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NEUROSCIENCE IN CONSUMER MARKETING RESEARCH. AN ANALYSIS DRAWN FROM THE EXAMPLES OF FOOD PRODUCTS

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Abstract. This article aims to contribute to the discussion about the potential for the implementation of consumer neuroscience into marketing research. This article highlights three areas of consumer neuroscience: methods used by consumer neuroscience, the findings and their interpretations and the ethical aspects. The article has a partly descriptive character as the research area of neuroeconomics or consumer neuroscience is new. To illustrate the investigated problems the selected studies, especially connected with food products, were presented as a review of literature.

Key words: consumer neuroscience, marketing research, neuromarketing, neuroeconomics

INTRODUCTION

The birth of neuroeconomics is connected to the technical improvement and broader accessibility to new technology to scan the human body, especially functional magnetic resonance imaging (fMRI), electroencephalography (EEG) and magnetoencephalography (MEG). Although these imaging methods are not new[1], nowadays an advanced imaging technology allows a much more detailed picture of how the body and brain works to be obtained. The development of neuroimaging technology and neuroscience has raised the question of if it is possible to apply neuroscience to study human behaviour in the field of economics and marketing. The question is not entirely new, as

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[1] The first MRI scan of human body was produced in 1977, the first MRI scanner built in 1980 [Kirsh 2014], and the field of electroencephalography was born in the beginning of 20th century [Magiorkinis et al. 2014].

marketing research based on psychophysiological observations of consumer's reactions (pupil dilation, electrodermal response) were conducted in the 1960s [Solnais et al. 2013]. Later, the EEG was employed for marketing purposes in 1970s [Solnais et al. 2013], and the fMRI at the end of the 1990s [Vlăsceanu 2014a]. It is worth mentioning that in the USA, the implementation of MRI scanners, up to field strengths of 4.0 T, was approved for marketing in 1998, and in 2002 the approval included up to 3-T MRI scanners for the skull base, brain, and whole body [Kirsch 2014].

As a consequence of developing imaging technology and its implementation within the analysis of consumer's behaviour, new sub-fields of science have been emerging: neuroeconomics, neuromarketing and consumer neuroscience. The part of literature defines the term of neuroeconomics as the application of neuroscientific methods to analyse and understand economically relevant behaviour [Kenning and Plassmann 2005], with the aim to "[…] to create a theory of economic choice and exchange that is neurally detailed, mathematically accurate, and behaviorally relevant" [Camerer 2008, p. 416]. The term "consumer neuroscience" is often understood as a subfield of neuroeconomics, which focuses on the problems connected with consumer buying-process (e.g. a consumer's preferences), while the term of neuromarketing refers to the practical and commercial application of consumer neuroscience [Solnais et al. 2013]. However, consensus about the definition and terminology has not been reached yet. Some researchers apply the term of consumer neuroscience, while other authors – use the term of neuromarketing to indicate the new neural research area of consumer behaviour. Moreover, much research in neuroeconomics is virtually the same as research in the consumer neuroscience or neuromarketing fields [Lee et al. 2006]. In this article, following other authors, I use the term of consumer neuroscience for further discussion, as – in my opinion – this term adequately describes the main concept: consumer research based on the usage of advanced neuroimaging technology.

THE PROBLEM

This article aims to contribute to the discussion about the potential of implementing consumer neuroscience in marketing research. Neuroeconomics or consumer neuroscience are new and developing fields of study, and therefore research in these fields still raises many questions about the possibilities and constraints. This article focuses on discussing the following questions:

1. Do the methods of consumer neuroscience allow researchers to obtain valuable data for marketing research purposes? What kind of marketing problems can be solved?
2. What are the constraints connected with implementing the methods of consumer neuroscience?
3. How are the findings of consumer neuroscience to be "read" and understood through the perspective of marketing?
4. Is consumer neuroscience unethical?

As this article tries to convey the broader "picture" of consumer neuroscience, the further discussion highlights the most pressing issues, but is not focused on details.

DO THE METHODS OF CONSUMER NEUROSCIENCE ALLOW RESEARCHERS TO OBTAIN VALUABLE DATA?

Considering the main purpose of marketing research and the way in which data is obtained, marketing research can be divided into quantitative and qualitative marketing research, and interview-based research and observation-based research. Which is better: observations or the interviewing of respondents? It seems that nowadays obtaining valuable data from interviewing a large sample of the respondents faces increasing obstacles and challenges, e.g. the consumers are "tired" of the growing number of requests to take part in surveys, and the consumers often falsify answers for questionnaires. Therefore, if we agree that traditional ways of interviewing customers do not lead to "perfect" data allowing companies to get valuable look inside consumer behaviour, the alternative methods of marketing research are based on gathering data from observations. So far, methods based on observations of physiological response to marketing stimuli have received very little attention. In traditional textbooks of marketing research these methods have been presented as "peripheral" compared to traditional interviews or even other methods based on observations (e.g. observations of customers' or a salesperson's behaviour at the shop).

Nowadays, consumer neuroscience is mostly based on the following methods to obtain data: electroencepahlography (EEG), magnetoencephalography (MEG), functional magnetic resonance imaging (fMRI), eye-tracking and other physiological observations such as skin response, heart rate, pupil dilation. Some of the literature also indicates positron emission tomography (PET) to be among the methods of neuroeconomics or neuromarketing. However, the application of PET for healthy participants is limited, as in the PET radioactive traces are used [Kenning and Plassmann 2005]. To my knowledge, there has not been any research within neuroeconomic or consumer neuroscience based on the PET in Poland. Table 1 presents a short description of neuroimaging methods usually used for consumer neuroscience.

Table 1. The description of methods used in consumer neuroscience

Electroencephalography (EEG)	The EEG measures the brain activity as the detection of the electric changes on the scalp, and the electrodes are attached to the respondent's head. The EEG allows to receive the high temporal resolution of milliseconds of brain activity, but the spatial resolution is low [Kenning and Plassmann 2005]. In consumer neuroscience the EEG is used as a stand-alone method or the EEG is used in conjunction with other tools such as eye-tracking
Magnetoencephalography (MEG)	The MEG detects changes of magnetic fields of brain activity
Functional magnetic resonance imaging (fMRI)	fMRI works on the basis of tracking the blood flow in the brain, and these "tracking" is possible due to changes in magnetic properties of blood oxygenation, so called blood oxygenation level dependent (BOLD) – signal [Camerer et al. 2005]

Source: Author's elaboration.

The implementation of methods of consumer neuroscience enables the gathering of data based on observation, and is therefore "more objective" than data from traditional interview-based surveys. Assume that we design a study aiming to select the layout of an advertisement. In "traditional" studies, we often compare results coming from the control group and the test group of respondents (e.g. the test group and control group are exposed to different layouts of the advertisement). This experiment raises (at least) questions about the form of the questionnaire which is used to gather respondents' opinion about an advertised products and advertisement, or the problem of the "similarity" between respondents in both groups (e.g. age and gender differences, initial attitude to the advertised product). While we use methods allowing researchers to measure how the consumer's brain works while the participants are exposed to marketing stimuli[2], we need a completely new approach to the study. First, the questionnaire is not irrelevant, but it plays a different role in the study. The questionnaire which is used for gathering information should be linked to the data obtained by observations due to e.g. fMRI scan, and from a particular respondent two kinds of data is gathered: the "more objective data" from neuroimaging, and also the data based on the interview. The other problems and constraints (e.g. age differences) between participants are still valid for the study. For example, if we find a common pattern of brain activity for example in 12 participants, we still do not know that this result would not be different if participants were of different ages.

The next aspect of the implementation of the consumer neuroscience is connected with the scope of marketing problems which can be solved. So far, the spectrum of marketing problems which have been investigated within the studies based on neuroscientific methods is quite narrow. Neuroscientific data does not allow researchers to solve all varieties of differently formulated problems which are within the scope of "traditional" marketing research[3]. Table 2 presents examples from literature: the problems which were investigated, and methods which were used as tools to obtain the data.

It is also worth highlighting that methods used in consumer neuroscience are often conducted within an environment which does not resemble the natural shopping or consumers' experience. Apart from mobile eye-tracking and the EEG, the neuroscientific research has to be conducted exclusively in a laboratory. This means that there are also limited forms of marketing stimuli which can be used. For the studies based on fMRI marketing stimuli can be visual (e.g. advertisements), it can be heard by participants (aural), or the participant can drink a sample liquid. However, within the closed space of fMRI the participant cannot move freely.

[2] Although it is worth emphasizing that this sentence it is not entirely true. For example the fMRI does not directly measure the neural activity, but the measurement is indirect – due to the changes of blood flow [Rachul and Zarzeczny 2012]. Other concerns connected with the problems of interpretation of findings are further presented in the article.

[3] The problems of marketing research varied from very general to very specific e.g. How to introduce new product to new market?, What is the percentage of customers who buy the brand A at least three times per week?, or What colour of the package does enhance the brand perception as ecological?

Table 2. The marketing problems and the methods used in selected studies

Author/Authors	Method	The problem investigated
Jones et al. [2012]	EEG	How high math anxiety and low-math anxiety consumers made the buying decisions for product with or without price discount
Ma et al. [2008]	EEG	The suitability of extending the brand of products
Vecchiato et al. [2011]	EEG	To analyse the changes in the EEG frontal activity during the observation of commercial video clips, and the researchers were focused on investigation the EEG frontal asymmetries in the distribution of the signals' power spectra related to experienced pleasantness of the video
Khushaba et al. [2013]	EEG and eye-tracking	To capture the process of choosing the most preferable form of product by respondents
Kenning and Plassmann [2005]		Overview of studies in literature which indicates that: – the implementation of MEG for the neural correlates of product choices – fMRI were used for investigating e.g. problems of neural responses to expectancy and experience of monetary gains and losses, neural correlates of cooperative behaviour, neural correlates of social rewards, neural correlates of decision-making processes during the ultimatum game
Solnais et al. [2013]		Overview of studies in literature which indicates: – the implementation of MEG for brands as a marketing stimuli – fMRI implementation for advertising, brands, price, products, packaging as a marketing stimuli

Source: Author's elaboration.

THE FINDINGS – HOW TO UNDERSTAND AND BELIEVE THE DATA?

To discuss the "features" of findings for consumer neuroscience I selected a few studies connected with food products. The publications about consumer neuroscience with reference to food product (brand, advertising, form of food product etc.) are still rarely presented in the literature, but publications can be found within three domains: research directly connected with the food industry, "general" neuroeconomics and medicine.

1. In literature we can find publications which directly emphasize the investigation of food products. For example, Lusk et al. [2015], in the article published in the Food Quality and Preference, investigated how consumers made choices between two milk options which varied in price and/or use of technology: growth hormones and cloning. First, the researchers found that both deliberative and effective processes are involved when deciding whether to choose a higher-price, more natural food (see details in Table 3). Second, researchers pointed out that the model which gives the best prediction to consumer's choices is based on all types of data: demographics, psychometric scales, product attributes, and neural data obtained by fMRI.

2. Within this scope of publications of neuroeconomics there are articles which give a useful inside look at "food-related" research, as the researchers quite often choose food products for their studies[4]. Examples of studies can be found among the papers including a presentation of one particular study [Khushaba et al. 2013 – Table 2; or the research of Thomas et al. 2013], and also within articles reviewing the scope of different studies [Solnais et al. 2013].
3. The third domain in which we can find results useful for the consumer neuroscience is medical literature referring to problems connected with eating habits. As the researchers used the different stimuli connected with food, these studies are equally important for a much broader food sector. There are the following examples of such studies: Stoeckel et al. [2008], Murdaugh et al. [2012], Bruce et al. [2013] – Table 2.

Table 3. The findings of neuroscientific research – the examples connected with food products

Author/Authors	Results (cited from the abstract)
Lusk et al. [2015]	"Functional magnetic resonance imaging (fMRI) data were obtained while consumers (n = 47) made choices between two milk options which varied in price and/or use of technology (growth hormones and cloning). Results revealed both deliberative and affective processes were involved when deciding whether to choose a higher-price, more 'natural' food. Brain activations in the dorsolateral prefrontal cortex and insula predicted the choice of higher-priced but more 'natural' foods produced without the use of controversial technology. Brain activations in price-alone or technology-alone decisions predicted behavior in choice tasks involving price-technology tradeoffs, revealing cross-task predictive power." (p. 209)
Khushaba et al. [2013]	"Subjects were shown 57 choice sets; each choice set described three choice options (crackers). The patterns of cortical activity were obtained in the five principal frequency bands, Delta (0–4 Hz), Theta (3–7 Hz), Alpha (8–12 Hz), Beta (13–30 Hz), and Gamma (30–40 Hz). There was a clear phase synchronization between the left and right frontal and occipital regions indicating interhemispheric communications during the chosen task for the 18 participants. Results also indicated that there was a clear and significant change ($p < 0.01$) in the EEG power spectral activities taking a place mainly in the frontal (delta, alpha and beta across F3, F4, FC5 and FC6), temporal (alpha, beta, gamma across T7), and occipital (theta, alpha, and beta across O1) regions when participants indicated their preferences for their preferred crackers. Additionally, our mutual information analysis indicated that the various cracker flavors and toppings of the crackers were more important factors affecting the buying decision than the shapes of the crackers" (p. 3803)
Bruce et al. [2013]	"Compared with the healthy weight children, obese children showed significantly less brain activation to food logos in the bilateral middle/inferior prefrontal cortex, an area involved in cognitive control" (p. 759)

Source: Author's elaboration.

[4] Although the titles of the publications do not often emphasize the product which is used as a stimuli.

So far, the explanation of findings within consumer neuroscience lies in an explanation for a particular case. There are still too few studies in the field of consumer neuroscience, therefore it would be premature to say that consumer neuroscience brings new foundations to new marketing paradigm. As Hubert [2010] pointed out the constraints of neuroeconomics lay in uncertain reliability and validity of findings due to lack of replication of existing studies, small samples of participants of the studies, limitation of experimental settings, and therefore the possibilities to derive practical or ethical-normative recommendations beyond individual case are limited. Also Levallois et al. [2012] indicate that the translation of results based on neuroimaging data to complex social sciences constructs and theories is difficult. Rachul and Zarzeczny [2012] points out to "general" rise of neuroskepticism, which brings the concerns e.g. about the methods of analysing results, the possible over-interpretations of results, presentation of the findings in a premature or biased way, concerns about the technology and methodology problems, inappropriate applications and concerns about privacy.

In my opinion, the indicated constraints support the argument that the term "neuromarketing" does not accurately depict its meaning and the main concept. The terms describing the marketing paradigms – such as relationship marketing, the experience marketing, or the transactional marketing – clearly indicate the base of marketing strategy and the marketing tools which organizations can use in order to survive and grow e.g. relationship marketing emphasizes the role of the relations with different entities, especially with customers, and due to the quality of these relations the company receives the customer's loyalty, recommendations and customer's support. So far, the application of neuroscientific methods to understand the consumer decision-making process does not lead to results which allow the building of a new marketing theoretical and practical framework, although neuroscience helps to understand some important constructs e.g. the construct of trust[5] (which plays crucial role e.g. in relationship marketing).

The understanding and the proper interpretations of the findings depend on overcoming the barriers of communication, collaboration and understanding between different sciences: neurology, economy, marketing, mathematics. Even the three examples of results presented in Table 3 clearly indicate that the findings of consumer neuroscience are difficult to present and understand from the perspective of traditional economics or marketing, as they are based on medical knowledge and language. Moreover the interpretations of the neurosignals captured in different methods need to be analysed on the basis of advanced mathematics. The barriers of communication between different fields of science lie not only in the area of language, but also in the area of 'different questions, different abstractions' used by economics, marketing and neuroscience (see interesting discussion in Aydinonat [2010]). So far, the frameworks of understanding the problems which are used by the traditional marketing and consumer neuroscience are so different, that the translation of results and cooperation between these two fields is difficult.

[5] For instance, trust is discussed in the following articles: Kenning and Plassmann [2005], Lee et al. [2007], Javor et al. [2013].

ETHICAL ASPECTS OF CONSUMER NEUROSCIENCE

The last, but not least important aspect of consumer neuroscience is the ethics. The problem about the ethical aspect of consumer neuroscience needs to be carefully investigated. Ethical aspects are considered on two sub-fields: ethical aspects connected with designing the studies and the ethical issues connected with the ethical, social and legal impact of neuroscientific research on existing social and legal structures [Vlăsceanu 2014b]. As detailed discussion about neuroethics, and ethical aspects of consumer neuroscience is beyond the scope of this article, I would like to highlight two selected issues. First, it is obvious that the methods of consumer neuroscience cannot harm participants in any way. However, theoretically we can foresee the situation where a particular participant takes part in a series of studies based on fMRI. Although fMRI is considered safe for usage for a healthy person, we must remember that magnetic field inside the MRI is extremely strong, and if the participant goes through an fMRI scan – let's say once a month – it is difficult to say how the research may influence the participant's health.

Another ethical concern is about unethical attempts to press "the buy-button" in the consumer's mind. However, an understanding on the neural level of how a consumer's brain works does not mean that the companies will be able to "manage and influence the consumer's brain", e.g. discovering that a particular advertisement triggers the activity of a particular part of brain does not imply that the consumer may be "forced" to buy a product. It seems that the usage the term of "neuromarketing" instead of "consumer neuroscience", increases the possibility that neuroscientific methods would be viewed by the public through the perspective of the search for 'neurotools' which allow companies to press the "buy-button" in consumer's brain.

CONCLUSIONS

The field of consumer neuroscience is still in the very early stages of development, but we may presume that the impact of neuroscientific research on understanding consumer's behaviour will steadily grow. For successful implementation of consumer neuroscience we need to gradually accumulate the knowledge, which allows the construction of the research framework to integrate different fields of study. Therefore marketing research should, in a more detailed way, address such problems as: the identification of the scope of marketing problems which can be solved using a neuroscientific approach, the problem of designing the methodology of study, the problem of introducing detailed ethical standards of research, and at last – but highly important – identifying and overcoming the barriers of collaboration between researchers from different fields of science.

The following arguments summarize the discussion presented in this article:

1. The implementation of the methods of consumer neuroscience allows researchers to receive data based on observation, therefore - from perspective based on one respondent - 'more objective' than data from traditional interview-based surveys.
2. So far, the explanation of findings within consumer neuroscience mostly lies in an explanation for a particular case, and the generalization of findings to the larger population is very limited.

3. So far, the spectrum of marketing problems which have been investigated within the studies based on neuroscientific methods is quite narrow.
4. Consumer neuroscientific studies are often conducted within an environment which does not resemble the natural shopping or consumer's experience.
5. The form of marketing stimuli which can be used for some methods such as fMRI is limited.
6. Consumer neuroscientific studies may raise questions about their validity.
7. The understanding and the proper interpretations of the findings of consumer neuroscience depend on overcoming the barriers of communication, collaboration and understanding between different sciences: neurology, economy, marketing, mathematics.
8. The ethical aspect of consumer neuroscience is "multi-layered", and should be addressed carefully.

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NEUROOBRAZOWANIE W BADANIACH MARKETINGOWYCH KONSUMENTÓW. ANALIZA NA PRZYKŁADZIE PRODUKTÓW ŻYWNOŚCIOWYCH

Streszczenie. Celem prowadzonych w artykule rozważań jest wzbogacenie dyskusji dotyczącej możliwości zastosowania metod neuroobrazowania w badaniach marketingowych. Prowadzone rozważania szczególnie akcentują trzy obszary: metody badawcze, wyniki badań i możliwości ich interpretacji oraz aspekt etyczny. Ze względu na początkową fazę rozwoju neuroekonomii oraz badań marketingowych na podstawie neuroobrazowania artykuł częściowo ma opisowy charakter. W celu zobrazowania prowadzonej dyskusji w artykule zaprezentowano wybrane studia badawcze, szczególnie te powiązane z produktami żywnościowymi.

Słowa kluczowe: badania konsumentów na podstawie neuroobrazowania, badania marketingowe, neuromarketing, neuroekonomia

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