenges the model of the rational choice theory by the modern neurobiological theory, suggesting the reconstruction of the standard intertemporal choice model over four lines, to reduce the gap between theory and the clinical definition of dependence:

1 the ranging discount rate

2 concept review of capital consumption

3 potential genetic predisposition to addiction (even though the investigation so far has not identified this kind of gene)

4 the social mechanisms that influence behaviour.

Foxall (2008) incites a discussion regarding reward, emotion, and consumer choice, in light of the theories of neuroeconomy and neurophilosophy. The nature of neuroeconomy is especially explored concerning the assessment of alternatives, choice, and emotion. The tendency of human consumers for discounts as future rewards illustrates how behavioural and neuroscientific accounts contribute for choices found in psychological explanations and the issues arising from both of them, that is, everyday choices and more extreme compulsions. The recognition that rewards are evoked by reinforcement strategies and that these rewards generate emotional reactions by classical conditioning expand the understanding of how neurological activity contributes to explaining consumer behaviour. That is the argument that enables neuroeconomy to play an explanatory and vital role, providing an evolutionary and consistent warrant for the ascription of intentionality. Hence, the behavioural perspective model is used for investigating consumer choices that lead to iterative theoretical development, giving neuroeconomy a decisive position within neurophilosophy.

Next, some ethical dilemmas discussed by the authors are presented, which concern the use of neuromarketing study techniques on consumer behaviour research. Wilson et al. (2008), analyse the impact of the findings and neuroscience methods in marketing practice and how they relate to the exercise of individual free will. They state that neuroscience methodology, neuroimaging technology, especially non-evasive, allow researchers to investigate brain activity at the basic neural level of functioning, hence, the authors describe ethical dilemmas surrounding the paradigm of free will. The issues concern the lack of transparency of promotional activities. In order to improve that, they suggest the application of some principles, such as warnings, choice, access, integrity, and execution. A fundamental role to decision makers and consumer researchers is to inform this debate by monitoring neuroscience advances, and to assess its implications to an ethical marketing practice.

Murphy et al. (2008) propose the application of a code of ethics by the neuromarketing industry. The objective of this code of ethics is to promote research and development, entrepreneurship, and profitable company to the beneficiary, as well as non-harmful use of neuroimaging technology at all stages of development, implementation, and promotion. These codes must be discussed in the neuromarketing research academic community, by independent researchers that work on the neural correlates field of study for decision-making, social behaviour, consumer preference, and neuroethics.

Complementing this idea, the authors Chancellor and Chaterjee (2011) state that the use of neuroscience should be cautious when it comes to aligning commercial interests, not to compromise the scientific value and the marketing research itself. However, the authors are favourable on affirming the aid that neuroscience may provide regarding marketing practices.

Plassmann et al. (2011) discuss neuroscience application to marketing, in particular to consumer psychology. Thus, through a qualitative study, they show a general view, stating that consumer psychology studies may integrate the results and concepts of neuroscience without actually applying neuroscientific methods. They stress that this approach is of great potential for the development of an interdisciplinary understanding of how consumers make decisions and may provide a significant improvement to the knowledge of their preferences. Thus, by creating such debate, the authors handle the applicability of neuroscience study techniques on neuromarketing by an ethic perspective.

Plassmann et al. (2015) point out that for the neuroscience field to prosper, the current focus on basic scientific research should be extended to the theory and practice of marketing, stating that neuroscience may become an important addition to marketing research and practice.

3.2 Dimension 2: Brain regions involved in the purchase decision process

The satisfactory reaction of a consumer towards a certain brand is, above all, a chemical reaction: substances released by the brain from symbolic representations deriving from communicational actions are capable of causing impulsive decision-making. Certain brain areas linked to sensations of pleasure and satisfaction are activated when presented with certain situations, or even brands, products or services.

Tanner and Maeng (2012) state that neuroscientific researches suggest that the brain developed specific capabilities that enable an automatic social judgement based solely on facial properties. However, few marketing studies consider the consequences of how facial images are automatically processed. The research developed by the authors sought to identify automatic perceptions of familiarity by using image-editing software to digitally combine unfamiliar faces with the faces of Tiger Woods and George Bush. Even though there was no conscious recognition of the faces, the trustworthiness ratings of the combined faces were clearly influenced by the aforementioned celebrities. Apparently, this occurs because the implicit recognition is sufficient for individuals to automatically access their valence judgements from either one of the two celebrities. These findings suggest that the marketing practice of digital manipulating the attractiveness of facial images may neglect the major influence of the familiarity of the faces.

Ambler et al. (2004) report an experiment using the methodology of non-invasive brain imaging, MEG, which explores how brain activation reacts differently according to brand familiarity. The research is innovative in the application of this new technique using relatively few individuals with a limited theory. According to the authors, familiarity with the brand seems to be a useful and probable indicator of purchase behaviour. Results indicate that the brain seems to use an active vocalisation in the choice process, enabling to identify a key area involved in the final decision of a product or brand, when compared to others.

Plassmann et al. (2008) analysed the influence of ambiguity on the signalling power of brand information. Thus, by means of fMRI they investigated whether (and, if so, how) choice ambiguity modulated the activity in previously identified brain areas to be involved in the process of brand preference and decision value, according to previous studies. Evidences of a growing preference for the signalling function of brand information were found, in a context of high ambiguity compared to a low ambiguity, followed by the increase of the growing difference in neural activation changes in the

ventromedial prefrontal cortex (vmPFC) and in the anterior cingulate cortex (ACC). These activation patterns have been earlier found to be correlated with brand preference.

On the other hand, Yoon et al. (2006), investigated through fMRI scanning whether semantic judgements of products and people are similarly processed. Results suggested they are not. The comparison of neural correlations of products *versus* the description of human judgements indicate a major activation of the medial prefrontal cortex of humans; as for products, activation was higher in the left inferior prefrontal cortex, an area known to be involved in object processing. These findings serve to challenge the view that product and brand processing are similar to human processing, and create a precedent for the use of fMRI techniques in the studies of consumer neuroscience. By proposing an approach to neurophilosophy, this study drew specific attention to the importance of both behavioural science and neuroscience, providing extensive contributions to psychology.

Klapproth (2008) reviewed the relationship between time and decision making in humans regarding the evaluation process, emphasising the role played by psychological time compared to physical time. The importance that time and its mental representations have on decision-making was highlighted. The study addresses the subjects of option duration, temporal decision-making, time between making a decision and experiencing its consequences, temporal perspective and decision makers, and the duration of the decision process.

Hedgcock and Rao (2009) presented a research that refers to a cognitive neuroscientific exam, which seeks to understand whether trade-off aversion explains the attraction effect. The main study involved the neuroimaging of individuals engaged in choice tasks while having their mental activity recorded. The authors examined whether the presence of a third, non-relevant option generated a relatively smaller activation in brain areas associated to negative emotions, when compared to the activation during choice tasks that involve two options equally (un)attractive. The results support the claim that trade-off is associated with relatively greater negative emotions.

On the same topic of trade-off aversion through fMRI methodology, Huettel et al. (2009) review their own articles, such as 'Integrating decision sciences and neural science: convergences and contradictions', written by Huetell and Payne; 'Using fMRI to inform marketing research: challenges and opportunities', written by Yoon, Gonzalez, and Bettman; and 'Aristotle's Anxiety: choosing among methods to study choice', written by Hedgcock and Rao.

On the other hand, Berns and Moore (2012) suggest that any differences in neural response for brands must be derived from culture. They state that not only do the signals that locate the regions related to rewards in the human brain predict individual purchase decisions, but also they are modestly predictive of population effects. While the emerging field of neuromarketing has made claims for such effect, it lacks real prospection data.

Venkatraman et al. (2012) discusses that consumer preferences for either products or brands rise from the combination of many different factors. Some factors come from the product's characteristics themselves (price, durability) whereas other factors come from consumers' own attributes (objectives, attitudes, income). For marketers they mean the effective segmentation: dividing a consumer base for a brand or product in distinct and substantial groups with different needs. Through the management of a brand, the authors propose that neuroscience provides an innovative way of establishing maps between the cognitive processes and marketing traditional data. A better understanding of the neural mechanisms of decision-making increases the ability that marketing professionals have to

offer products more effectively. Additionally, neuroscience may shape potential influences on the decision process – including price, choice strategies, context, experience, and memory – it may also provide new insights in individual differences in purchase behaviour and brand preference.

According to Karmarkar et al. (2015), price is a key factor for most purchases, but it may be presented at different decision-making stages before a purchase. The effects depend on the sequence of price and product information in the decision-making process, at both neural and behavioural levels. During magnetic resonance scanning, the price of a product was shown to the participants both before and after the product being presented. The experiment showed that early attention to price, or price primacy, altered the evaluation process, as perceived in the altered patterns of prefrontal cortex activities from prior purchase decisions. When visualising products first, there were general assessments strongly related to the product's attractiveness and desire, whereas when visualising prices first, there were general assessments related to the product's monetary gain. In line with the framework presented, price primacy proved to increase the purchase of products when the reward is easily perceived. Altogether, these results suggest that price primacy focuses on the rewards of the product and thus may influence the purchase.

Hubert el al. (2013) investigated whether individual differences in the tendency of impulsive purchases affect subconscious neural responses during the perception of product packages. fMRI exams were used to measure neural responses for the perception of product packages in participants with different impulsive buying tendencies. The results proved the existence of a corresponding relationship between strong impulsive buying tendencies and the activities of brain areas associated with impulsive and reflexive processes.

Jai et al. (2014) used fMRI to investigate whether sensorial presentations, specifically image zooming and video rotation, would evoke different brain cognitive and affective functions during the process of evaluating the product and purchase decision. The results suggest that although image zooming may evoke a more visual perception in the product evaluation process, visual rotation evokes more mental imagery, pleasure, and reward anticipation during the process of purchase decision.

According to Telpaz et al. (2015), through a relatively inexpensive and widely available method – EEG – it is possible to predict consumer's future choices for products. It was found that the neural activity measured by the mid-frontal electrode presented an increase in the N200 component and a weaker Theta band power, which correlates with a more preferred good. State-of-the-art techniques for relating neural measurements with choice prediction showed that these measures predict subsequent choices. Moreover, the accuracy of these predictions depends on both cardinal and ordinal distances of EEG data. Thus, the larger the difference in EEG data between two goods, the better the predictive accuracy.

The effects of advertising content in sensorial thoughts and in the perceived taste are discussed by Elder and Krishna (2010), who argue that promotional content for food products may affect taste perception by affecting sensorial cognitions. The study shows that multisensory ads result in higher taste perceptions than ads focusing only on taste, given this result is mediated by the excess of positive sensorial thoughts over the negative ones. Considering the effect of the ad is driven by either thoughts or cognition, restricting cognitive resources (that impose cognitive load) attenuate the enhancing effect of the multiple-sense ad. The results were obtained by three experiments and have several

implications for consumer behaviour researches that address cognitive and sensory perceptions, as well as several practical implications.

3.3 Dimension 3: Brain information process

The scientific discoveries about the human brain over the last years have broadened the perspective to understand the study on consumer behaviour. Knowing how the brain processes information allows marketing managers to review brand communication strategies, package design, advertising, store environment (background sounds and message reminder), metaphoric language and advertising, among others. Accordingly, Gordon (2001), making use of neuropsychology, reports about the inconsistencies that occur between what is found in the development and evaluation of brand strategy and what actually happens, which the author names 'real life'. The author analysed brain functioning and structure, consciousness and unconsciousness, memory and language. He suggests that the newly merged disciplines of neuroscience and cognitive psychology (called neuropsychology) offer the scientific basis for understanding how human beings create, store, recall, and relate to brands in everyday life.

Krishna and Schwarz (2014) outline key assumptions of the information-processing paradigm, challenging the computational metaphor of information processing by highlighting evidences of how mental activity is grounded on sensorial experiences. Later, the authors discuss some of the conceptual challenges presented in studies that generally appear under the title of embodiment, grounded cognition or sensorial marketing. The authors refer to corporal sensations as information sources, and then, focus on the role played by context-sensitive perception, scanning, and simulation of customer behaviour, that is, how the context in which the consumer is inserted stimulates the sensorial processing, by visual, tactile or olfactory stimuli, and its implications to consumer behaviour.

Focusing on brand, Gakhal and Senior (2008) investigate the role that the vmPFC plays in processing different types of ads. In this context, the authors sought to learn the interaction between the recording side of the brain and the type of ad that could reveal differences on the psychophysiological profile reflecting the emotional selling proposition (ESP) in brand platforms that portrays either beauty or celebrity. Hence, a study that measured electrodermal activity (EDA) was performed, aiming to identify the effects of fame and beauty in its responses. The results showed that the average of participants who looked at celebrities produced higher EDA response. This effect was revealed from recordings of the left side of participants' brains, suggesting a positive neural response using celebrities as brand representatives.

In addition, considering the importance that social representations exert on target segments, Cascio et al. (2015) investigate the relationship between social influence and decisions based on online recommendations among groups of adolescents. The participants of the study completed an App Recommendation Test, a task that captures neural processes on making recommendations to others, with or without peer information commonly available online. The results showed an increasing activity in the striatum and the orbitofrontal cortex, also the individual differences on the activation of the temporo-parietal junction during feedback suggest that peer recommendations differed when correlated with individual differences, in susceptibilities to the influence on

recommendation decisions among subjects. These brain regions are previously involved in social influence.

Stoll et al. (2008) considering neuroscience evidences that the brain processes negative visual stimuli differently from positive ones, investigated the possibility of analysing this scientific finding particularly for package design. Thus, an experimental study was designed using fMRI, which measured the brain activity of study participants while they were making decisions about the attractiveness of package of daily consumer products. Confirming scientific results of consumer neuroscience, attractive and unattractive packages triggered different changes in cortical activity. Significant changes occurred in the cortical visual areas of the occipital lobe and the precuneus – regions associated with the processing of visual stimuli and attention. It was also found that at the individual level, activity changed significantly within regions of rewarding processing. Moreover, comparing unattractive packages with attractive ones found increased activity in frontal lobe and insular cortex areas – regions associated with processing aversive stimuli, such as unfair offers or repulsive images. Such results may explain why attractive packages gain more attention at the point of sale, positively influencing turnover of daily consumer goods.

Bar and Neta (2008) using the theoretical neuroscience framework, sought to understand how visual opinions are formed. They analysed studies about:

1 quick predictions that facilitate visual recognition (research performed with fMRI)

2 trial predictions of others (experimental research with pictures of faces where participants issued judgement impressions)

3 preferred object for predictions (presentation of objects images with curves, using fMRI).

Conclusions revealed that the brain processes information quickly, by analogy, even without a lot of information, based on past experience memories and associative activation.

Understanding how the consumer processes advertising by examining how metaphoric language is treated on the right and left hemispheres of the brain is the study proposal by Vance and Virtue (2011). Hence, the authors emphasise the importance of gathering knowledge on the fields of cognitive neuroscience and marketing, aiming an analysis on a deeper level of introspection of consumers' minds. The research used a cognitive neuroscience method that isolates the activities of the hemisphere of the brain. Using a divided visual field paradigm, the participants read the literal metaphors or neutral slogans, and answered to related keywords presented to either the right hemisphere of the left visual field or the left hemisphere of the right visual field. The results of the study showed an advantage for the right hemisphere of the brain in relation to the left one, regarding the metaphors of slogans; great ease of the right hemisphere for the literal reading of slogans compared to metaphors used in slogans; metaphorical messages were remembered more easily than literal slogans. These results detail how consumers implicitly process messages, suggesting an important role of the right hemisphere on understanding both literal and metaphorical messages. The study differs from others because it delves into the consumer's psyche, providing an insight of cognitive processes underlying consumer behaviour.

The research by Fraser and Bradford (2012) analyses how background sounds are processed. The study presents recent works of cognitive psychology that highlights the

potential distraction represented by changes in background sounds. The auditory scene analysis (ASA) is introduced as a theoretical framework to connect structural characteristics of music to cognitive processing and message recall. The study quantified the influence of background sounds characteristics in processing of brand message. Results suggest that background sounds vary extensively in their potential effectiveness. The brain has evolved into a highly complex and sensitive state, with the ability to process pre-attentive stimuli. Experiment 1 showed that message recalls were higher for ads with background sounds with less frequent changes. Ad message recalls for new and unknown brands suffered greater interference from background sounds than for ads of established brands. In experiment 2, the frequency of background sound change was reduced in two announcements, keeping everything else constant, which improved message recall. Background sounds that evoke desired emotional responses or cause desirable images may be adjusted by reorchestrating fewer instruments or with a slight adjustment to help focusing attention and learning about the brand and message.

Elder and Krishna (2012) investigated the effect of visual depictions in advertising. The study showed that visual depictions of products in advertising, such as the subtle manipulation of guiding a product to an actor's hand, facilitate the mental simulation that evokes motor responses. The authors infer that seeing an object may lead to similar behavioural consequences to interacting with it, as the mind mentally simulates the experience. Four studies were used to show how visually describing a product facilitates more (versus less) of mental simulation results in high purchasing intentions. These studies reinforce the proposition of the authors regarding mental simulation.

The investigation by Craig et al. (2012) analyses neural processes during exposure to misleading advertising. Using neuroimaging methods, the research sought to understand how consumers process persuasive messages that vary in exploring perceived sincerity, investigating cognitive mechanisms underlying this transformation. The fMRI data, combined with an additional behavioural study, showed evidence of two distinctive results. First, confirming that from multicellular structures of persuasion emerge two distinct stages of brain activity: precuneus activation at earlier stages, and joined activation of the upper temporal and temporo-parietal sulcus at later stages. Secondly, a disproportionately higher brain activity associated to claims that are moderately misleading than to those that are either highly believable or misleading. These results suggest reviewing what types of complaints deserve the attention of consumers, and that consumers may be particularly vulnerable to misleading advertising.

Boksem and Smidts (2015) turn to the measures of declared preference and neural measures (electroencephalography – EEG) to understand brain responses to commercially released movie advertisements (movie trailers), to investigate their potential to provide insights on individual preferences as well as their commercial success among the general public. The results show that EEG measurements (beta and gamma oscillations) provide information about a single individual and preferably throughout the public, beyond the measures of declared preference, and so may initially be used as a neural marker for commercial success. These results provide the first evidence that EEG measurements are related to results of real-word, and that these steps may significantly increase neural models that foresee choice behaviour related to models that only include measures of declared preference.

4 Discussions on the issue

The neuromarketing field should be considered a legitimate and important area for future research, for it enables a better understanding of consumer behaviour contributing for the advance of tactics and strategies of marketing in the organisational context.

In the academic field, it is worth noting as a main contribution the interdisciplinary approach among psychology, neuroscience, and marketing, bringing to light the applicability of neuromarketing. Thus, the development of this science led to the search for new knowledge by mapping brain records through research and discoveries in several areas of knowledge. In this context, studies focused on consumer behaviour presenting practical applications were performed through experiments. Also it is emphasised the importance of neuromarketing against traditional methodologies – such as focus group studies, in-depth interviews, and surveys – as it enables a better understanding of brain activity, providing the qualification of marketing researches.

Neuromarketing is a research field that has contributed to the advanced understanding of consumer's behaviour. One of the methods used by neuromarketing is the Innervision method. It uses small samples with qualitative approach and indirect intervention, analysing emotions, reasons, and human behaviour. Another method is the fMRI, which helps tracking brain activities, and informs how brain areas are activated by sales presentations, for instance. Thus, mechanisms such as neuroimaging may assist neuromarketing management practice, presenting the most effective tools that may be used in marketing. Therefore, neuromarketing consists on the application of neuroscientific methods to analyse and understand human behaviour in relation to market trades and marketing. Furthermore, it may be used for both commercially and intra-/inter-organisational researches, and not only for consumer behaviour studies. In this perspective, neuromarketing seeks to understand what motivates the human brain, in order to learn whether marketing efforts are consistent with what really motivates human beings.

Considering the results of the articles analysed in this neuromarketing systematic literature review, it is clear that the advances in the field allow further understanding of relevant and specific issues about consumer behaviour, as well as expanding them through new research methods. Hence, an agenda for future studies is proposed.

5 Research agenda for future studies

The investigations presented and analysed in dimension 1: concepts, applications, and methods allow suggesting the expansion of the use of neuroscience techniques, such as the use of neuroimaging for the solution of marketing research problems, aiming at a more clear understanding of the impact of marketing mix tactics: product, price, communication, and distribution channels. It is worth noting that neuroimaging provides a better, more precise and objective observation, which enables getting closer to understanding what really happens as responses to marketing stimuli in specific situations of consumer behaviour.

Using neuroimaging, a broad field of investigation emerges for further knowledge about:

1 neural activation regarding brand representations and associations in the decision process of consumers

2 neural activation regarding the emerging feelings from the relation between consumers and their preferred brands

3 extend the studies about 'non-consumption' from insights related to attributes of purchase, price, point of sale, reliability, and negotiation process

4 the impact of successful ad campaigns and unsuccessful sales

5 the relation between free will and the lack of transparency in promotion and ad campaigns

6 the ethical application of neuromarketing in marketing practice.

Contributions of the experimental studies presented in Dimension 2: brain regions involved in the purchase decision process allow suggesting the evaluation of the impact of advertising in projection and other aspects of brand value that may be discovered through imaging, that is, through non-invasive brain imaging by MEG, for routine purchases. The articulation of these events through publicity, experience, and choice processes require more investigation and the replication of the same methodology for complex purchases.

To focus on studies that raise the discussion of brain activation regarding self-reported sympathy and its implications on branding, symbolic attributes of marketing, similar visible material characteristics, thus measuring its causal interactions. Moreover, to deepen the studies about the automatic perceptions of familiarity *versus* attractiveness of facial imagery; brain activation regarding familiarity with the brand in the consumer purchase process.

Another important issue that deserves special attention concerns the ongoing debate about the tendencies of the individual in the face of impulsive consumption. Behavioural and neuroscientific researches may contemplate this discussion by investigating different situational influences and types of products, as well as matching different measures of impulsivity or impulsive purchase behaviour and the actual behaviour.

Dimension 3: brain information process inspires several concerns in order to develop specific topics, initially considering the articles selected for this study. Extending the debate on the study of the nature of fame and beauty in the specific conduction of consumer behaviour enables identifying how the brain processes information related to stereotypes typical of the consumption society, seeking to establish relations with the cultural values of that society. Another important issue that deserves attention from researchers is the discussion on how the brain stores experiences and from that, how impressions, preferences, judgements, and predictions are emitted concerning brand, products, and services.

Advances aiming to relate brain activation to choice behaviour should be considered, however, evidence that neural measures may actually be useful for predicting the success of marketing activities are still limited. Thus, intensifying the investigations of brain activations and their importance in consumer choice behaviour becomes relevant and thought-provoking.

The neuroscience area that studies consumer behaviour still has a lot to develop and should be seen as a challenge for researches in this field. To develop the studies in the specific field of decision-making, researchers may aim at an in-depth investigation on behaviour (Hubert and Kenning, 2008).

In addition, focusing the debate among all parts involved in neuromarketing is required to explore and conceptually improve the research models and, in the meantime, strengthen and pursue new goals for neuromarketing.

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