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## CONTEMPORARY DATA EXPLORATION TECHNOLOGIES IN MARKETING

### Summary

The development of research in the area of neuromarketing and functioning of the human brain lets better get to know consumer behavior. The knowledge about the buyer become more accurate, if is developed as a result of an interdisciplinary look at determinants of their activities. The article presents the possible applications of biometric examinations, such as: Functional Magnetic Resonance Imaging (fMRI), Electroencephalography (EEG), Electromyography (EMG), Eye Tracking, in marketing in order to better understand consumer behavior.

**Keywords:** neuromarketing, biometrics, consumer behavior

### Introduction

Zaltman (2008) writes in his book that “the world has changed but the methods which serve understanding consumers have not”. People working in marketing still rely on the known but ineffective research techniques and stubbornly misread consumers thoughts and actions (Wierzchoń, Orzechowski 2010). There arises a question: what methods should be used to get to know customers needs and behavior and to build effective marketing?

### 1. The use of biometric research in marketing – neuromarketing

The term „neuromarketing” was used for the first time by Ale Smidts, professor in Rotterdam Management School during the inaugural lecture in 2002

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(Mruk, Sznajder 2008; Wierchoń, Orzechowski 2010; Renvoise, Morin 2011). The essence of marketing as a discipline is researching processes occurring in trading, which means adjusting company's offer to the defined consumers needs as well as needs that they were made conscious of (Mruk, Sznajder 2008). Within the evolution of marketing conception there are conducted researches on how human brain works. They allow better understanding and more detailed getting to know the client, and as a result – proper preparation of products and service offer.

In the globalization and growing competition era, a company can strengthen its position on the market if it is focused on creating customer value. The more the client is bound with the company in the long perspective the higher the company's value will be. Knowing the rules of neuromarketing can be useful in customer value management. Using neurobiological knowledge in marketing context contributes to better understanding of such processes as emotions, memory or decision making. Undoubtedly they are key concepts for advertising and consumer behavior. The consequence of such technological innovations in research on the mind is “cognitive revolution” (Mruk, Sznajder 2008).

In the second half of 1990s the world of business became interested in “cognitive revolution”. As a result there arose a new discipline which studied how the mind works in contact with advertising stimulation – neuromarketing. In the neuromarketing approach it is possible to objectively measure people's reaction to the given advertisement or product by studying processes taking place in their brains.

Neuromarketing can show how consumers react to the studied product and the marketing communication accompanying it. It allows defining what is more important for them – the packaging color its shape, and in advertising – the music or the image.

### **1.1. Electroencefalography (EEG)**

Among the research methods of neurophysiology, electroencephalogram (EEG) stands out as having the longest history of use, the lowest cost, being totally non-invasive and having the highest time definition. The EEG device registers electric activity of cortex. The first such examination was conducted in 1924 by Hans Berger (Jaśkowski 2009; Preuss 2010).

The main generators of EEG recording are postsynaptic potentials. The potential moves along axon towards a synaptic gap ending where neurotrans-

mitter is released. To see the EEG signal on the screen it is necessary to amplify it 1,000,000 times (Figure 1).

EEG signal amplitude changes in the range from 0  $\mu\text{V}$  to 100  $\mu\text{V}$ , however, generally seldom is higher than 20  $\mu\text{V}$ . They are voltages about three orders of magnitude smaller than standard voltmeter sensitivity. The measurement of electrical brain activity is often accompanied by a large amount of noise very often having amplitude several times higher than the EEG recording itself. The source of this noise is the environment surrounding human being (e.g. various electrical appliances, cables laid inside walls) as well as the human himself (e.g. signals controlling heart or muscles work).

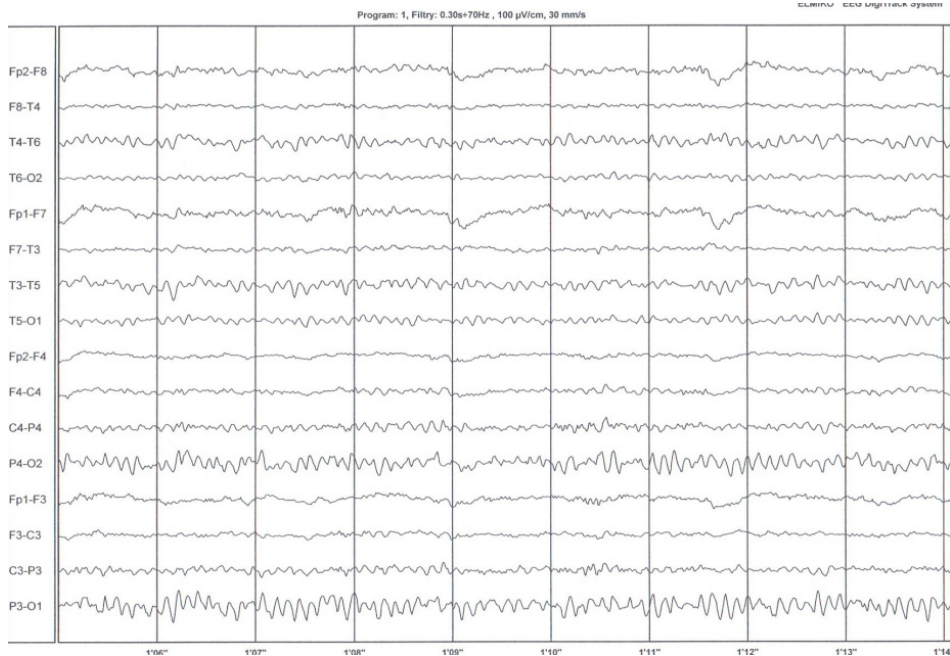


Figure 1. Exemplary brainwaves recording

Source: personal photograph by author.

The brain activity changes under the influence of stimuli reaching it and activities performed by human. Because of this reason also the arrangement of electrical potential on the surface of the head changes in time. Brain electrical activity also changes in space. Within the brain there can be distinguished areas

responsible for particular functions. For example, processing visual stimuli takes place in occipital lobe, whereas, it is acclaimed that frontal lobe is responsible for abstract thinking and functions connected with memory.

Due to this reason during the EEG examination there should be used the possible highest number of electrodes. In the scientific research the number of electrodes ranges from several to 256. Most frequently for the EEG examination there are used appropriate caps (Figures 2 and 3).

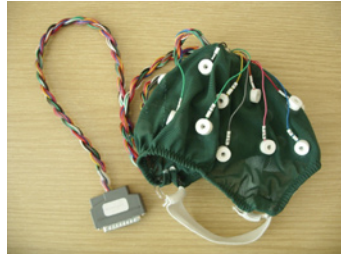


Figure 2. Automatic EEG cap made by ELMIKO – 20 tin electrodes build in outside  
Source: personal photograph by author.

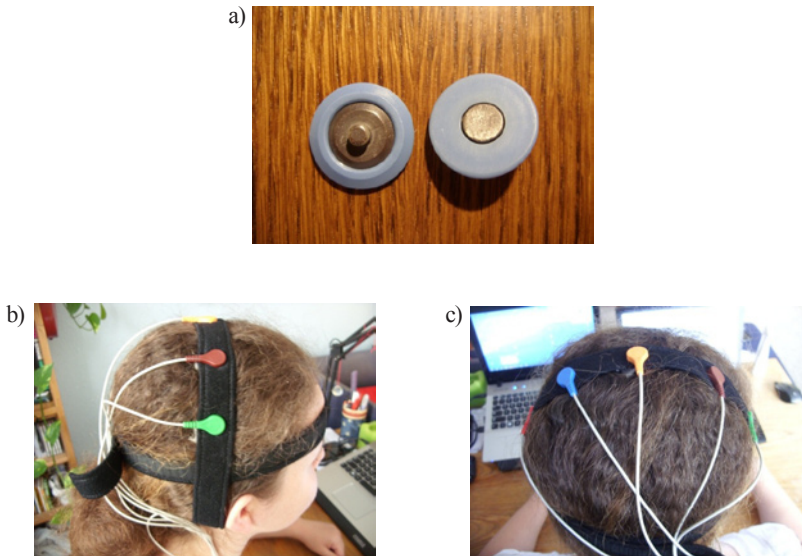


Figure 3. a) disposable electrodes EEG, b) and c) the way of connecting disposable EEG electrodes on the head using two belts  
Source: personal photograph by author.

One of the most popular EEG signal analysis techniques is frequency analysis, thanks to which there are separated particular bands (rhythms, oscillations) from the EEG signal. The most frequently analysed band in marketing research is so called alpha band, having oscillations between 8–12Hz (which means from 8 to 12 cycles per second). The researches so far indicate the reverse dependence between waves amplitude in this band and the attention intensity. It means the smaller the alpha waves amplitude, the more intense the attention of the examined person. Other frequently examined band in the EEG is theta band, having oscillations between 4–7 Hz. This band is connected with the processes of memorising. Numerous researches showed a significant amplitude increase in this band during tasks connected with memorizing. Such analysis of EEG signal is often used for examining commercials (Mruk, Sznajder 2008; Jaśkowski 2009; Preuss 2010; Zurawicki 2010; Pradeep 2011; Weinschenk 2011).

Another EEG signal analysis method, also used in neuromarketing research, is Event Related Potential (Jaśkowski 2009). It is a method whose aim is to capture specific brain activity connected with processing a particular stimulus e.g. product packaging. In ERP technique the presentation of the given stimulus is repeated many times. Subsequently, the EEG signal courses are averaged, assuming that the signal caused by processes connected with particular stimulus processing will

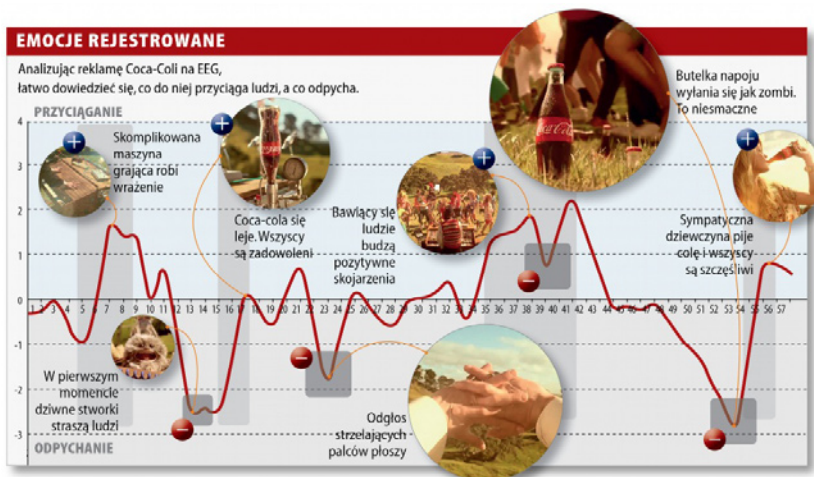


Figure 4. The recording of emotional reaction to the viewed Coca-Cola commercial

Source: [www.forbes.pl/artykuly/sekcje/strategie/zagladajac-pod-kopule,25542,3](http://www.forbes.pl/artykuly/sekcje/strategie/zagladajac-pod-kopule,25542,3) [accessed on 20.12.2012].

become averaged, whereas, all the other processes will be deleted in the process of averaging.

Currently based on brainwaves analysis it is possible to (Mruk, Sznajder 2008; Wierchoń, Orzechowski 2010):

- describe the whole advertisement with split second precision (Figure 4),
- show scenes which generate the strongest emotional involvement,
- describe reactions to the image, sound, said words or used special effects,
- recommend the best version of soundtrack, which strengthens the message included in the image most effectively,
- choose the best way of logo and packaging display,
- define, if the opening scene has got potential of standing out the advertisement from the block of commercials,
- decide, which version of ending will best stimulate pro-purchase action.

### 1.1. Studying galvanic skin response (GSR)

Galvanic skin response (GSR), also known as electrodermal response (EDR), psychogalvanic reflex (PGR), skin conductance response (SCR) or skin conductance level (SCL), is a measurement of the skin electric resistance changes depending on its moisture level caused by the changes of the sweat glands activity controlled by the sympathetic nervous system. These changes are treated as symptoms of experiencing emotions or spontaneous reaction to stimulus.

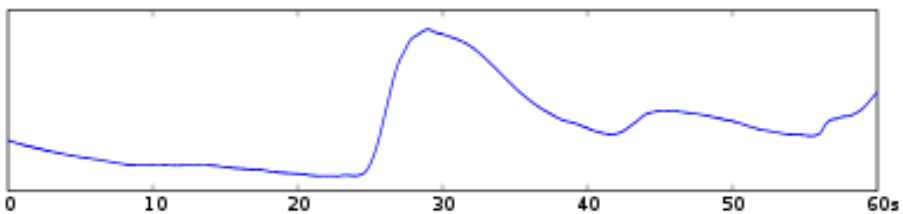


Figure 5. Exemplary GSR recording in 60 seconds time.

Source: [http://wikipedia.wp.pl/wiki/Reakcja\\_sk%C3%B3no-galwaniczna?ticaid=1f555](http://wikipedia.wp.pl/wiki/Reakcja_sk%C3%B3no-galwaniczna?ticaid=1f555) [accessed on 20.12.2012].

Some very interesting observations appear when the EEG measurements are accompanied with galvanic skin responses analysis. They are evidence of the

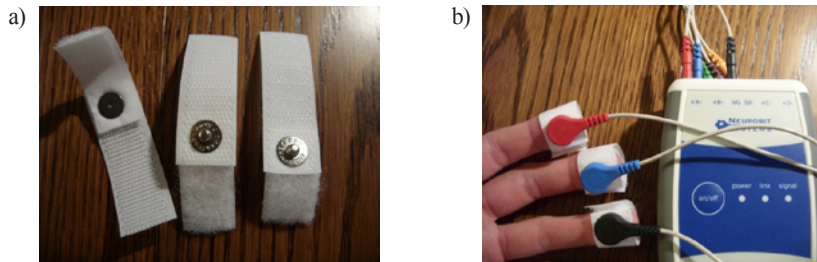


Figure 6. a) reusable GSR electrodes b) the way of connecting electrodes during GSR examination

Source: personal photograph by author.

organism stimulation. The example can be so called goose bumps as a reaction to stress or fright. Putting together GSR and EEG results it is possible to learn, for example, if skin response to the given stimulus is positive or negative.

## 1.2. Electromyography (EMG)

Electromyographic research is based on registering muscles electrical activity. This activity is connected with the ability of sodium and potassium ions to permeate the cell membrane. As a result of nonuniform sodium and potassium ions arrangement within the muscle cell there occurs polarisation of cell interior electric charge in relation to the cell membrane.

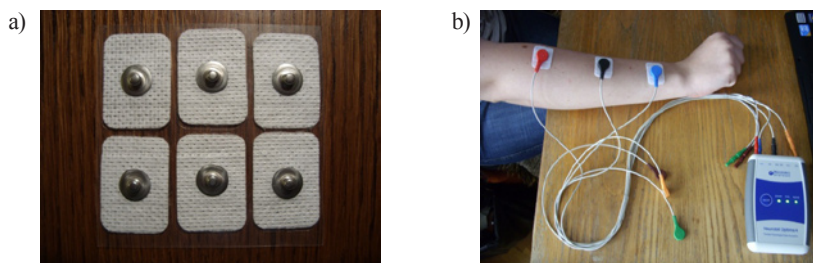


Figure 7. a) disposable EMG electrodes, b) exemplary way of connecting electrodes for EMG examination

Source: personal photograph by author.

Polarisation potential – amounting to approximately 80 mV at rest – changes depending on the muscle activity. Using electromyographs with needle electrodes the variable electrical biosignals from muscles at rest and during effort are registered. In marketing research EMG is used to examine emotional reactions.

The findings on the emotions experienced in a particular moment are based on three basic facial muscles activity: zygomaticus major, orbicularis oculi and corrugator supercilii (the “frowning” muscle). It is so called facial muscles micro-expression analysis. However, similarly as in the GSR research, while examining consumer emotional reaction to the watched commercial or brand it is necessary to analyse EMG recording together with brain EEG.

### 1.3. Functional Magnetic Resonance Imaging (fMRI)

Applying fMRI in marketing is connected with a discovery made by Seiji Ogawa in the early 1990s. He stated that hemoglobin with bound oxygen (oxyhemoglobin) has got different magnetic features than its form without bound oxygen. Due to that the picture of brain blood vessels in magnetic resonance image changes depending on the amount of oxyhemoglobin and deoxygenated

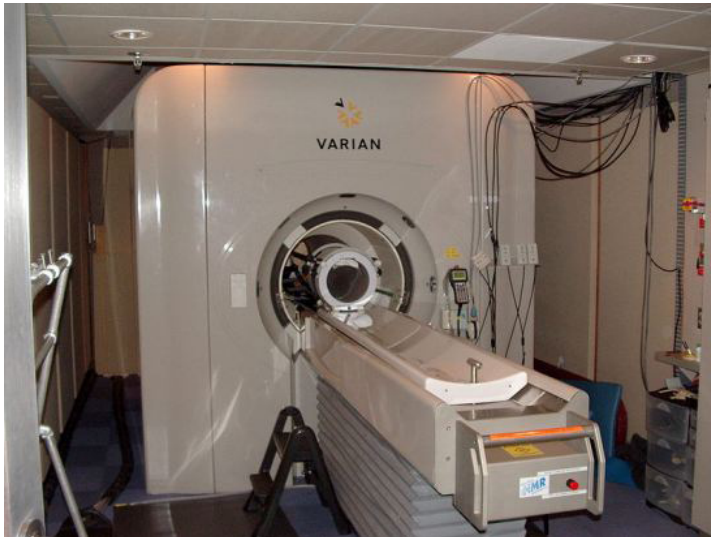


Figure 8. Functional Magnetic Resonance Imaging (fMRI)

Source: [http://pl.wikipedia.org/wiki/Funkcjonalny\\_magnetyczny\\_rezonans\\_j%C4%85drowy](http://pl.wikipedia.org/wiki/Funkcjonalny_magnetyczny_rezonans_j%C4%85drowy) [accessed on 20.12.2012].



hemoglobin, i.e. on how oxygenated the blood is. fMRI does not measure brain functions directly but it is based on an assumption that measuring the pace and capacity of blood flow we can presume the level of neural tissue activity. In case of fMRI the active neurons use more oxygen taken from capillaries and as a result the brain sends more oxygen to these areas. The change of blood supply and higher concentration of oxygenated blood resulting from it follows with about five seconds delay in relation to the neurons' activity increase. It is so called hemodynamic response.

Using fMRI in marketing research it is possible to observe the mentioned above hemodynamic response change of particular brain areas in reaction to the used stimulation, for example to the watched or listened commercial. Unfortunately, during the whole examination the tested person can move their head not more than few millimeters, so the head immobilization is required. Another inconvenience of fMRI scanner is huge noise. Despite all these inconveniences it is currently the most precise technique which allows measuring brain activity in a non-invasive way.

As an example of fMRI application in marketing context can serve the research known as "Pepsi Challenge in a scanner" (Zaltman 2008). In the 1980s PepsiCo concern conducted research in which people in the street where offered two drink samples (Pepsi and Cola) and they were asked to tell which tastes them more.

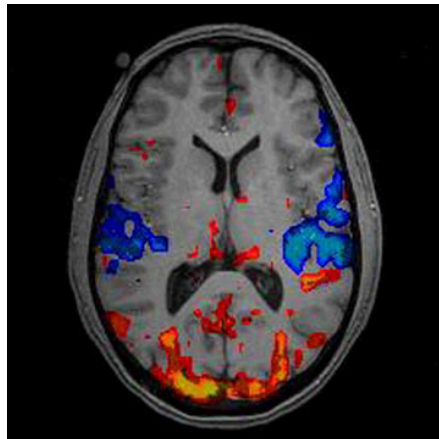


Figure 9. Brain activity seen using fMRI

Source: <http://scientopia.org/blogs/scicurious/2010/06/16/what-does-that-mri-signal-mean-anyway> [accessed on 20.12.2012].

It turned out that over 50% of people chose Pepsi (often those who have been so far convinced that they prefer Cola). Professor Read Montague decided to check how it is possible that most people choose Coca-Cola, although Pepsi tastes better, conducting an experiment using fMRI. In the experiment conducted by Professor Montague the participants were given Cola and Pepsi after having been asked which drink they prefer. Subsequently they had a taste test in which they were given a drink anonymously and the participant's task was to decide if the sample tastes them or not. It turned out that when there was lack of information about the product's brand the primary preferences disappeared and the examined persons classified approximately by 50% into both groups "liking" particular drinks.

#### **1.4. Eye tracking (oculography)**

The eye tracking is a technique that turned out to be particularly useful in consumer behavior research. Thanks to eye tracking web designers have got a possibility to see how consumers see and read websites created by them (Weinschenk 2011). They can check which way goes the potential customers sight to realise the intended tasks, in which parts the websites they get stuck, how they react to the advertisement (if they look at it at all), if the menu navigation for people visiting the website for the first time is clear, how the readers react to the text and image content as well as to films and clips in flash technology content (Figure 10).

Eye tracking devices, using the advanced video technology and infrared light record the eye movement. There are also available on the market mobile devices for example Eye Trackers worn on the head, using the same technology as the stationary devices. Considering the fact that looking and cognitive processes connected with it take place almost always and everywhere, eye tracking research is not used exclusively for studying application and WWW services usefulness. Contemporary Eye Trackers become more and more common in researching many fields, ranging from moving around real shop and watching shelves, perceiving urban space, watching outdoor advertisements and TV commercials to driving a car or even sport games.

Human perception analysis provides us with information for studying not only where the sight is directed but it is also a basis for research on the way of solving problems, reasoning, attention or mental images. Eye tracking allows getting to know many cognitive and behavioral aspects of human being, and because of that the range of its use becomes wider.



Figure 10. The paths of scanning the website using eyes. The circles depict fixations – the higher the circle diameter the longer the fixation. The lines between circles show the direction of scanning (saccadic eye movement)

Source: <http://interaktywnie.com/biznes/artykuly/usability/tajniki-eyetrackingu> [accessed on 20.12.2012].

The main measurements in eye tracking research are fixations, i.e. focusing sight on a given element and saccades which are rapid eye movements occurring between subsequent fixations. It must be remembered that eye tracking research do not provide unambiguous answer to the question if the reader understands the read content. We only obtain data about how the content is processed but these data can be differently interpreted.

The eye tracking future is not only the Internet researching but above all other visual media such as television, games, virtual environments and the urban space. Not only the research field will widen but also knowledge on psychological bases of looking, attention and memorising. This progress will be influenced by technological progress and the more exact measures made with the aid of less and less invasive equipment. On the Polish market the analyses of such fields as urban space or TV using mobile devices are still rare.

The current eyetracking research results can provide answers to the following questions:

- Which elements of the website draw the examined people's attention and after what time?

- Which element focuses the attention the longest?
- What keeps our interest on the satisfying level?
- To which elements the person returns?
- What is the model and direction of space scanning sequence like?
- Are the participants disoriented or interested?

It must be remembered that conscious information processing required for the analysis of the read text occurs in time 50–120 ms per word (depending on its length) from the beginning of fixation. For images it is 45–75 ms per the element of the studied scene.

## **2. Neuromarketing versus classical marketing – comparative analysis**

Both classical marketing and neuromarketing have the same main aim. It is influencing consumer in such way that he would make the demanded purchase. However, classical marketing puts emphasis on rationality while neuromarketing on emotions (Mruk, Sznajder 2008). Classical marketing assumes that human being is an economic and rational being and that his choices are results of rational and economical premises. Neuromarketing, not excluding rationality, assumes that important factors influencing the consumer are his own subconsciously conditioned emotions. Neuromarketing deals with human decision making process theory resulting from subconscious and generally unexplained mechanisms taking place in human brain. Neuromarketing virtually does not focus on the rational shaping of the product image or its advertising but on the human brain – on studying it and stimulating its functions in order to obtain the demanded reaction.

Classical marketing uses traditional methods of getting to the customer e.g. surveying. Whereas neuromarketing uses equipment and research methods used in medicine, physics, psychology, e.g. functional magnetic resonance imaging, electroencephalography etc. Additionally, biometric research differs from the classical interview or survey because it can take place without words. Respondents watch TV commercial and the brain activity is registered by fMRI scanner or electroencephalograph (EEG). Examining respondents using biometric devices it becomes possible to objectively measure people's reaction to the given advertisement or product. In reality, the data obtained from biometric devices should be a complement of the data gained through the declarative way.

## **Conclusions**

In the market and competitive economy most decisions are taken in the situation of uncertainty in which it is difficult to predict future incidents without possessing additional information. The risk degree of reaching goals depends on possessing appropriate information (data). The role (usefulness) of marketing research increases in proportion to the company's activity uncertainty increase. This uncertainty gets higher when:

- the competition appears and strengthens,
- the export markets are widened and deepened,
- the seller's markets transforms into the buyer's market,
- the government's economical policy changes,
- the consumer needs and demands change.

Marketing research do not eliminate risk totally, however, proper use of the research reduces the risk considerably and causes that the taken decisions will be less burdened with mistakes and intuitive assessments.

The ability to use information influences the rightness of the taken decisions. This ability consists of understanding and distinguishing types of information and ways of its arising and using in different stages of decision making process. This process is the same in different fields of human activity. Everyone who takes a decision goes through the subsequent stages of decision making process. They are: defining the aim, choosing the best alternative, taking and realizing the decision and control of decision taking results. Realisation of each of the mentioned stages requires certain information which marketing research can provide to the entrepreneur.

Marketing research have at least three functions: it means they are used to define marketing problems and general ideas for solving them, they allow formulating and assessing alternative conceptions of company's progress marketing strategies and allow comparing company's activity results with the aims and explaining occurring anomalies. Marketing research is used mainly in planning marketing actions concerning products, advertising, solving problems concerning for example causes of sudden fall of sales and market share as well as in watching changes on the market. The aims of marketing research are:

- finding and assessment of market opportunities,
- improving and assessment of marketing elements: product, price, promotion, place.

- assessment of product/brand position on the market,
- the analysis of purchase and consumption processes, including for example purchase/consumption reasons, ways of making decision,
- consumers segmentation.

Firms which include biometric research into their marketing practice have an opportunity to build a more effective and durable relation with consumers and at the same time they can do it in a cheaper way. Neuromarketing is used not only in analysing advertisements effectiveness, but also in other fields – e.g. coaching. With its use it is possible to check if the session with a coach bring effects and also to individualise the training considering a particular person. Biometric is also used in creating packaging or arranging shop displays and decor because it allows depicting the elements that are appealing and interesting and which activate the observer's brain and motivate them to action. These kind of research can be also used in examining reactions to products' photographs in informative brochures or newspapers. The other examples are websites, computer games and films. In this case, biometric examination allows checking in which moments the players' tension decreases, which sequences are unnecessary, too long or are negatively perceived, and which are involving and stimulating. Neuromarketing can also answer the question if the film trailer will encourage people to watch a programme on TV or to buy a cinema ticket.

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## WSPÓŁCZESNE TECHNOLOGIE EKSPLOKACJI DANYCH W MARKETINGU

### Streszczenie

Rozwój badań w obszarze neuromarketingu oraz funkcjonowania mózgu człowieka pozwala lepiej poznawać zachowania konsumentów. Wiedza o nabywcy staje się bardziej dokładna, jeśli powstaje w wyniku interdyscyplinarnego spojrzenia na uwarunkowania jego działań.

W artykule przedstawiono w jaki sposób można zastosować badania biometryczne, takie jak: funkcjonalny rezonans magnetyczny (fMRI), elektroencefalografia (EEG), elektromiografia (EMG), okulografia w marketingu, aby lepiej zrozumieć zachowania konsumentów.

**Słowa kluczowe:** neuromarketing, badania biometryczne, zachowania konsumentów