Neuromarketing: the future of market research or a passing trend?

Céline Solnais
celinesolnais@correo.ugr.es

Juan Sánchez-Fernández
sanchezf@ugr.es

José Ángel Ibáñez-Zapata
joibanez@ugr.es

Department of Marketing and Market Research
Faculty of Economic and Business Sciences
University of Granada
Campus Universitario de La Cartuja, s/n
18071 Granada, Spain

Abstract

Over the past decade, the popularity of neuroimaging and psychophysiological techniques such as functional magnetic resonance imaging and eye tracking has grown rapidly within the marketing discipline. Yet, 'neuromarketing' has become a buzzword associated with both optimism and uncertainty about its future place in market research. In this paper, we propose to address this question by examining the approach adopted by neuromarketing and consumer neuroscience as well as its applications. After discussing the main points of difference compared to traditional methods, we conclude about the role of a multi-disciplinary approach to consumer research and consider future research challenges.

Key-words

Neuromarketing; consumer neuroscience; consumer behaviour; functional magnetic resonance imaging; electroencephalography; eye tracking

Please cite as: SOLNAIS, C., SÁNCHEZ FERNÁNDEZ, J., IBÁÑEZ ZAPATA, J. A. (2015) "Neuromarketing: the future of market research or a passing trend?", Proceedings of the 2015 International Marketing Trends Conference

Introduction and objectives

Over the past decade, the application of neuroscience to marketing has become a popular trend resulting in the rapid growth of the neuromarketing industry as well as in the birth of a new field of academic research called 'consumer neuroscience'. This increasing popularity lies in the attractive concept of applying modern neuroimaging technology as a means to explain consumers' perceptions and shopping decisions based on brain activity. Thus, consumer neuroscience can be defined as "the study of the neural conditions and processes that underlie consumption, their psychological meaning, and their behavioural consequences" (Reimann et al. 2011, p. 610).

In particular, functional magnetic resonance imaging (fMRI) has been at the centre of attention as it makes it possible to analyse neural activity not only in the outermost parts of the brain but also in deep brain structures, with high spatial resolution. For example, fMRI enables to locate activity changes in the limbic system, which includes areas of particular interest to the analysis of consumer behaviour such as the hippocampus, involved in long-term memory, and the amygdala, involved in emotional responses (Solnais et al. 2013).

The umbrella term of 'neuromarketing' additionally encompasses older psychophysiological techniques concerned with data other than brain activity. For example, galvanic skin response (GSR) consists in measuring the electrical conductance of the skin (also known as electrodermal response) as an indicator of arousal during exposure to marketing stimuli. Likewise, eye movements can be recorded through eye tracking to analyse the way consumers attend to brand information and process choice alternatives. In Table 1, we summarise some of today's most popular techniques along with the measures they provide about the psychological processes underlying consumer behaviour.

TABLE 1. Common techniques of consumer neuroscience and neuromarketing

Technique	How it works	Application	Main limitation
fMRI	A MRI scanner detects regional changes in the level of blood oxygenation in the brain (the BOLD signal) caused by neural activity.	Analysing cognitive and affective responses	Low temporal resolution
Electroence-phalography (EEG)	Electrodes are placed on the participant's head to detect changes in the electric current along the scalp (called brain waves) caused by neural activity	- Analysing cognitive information processing (attention) - Analysing differences in responses between left and right brain hemispheres	Low spatial resolution
Eye tracking	An eye-tracker device detects eye movements to compute the location, duration and frequency of eye fixations on the stimulus of interest.	Analysing visual attention	Only provides a measure of *overt* attention processes
Skin	A galvanometer monitors the	Analysing the arousal	Does not measure the

conductance	ability of the skin to conduct electricity, which depends on the level of moisture induced by sweat.	dimension of emotional responses	valence dimension (pleasure vs. displeasure) of emotional responses
Heart rate variability (HRV)	An electrocardiogram records the electrical activity of the heart caused by muscle contraction so as to compute the rate and regularity of heartbeats.	Analysing attention	Respiratory patterns may vary across experimental conditions and subjects and affect HRV
Facial electromyo-graphy (EMG)	Electrodes are placed on the face of the participant to detect the electrical signals caused by the contraction of muscle fibres	Analysing the valence dimension of emotional responses	The intrusiveness of the electrodes may affect natural facial expressions (e.g. due to discomfort)

Prepared by the authors. For a methodological review of consumer neuroscience techniques see Wang & Minor (2008), Senior & Lee (2008) and Kable (2011).

The rationale for analysing consumer behaviour based on physiological responses is concerned with the objectivity of these data compared to self-reported measures traditionally collected through surveys and interviews. Adopting a psychophysiological approach indeed enables to eliminate the cognitive biases typically affecting participants' responses to researchers' questions in market research. The concept of bypassing rational thought to directly access consumers' most intimate responses has contributed to turning neuromarketing into a buzzword associated with both fantasies and fears around the idea of reading people's minds. Yet, even the latest neuroimaging techniques do not allow such thing and the derived insights remain limited by the available neuroscientific knowledge as still little is known about the brain and its highly complex mechanisms. Part of the initial buzz around neuromarketing may therefore have been based on expectations that exceed the realistic capacities of these techniques. Altogether, these diverging arguments raise the following question: *is neuromarketing the future of market research or is it just a fad?*

This paper is aimed at evaluating the trend of neuromarketing by examining the key novelties and insights brought by this approach to the field of marketing. The application of neuroscientific and other psychophysiological techniques indeed entails three key points of difference compared to traditional market research. First, they enable to track consumers' moment-by-moment response during realistic conditions of exposure to marketing. Second, they offer the opportunity to obtain a more in-depth understanding of the way consumer preferences are formed by considering inner psychophysiological processes. Third, they may shed light on unconscious processes influencing consumers' perceptions and decisions. After discussing the value of each of these aspects, we formulate conclusions about the proposed question and discuss the main challenges for future research.

Tracking consumer response in real time

A key characteristic of neuromarketing techniques is the possibility to record consumers' response to marketing in real time, under realistic conditions of exposure. This approach was already adopted when psychophysiological measures such as pupillary dilation and electrodermal response were first applied in the 1960s. Today, modern eye-tracking and EEG technologies enable to detect changes in eye movements and brain activity with a resolution on the order of just milliseconds. This is of high interest for studying the effects of marketing stimuli that are dynamic in time and monitoring shopping behaviour moment by moment without interrupting the decision-making process.

In particular, EEG can be used to detect the left-right asymmetry of consumers' frontal cortex as they are processing product alternatives during in-store and online shopping or while exposed to ads. For example, this methodology can be applied to understand how specific commercial scenes are processed by the brain and infer the emotional impact of a television ad at each moment of interest. In this aim, one study tested three alternative TV ads for the same brand and product and identified the design that allowed generating greater activity in the left frontal cortex for each type of scenes (Ohme et al. 2010). According to the approach-avoidance model, behaviour relies on two main motivational systems depending on whether one is anticipating a desirable or aversive outcome, and every emotional state contains approach and/or withdrawal components (Davidson 2004). The evidence shows that it is the left frontal cortex that is involved in a system motivating approach behaviour, which is generally associated with positive emotions, whereas the right frontal cortex is involved in withdrawal motivation, which has been shown to be associated with negative emotions (Harmon-Jones 2003). Therefore, Ohme et al. (2010) were able to identify the advertising designs that were the most effective in generating favourable emotional states for the processing of communication messages, i.e. with a dominant approach component.

The evidence from consumer neuroscience suggests that a stronger engagement of the left frontal hemisphere during exposure to TV ads may equally be beneficial for the long-term memory of specific scenes (Rossiter et al. 2001). In addition, EEG can be combined with other high temporal resolution techniques so as to gather additional insights about consumers' attention and arousal throughout the duration of a commercial. For example, synchronising data from both EEG and eye-tracking recordings can enable to relate brain activity to the exact focus of participants' attention at a given time and identify the specific part of the scene that triggered left frontal hemisphere activations (Ohme, Matukin & Pacula-Lesniak 2011). Altogether, the benefits of these techniques have contributed to the popularity of neuromarketing and consumer neuroscience for advertising testing.

Another benefit from recording consumer response in real time is the ability to track the detailed decision-making process and strategy adopted by consumers during purchase decisions. Whilst it might be straightforward to directly ask participants to express a preference, their retrospective responses about the detailed steps of information processing through which they went are likely to be incomplete and unreliable due to inevitable memory biases. Modern eye trackers provide a non-intrusive process tracing methodology to record consumers' decision making moment by moment under realistic conditions. Thus, eye tracking can be applied to monitor the amount of information processed for each product benefit of interest and the strategies employed when comparing different product alternatives during choice tasks, which is likely to depend on decision complexity and available time. For example, eye-movement measures have been used to identify whether consumers make

multiple comparisons, i.e. with respect to each product attribute of interest (attribute-by-attribute processing), or if they opt for a faster and easier strategy by solely comparing the overall value perceived for each alternative (Meißner & Decker 2010; Su et al. 2012). Understanding the exact steps of information search and acquisition followed by consumers during decisions supports a more precise and detailed analysis of their shopping behaviour, which is particularly relevant for product and packaging design.

Moreover, measuring consumer response through real-time physiological data may serve to overcome the issue of cognitive and recall biases typically associated with survey and interview questions made a posteriori. Memory-based measures collected through recall tests have indeed failed to provide a reliable proxy for visual attention to marketing stimuli (Krugman & Fox 1994; Pieters, Warlop & Wedel 2002; Chandon et al. 2009; Atalay, Bodur & Rasolofoarison 2012). The evidence suggests that these measures may be influenced by participants' familiarity with a given brand, which can lead to inaccurate inferences about the impact of a product or ad. Thus, when comparing the effectiveness of different ads, participants may report recalling an ad due to their familiarity with the brand, but not because they have paid more attention to this ad. Psychophysiological techniques such as eye tracking may therefore help evaluate the true effectiveness of marketing in catching attention based on more reliable measures of attention. Nevertheless, this approach relies on the assumption that eye movements are intimately linked to human cognitive processing, which is known as the 'eye-mind hypothesis' (Just & Carpenter 1980). Whilst there is evidence of a positive relationship between eye fixations, cognitive activity and memory (Rayner 1998; Pieters, Warlop & Wedel 2002), eye-tracking experiments need to account for the limitation of such methodology. Eye fixation measures are indeed restricted to *overt* attention processes so that the relationship with cognition is likely to be imperfect.

Examining the inner psychophysiological processes involved in consumer behaviour

A significant novelty brought by neuromarketing is the possibility to shed light on the inner psychophysiological processes underlying consumer behaviour. Modern neuroimaging technology such as fMRI makes it possible to examine the brain mechanisms involved in cognitive and emotional responses to marketing stimuli. In other words, the objective is to obtain an in-depth analysis of consumer behaviour by looking at what can be considered the hidden part of the iceberg, that is, brain activity. This aspect has previously been argued to be essential to help improve our understanding of *how* marketing works by looking at the neural triggers involved in traditional constructs such as attitudes and purchase intents (Ariely & Berns 2010).

According to the growing evidence from decision neuroscience, consumer preferences are formed in the reward system of the brain. Specifically, perceived value is coded by the striatum and its components (e.g. the nucleus accumbens), that is, a deep area of the forebrain which activity is modulated by dopamine inputs. At the neural level, attractive products and brands are indeed processed as rewards in the same way as food, money and drugs (Wise & Rompré 1989; Berridge 1996; Knutson et al. 2001). Consumer preferences can be explained in terms of a greater expected value, which has been found to activate the striatum in fMRI research (Table 2). For example, pictures of sport cars have been associated with greater neural activity in this area compared with car categories perceived as less attractive (Erk et al.

2002). This evidence illustrates the ability of highly attractive products symbolising wealth and social status to signal greater value and stimulate the reward pathways of the brain.

TABLE 2. Neuroimaging evidence of the role of the striatum in the formation of consumer preferences

Role of the striatum	Reference
Anticipation of gain from the purchase of preferred products during choice tasks	Knutson et al. (2007)
Representation of the reward value of preferred food products during binary choices based on packages	Van der Laan et al. (2012)
Representation of reward value during the passive viewing of preferred consumer products in the absence of choice task	Levy et al. (2011)
Stronger activation in the striatum induced by popular brand labels during the taste evaluation of the same cola drink	Kühn & Gallinat (2013)
Evaluation of attractive product ranges vs. less attractive ones	Erk et al. (2002)
Evaluation of aesthetic product packages vs. less aesthetic ones	Reimann et al. (2010)

Prepared by the authors

Furthermore, the medial prefrontal cortex (mPFC) also plays a major part in the formation of consumer preferences due to its role in the decision-making processes involved in the evaluation and comparison of reward value from different alternatives (Paulus & Frank 2003; Day, Shyi & Wang 2006). As a result, the application of fMRI has started to make a significant contribution to marketing research by enabling consumer preferences and purchases to be predicted based on the measured activation in these areas. In particular, the relative activity of the mPFC was found to predict taste preferences while consumers were experiencing the consumption of cola drinks under a blind test condition (McClure et al. 2004). Likewise, in a simulated shopping experiment involving real money, purchase decisions correlated with the activity in the striatum, which encoded the anticipated reward value from product alternatives (Knutson et al. 2007). In addition, another study found that the activation in the striatum and mPFC during the mere viewing of products could be used to predict subsequent choices made after the fMRI experiment (Levy et al. 2011).

Altogether, the evidence from consumer neuroscience indicates that the subjective value of brands and products is represented in the striatum and medial prefrontal cortex, whether these stimuli are processed freely or during choice tasks. These findings illustrate the potential to provide new neural-based measures of perceived value for estimating the effectiveness of brands and products based on brain activity. In addition, the formation of consumer preferences relies on the integration of emotional feedback from areas such as the insula, which is known to be associated with the perception of social and financial risks as well as unfair economic situations (Sanfey et al. 2003; Knutson & Bossaerts 2007). In particular, excessive prices were found to activate the insula during purchase decisions in Knutson et al's experiment (2007). Further work on the brain mechanisms involved in both positive and negative emotional responses to marketing stimuli is likely to play an important part in future consumer neuroscience research given the role of emotions in consumer attitudes and their influence on cognitive processes (Bagozzi, Gopinath & Nyer 1999).

A limitation to the above contribution is concerned with the use of 'reverse inference' in consumer neuroscience. In neuroscience, fMRI studies traditionally manipulate a cognitive or emotional process of interest to determine the brain area(s) activated by this process. On the contrary, the application of neuroimaging to consumer research often calls for a backward reasoning whereby an inference is made about the participants' psychological response (e.g. negative emotions) based on the activated brain area(s) (e.g. the amygdala) and what is assumed about the role of the latter (Poldrack 2006). This type of inference therefore assumes that the activation of a particular brain region is associated with only one psychological process. Yet, a specific brain region can be activated by more than one mental process (e.g. the amygdala is known to be involved not only in aversive responses but also in memory). Reversely, a given mental function is often associated with several interconnected areas that communicate and interact between each other, rather than a single well-defined area. Despite this limitation, Hutzler (2014) demonstrated that carefully drawn reverse inference can have high predictive power when conditioned by the specific experimental task setting in consideration and discarding unsupported mental processes. In cases where the number of likely interpretations and uncertainty remain too high, reverse reference may still serve to generate useful hypotheses for future studies (Poldrack 2006).

Exploring unconscious responses to marketing stimuli

Last but not least, neuromarketing techniques may enable to examine unconscious cognitive and emotional processes involved in consumers' response to marketing stimuli. As opposed to self-reported measures, psychophysiological measures do not depend on participants rationalising about their preferences and decisions through conscious thought. In other words, this approach is not limited to the conscious component of human behaviour and may therefore serve to identify processes that affect behaviour despite consumers not being aware of it. This is an important contribution to consumer research considering that about 95% of our cognitive and emotional processing could be produced at an unconscious level (Zaltman 2003).

In particular, consumers may not be fully aware of the way brands influence their perceptions and preferences in a non-rational manner. An influential fMRI study showed that when participants are asked to compare the taste between Pepsi and Coke drinks having previously been informed of the brand name, the hippocampus significantly activates in the brain and Coke becomes the preferred option compared to a blind test condition (McClure et al. 2004). Such results suggest that available brand information may be unconsciously processed and trigger the retrieval of consumers' experience with the brand through the hippocampus, such as brand associations from past exposure to advertising. As a result, consumer preferences may not fully rely on a rational judgement. In this example, decisions were not strictly based on tangible product attributes such as taste; instead, brand memory created a biased perception of sensory information and influenced preferences.

Likewise, the eye-tracking methodology may contribute to identifying unconscious responses to advertising stimuli. As an illustration of this, a recent study found eye fixations on online banner ads to affect attitudes despite the banners achieving very low recognition rates according to self-reported measures collected after the experiment (Lee & Ahn 2012). This finding suggests that attitudinal changes may occur following exposure to advertising

although consumers do not recall having seen a given ad. As a result, the authors proposed that online banners might be processed at a pre-attentive level despite their poor click-through effectiveness. Further eye-tracking research could help better understand how online advertising is processed by busy Internet users while providing an insight into the formats and designs that are more likely to be effective.

The idea of accessing unconscious mechanisms involved in consumer decisions raises an important ethical debate. Such approach can be seen as an invasion of individuals' private mental activity, which could be used to manipulate behaviour. However, even today's most advanced neuroscience techniques do not enable to read people's thoughts. The underlying technology is indeed about measuring observable manifestations of *brain* activity, which is not the same as looking into what is commonly known as the 'mind' (Perrachione & Perrachione 2008). Despite this distinction, the adoption of a code of ethics like the one proposed by Murphy et al. (2008) is important to prevent potential misuses and encourage the development of the field within a clear normative framework. In fact, in their 'Manifesto for Neuromarketing Science', Senior and Lee (2008) argued that the application of neuroscience to marketing was even an opportunity to enhance the scientific approach used in consumer research: "Neuromarketing is here and, instead of creating legions of consumer zombies controlled by omnipotent corporations who use neuroimaging to create hypereffective advertising campaigns, we have seen the beginnings of a more rigorous, and altogether more relevant, scientific approach to the study of marketing questions" (Senior & Lee 2008, p. 263).

The possibility of accessing unconscious psychophysiological processes may deepen our understanding of the inner triggers underlying consumption, including irrational consumer behaviour such as compulsive behaviour and shopping addictions. For example, a recent fMRI study scanned the brain of compulsive and non-compulsive buyers during purchase decisions and found a significantly higher activation in the striatum of compulsive buyers (Raab et al. 2011). These results indicate that compulsive shopping behaviour could be induced by an excessive stimulation of dopamine-receptive regions of the brain's reward system in a similar way as individuals become addicted to drugs. Further advances in this area may therefore help provide more knowledge on the neural component of such behaviour, which could raise awareness on the inner processes influencing purchase impulses and support new solutions for dealing with addictions.

Discussion and future research challenges

Whilst the most fantasist commercial expectations from neuromarketing are unlikely to be met by today's technology and knowledge, the present paper suggests that it will be more than a passing trend. The application of neuroscientific techniques to marketing indeed provides three important benefits for studying consumer behaviour: 1) the use of unbiased moment-by-moment measures of consumer response and decision-making process with valuable inferences for both advertising and product design; 2) an in-depth analysis of the cognitive and affective triggers of brand choice based on inner psychophysiological processes; 3) the possibility to explore the unconscious component of shopping behaviour and better understand irrational decisions. These benefits are key points of difference brought by consumer neuroscience compared to traditional consumer research. On this basis,

neuroimaging and other psychophysiological techniques deserve their place in the portfolio of methods as a means to grasp the effects of marketing from a new perspective and obtain richer insights on the factors influencing purchase.

Nevertheless, this paper discussed several limitations to the application of neuroscience to marketing. In particular, one should be wary about a too simplistic use of reverse inference in fMRI studies. Cognitive processes indeed rely on complex neural networks within the brain rather than a strict division into separated blocks of mental functions, and the growing evidence from consumer neuroscience indicates that purchase decisions are no exception to the rule. In addition, the application of neuroscience to marketing raises several challenges when it comes to turning physiological data into useful insights for marketing theory and practice. One difficulty is to continue reducing the gap between the fields of neuroscience and consumer research so that the latter can truly benefit from the former. Thus, the contribution of psychophysiological methods will depend on the ability to connect findings with existing models of consumer behaviour and develop more reliable ones based on this new source of data. This will require an increasingly closer integration between neuroscientific and marketing perspectives within the field of consumer neuroscience, which will be supported by further multidisciplinary collaboration in future research.

In doing so, it will equally be important to address the methodological challenges associated with the use of psychophysiological measures in marketing. Numerous factors including participant characteristics and external factors such as environmental disturbances can indeed influence participants' physiological states and produce artefacts in the data. In practice, experimental designs and stimuli are typically of low complexity in order to control the factors influencing psychological and physiological activity at each time of the experiment by limiting them to a few variables of interest. This is paramount for a relationship to be established between a physiological response and a particular psychological state. Furthermore, the adoption of a multi-method approach combining different psychophysiological techniques as well as self-reported measures has been recommended in the literature as a means to enhance reliability through result triangulation (e.g. Wang & Minor 2008).

Conclusion

Consumer neuroscience and neuromarketing are unlikely to become *the* single way of doing consumer science and market research in the future due to the aforementioned limitations and its cost compared to traditional methods. Nevertheless, this paper examined three types of applications in which it may be beneficial and help integrate multiple perspectives for addressing marketing questions in a way that minimises biases. Further research in this direction should therefore support the creation of synergies between disciplines as a fruitful way to generate novel theory and insights at the intersection between marketing, neuroscience and psychology.

Managerial implications

The present paper discussed promising applications in which the 'neuromarketing' approach can be adopted to conduct a more in-depth analysis of consumer response to marketing, with the potential to predict preferences based on objective physiological data. From a marketing management point of view, investing in this type of market research may enable to obtain complementary insights about the way a given brand is perceived by the target market while providing an interesting alternative for advertising and product testing. In this aim, a rigorous application of neuroscientific techniques and knowledge will be required as well as the setting of strict ethical standards in the industry.

References

Ariely, D. & Berns, G. (2010) "Neuromarketing: the hope and hype of neuroimaging in business", Nature Reviews.Neuroscience, 11(4), 284.

Atalay, A.S., Bodur, H.O. & Rasolofoarison, D. (2012) "Shining in the center: central gaze cascade effect on product choice", Journal of Consumer Research, 39(4), 848-866.

Bagozzi, R.P., Gopinath, M. & Nyer, P.U. (1999) "The role of emotions in marketing", Journal of the Academy of Marketing Science, 27(2), 184-206.

Berridge, K.C. (1996) "Food reward: brain substrates of wanting and liking", Neuroscience & Biobehavioral Reviews, 20(1), 1-25.

Chandon, P., Hutchinson, J.W., Bradlow, E.T. & Young, S.H. (2009) "Does in-store marketing work? Effects of the number and position of shelf facings on brand attention and evaluation at the point of purchase", Journal of Marketing, 73(6), 1-17.

Davidson, R.J. (2004) "What does the prefrontal cortex "do" in affect: Perspectives on frontal EEG asymmetry research", Biological psychology, 67(1), 219-234.

Daw, N.D., O'Doherty, J.P., Dayan, P., Seymour, B. & Dolan, R.J. (2006) "Cortical substrates for exploratory decisions in humans", Nature, 441(7095), 876-879.

Day, R.F., Shyi, G.C.W. & Wang, J.C. (2006) "The effect of flash banners on multiattribute decision making: Distractor or source of arousal?", Psychology & Marketing, 23(5), 369-382.

Erk, S., Spitzer, M., Wunderlich, A.P., Galley, L. & Walter, H. (2002) "Cultural objects modulate reward circuitry", Neuroreport, 13(18), 2499-2503.

Harmon-Jones, E. (2003) "Clarifying the emotive functions of asymmetrical frontal cortical activity", Psychophysiology, 40(6), 838-848.

Hutzler, F. (2014) "Reverse inference is not a fallacy per se: Cognitive processes can be inferred from functional imaging data", NeuroImage, 84, 1061-1069.

Just, M.A. & Carpenter, P.A. (1980) "A theory of reading: from eye fixations to comprehension", Psychological Review, 87(4), 329.

Kable, J.W. (2011) "The cognitive neuroscience toolkit for the neuroeconomist: A functional overview", Journal of Neuroscience, Psychology, and Economics, 4(2), 63-84.

Knutson, B. & Bossaerts, P. (2007) "Neural antecedents of financial decisions", The Journal of Neuroscience, 27(31), 8174-8177.

Knutson, B., Adams, C.M., Fong, G.W. & Hommer, D. (2001) "Anticipation of increasing monetary reward selectively recruits nucleus accumbens", Journal of Neuroscience, 21(16), 1-5.

Knutson, B., Rick, S., Wimmer, G.E., Prelec, D. & Loewenstein, G. (2007) "Neural predictors of purchases", Neuron, 53(1), 147-156.

Krugman, D.M. & Fox, R.J. (1994) "Do adolescents attend to warnings in cigarette advertising? An eye-tracking approach", Journal of Advertising Research, 34, 39-52.

Kühn, S. & Gallinat, J. (2013) "Does Taste Matter? How Anticipation of Cola Brands Influences Gustatory Processing in the Brain", PloS one, 8(4).

Lee, J. & Ahn, J.-H. (2012) "Attention to Banner Ads and Their Effectiveness: An Eye-Tracking Approach", International Journal of Electronic Commerce, 17(1), 119-137.

Levy, I., Lazzaro, S.C., Rutledge, R.B. & Glimcher, P.W. (2011) "Choice from non-choice: predicting consumer preferences from blood oxygenation level-dependent signals obtained during passive viewing", The Journal of Neuroscience, 31(1), 118-125.

Maren, S. & Quirk, G.J. (2004) "Neuronal signalling of fear memory", Nature Reviews Neuroscience, 5(11), 844-852.

McClure, S.M., Li, J., Tomlin, D., Cypert, K.S., Montague, L.M. & Montague, P.R. (2004) "Neural correlates of behavioral preference for culturally familiar drinks", Neuron, 44(2), 379-387.

Meißner, M. & Decker, R. (2010) "Eye-tracking information processing in choice-based conjoint analysis", International Journal of Market Research, 52(5), 591.

Ohme, R., Matukin, M. & Pacula-Lesniak, B. (2011) "Biometric measures for interactive advertising research", Journal of Interactive Advertising, 11(2), 60-72.

Ohme, R., Reykowska, D., Wiener, D. & Choromanska, A. (2010) "Application of frontal EEG asymmetry to advertising research", Journal of Economic Psychology, 31(5), 785-793.

Paulus, M.P. & Frank, L.R. (2003) "Ventromedial prefrontal cortex activation is critical for preference judgments", Neuroreport, 14(10), 1311-1315.

Perrachione, T.K. & Perrachione, J.R. (2008) "Brains and brands: Developing mutually informative research in neuroscience and marketing", Journal of Consumer Behaviour, 7(4-5), 303-318.

Pieters, R., Warlop, L. & Wedel, M. (2002) "Breaking through the clutter: Benefits of advertisement originality and familiarity for brand attention and memory", Management Science, 48(6), 765-781.

Poldrack, R.A. (2006) "Can cognitive processes be inferred from neuroimaging data?", Trends in cognitive sciences, 10(2), 59-63.

Raab, G., Elger, C., Neuner, M. & Weber, B. (2011) "A Neurological Study of Compulsive Buying Behaviour", Journal of Consumer Policy, 34(4), 401-413.

Rayner, K. (1998) "Eye movements in reading and information processing: 20 years of research", Psychological bulletin, 124(3), 372-422.

Reimann, M., Zaichkowsky, J., Neuhaus, C., Bender, T. & Weber, B. (2010) "Aesthetic package design: A behavioral, neural, and psychological investigation", Journal of Consumer Psychology, 20(4), 431-441.

Reimann, M., Schilke, O., Weber, B., Neuhaus, C. & Zaichkowsky, J. (2011) "Functional magnetic resonance imaging in consumer research: A review and application", Psychology and Marketing, 28(6), 608-637.

Rossiter, J.R., Silberstein, R.B., Harris, P.G. & Nield, G.E. (2001) "Brain-Imaging Detection of Visuai Scene Encoding in Long-term iVIemory for TV Commercials", Journal of Advertising Research, 41(2), 13-21.

Sanfey, A.G., Rilling, J.K., Aronson, J.A., Nystrom, L.E. & Cohen, J.D. (2003) "The neural basis of economic decision-making in the ultimatum game", Science, 300(5626), 1755-1758.

Senior, C. & Lee, N. (2008) "Editorial: A manifesto for neuromarketing science", Journal of Consumer Behaviour, 7(4-5), 263-271.

Solnais, C., Andreu-Perez, J., Sánchez-Fernández, J. & Andréu-Abela, J. (2013) "The contribution of neuroscience to consumer research: A conceptual framework and empirical review", Journal of Economic Psychology, 36, 68-81.

Su, Y., Rao, L.-L., Li, X., Wang, Y. & Li, S. (2012) "From quality to quantity: The role of common features in consumer preference", Journal of Economic Psychology, 33(6), 1043-1058.

Van der Laan, L.N., De Ridder, D.T.D., Viergever, M.A. & Smeets, P.A.M. (2012) "Appearance matters: neural correlates of food choice and packaging aesthetics", PloS one, 7(7), 1.

Wang, Y.J. & Minor, M.S. (2008) "Validity, reliability, and applicability of psychophysiological techniques in marketing research", Psychology and Marketing, 25(2), 197-232.

Wise, R.A. & Rompré, P.P. (1989) "Brain dopamine and reward", Annual review of psychology, 40(1), 191-225.

Zaltman, G. (2003) "How consumers think: Essential insights into the mind of the market", Harvard Business School Press, Boston, MA.