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NEUROMARKETING - THE RIGHT MIRROR OF THE CONSUMER

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ABSTRACT

It has long been known that electrical currents in the brain in response to stimulation of the senses occur. By placing the electrodes on the scalp, it is possible to register these bioelectric potentials or electrical activities, and this procedure is called electroencephalography - EEG. For years this non-invasive technique has been used in medicine as a diagnostic method. The combination of electroencephalography and A related medical research technique with marketing is called neuromarketing. Neuromarketing origin in the field of neuroscience and is applied in order to better understand the functioning of the human brain. It is a relatively new field of consumer and marketing research using the latest technology for the study of neurophysiological processes that take place when making individual decisions. Tools and methods used in neuromarketing analyzes are rapidly developing the ability to better visualize consumer subconscious responses to environmental concerns. In fact, neuromarketing represents the bridge between marketing and neuroscience, a research field that is developing extremely vigorously.

KEYWORDS: neuromarketing, electroencephalography, neuron, brain, consumer.

1. Foreword

During cerebral processes, the brain activates certain regions that require higher blood flow due to the increased demand for increased oxygenation of the engaged areas, or increased bioelectric activity that can be detected and measured by neuromarketing methods. Neurophysiological studies show that in the basics of each condition or process in the nervous system there are neurobiochemical events or changes. These changes can be caused by very different stimuli, from solving a complex mathematical task, to watching TV programs An analysis of the brain activity while the subject is exposed to a product, for example, it's attractive packaging, or a site that occupies the sales area, a warning sticker for consumer safety and health, or a stimulant-induced by subliminal messages, can produce surprising results. The ability of neuromarketing technic to have a direct insight into the events in the consumer's mind removes any nonspecific and confusion about the observed response of the respondents. Unlike the traditional psychological interpretations of the respondents, by introducing neuromarketing methods and instruments, researchers are able to directly monitor the changes in bioelectric potentials of neurons, without unquestionable m identification of measures of the activities of certain regions of the brain on the stimulus of the environment. So talking about neuromarketing and the application of research techniques in his essay Pushing the buy button Witchalls transmits the explanation of Dr. Kalvert, (Gemma Calvert): "With the help of functional magnetic resonance, you cannot change the behavior of the brain, you cannot force people to get out and buy something. it's a descriptive technique - it describes what the brain does "(Witchalls, 2004). Brain scans identify the activity of specific brain regions, measure the level of impact of the stimulus from the environment, which has led to the understanding that the brain during the automated process makes a number of decisions subconsciously (Camerer, & Thaler, 1995: 209; Camerer, Loewenstein & Prelec, 2005: 9-64).

Fugate, neuromarketing defines as: "A sub-domain of neuroeconomics that treats marketing relevant problems by methods and insights into brain research" (Fugate, 2007: 385). Large amounts of data revealed during neuromarketing analysis, promise a better understanding of consumer behavior, increase the belief that the marketing strategies of the future will be more efficient and more consumer-oriented. Ale Smidts, director of the Rotterdam School of Management at the Center for Neuroeconomics at the University of Erasmus, coined the term neuromarketing (Lewis & Bridger, 2005: 36-37), giving his definition: "Neuromarketing means the use of identification a cerebral mechanism for understanding consumer behavior in order to improve the marketing strategy "(Smidts, 2012).

2. Development of bioelectric brain potential research

Early researchers had very modest options, given the area they were trying to explain. Mostly they used electrometers called electroscopes that detected poor electrical potentials, and the experimenter could follow these changes on the instrument through subtle mechanical changes, such as turning a needle or thin sheet of gold. Emil Du Bois-Reymond, (1818 -

1896) constructed a galvanometer 4000 times more sensitive than the instruments of that time. It is also responsible for the development of non-polarized electrodes, unchanged in use in the longer term (Pearce, 2001: 620). Galvanometer was significantly improved in 1858. Lord Kelvin, (William Thompson), designed his device by placing a small needle inside the winding. The needle turns into a magnetic field that occurs as a result of the flow of electrical current through a solenoid. In this way, the device became more sensitive and could be used to measure the flow of a very low voltage current. Otherwise, Lord Kelvin is commonly known in the field of thermodynamics, according to the Kelvin Temperature Measurement Scale (Randal, 2006: 162).

The next improvement was done by d'Arsonville in 1870, by placing movable coils in the field of a permanent hinged magnet, significantly increasing the sensitivity of the measuring apparatus (Keithley, 1999: 196).

Richard Caton, first notices the ability of a neuron to realize a bioelectric intercellular potential-bioelectricity, which can be detected by a galvanometer. Employed at Royal Infirmary-Liverpool, recorded the electrical activity of the open brain of rabbits and apes using a galvanometer with a mirror. In order to improve visualization of the results, when measuring the weak signals, the wavelength was enhanced by the oxygen lamp, which illuminated the mirror and thus reflected the two-dimensional display of the scale on the wall of its laboratory About his 1875 experiment. Caton himself says: "The emergence of an electric current in gray matter is related to its function" (Collura, 1993: 476).

Caton's work inspired further research into the cerebral electrobiological activity, in fact, his discoveries were based on electroencephalography. The research conducted two years later confirms and expands the previous results. Caton reports that he has studied over 40 cats, rabbits, and monkeys. He observed variations in brain activity associated with sleep, full alertness, anesthesia, and the death of small guinea pigs (Collura, 1993: 476-477).

Clearly, this brief review of equipment development and measurement methodology prior to Katon era shows how much effort has been made to ensure that from the initial idea of the existence of a bio-electric potential, the necessary level of instruments capable of detecting, measuring and then recording on the tape is reached.

The first successful electroencephalographic (EEG) record performed on a human being was performed by Hans Berger (1873 - 1941) a German neurologist. His psychophysical experiments, connected with the flow of blood through the brain and neural activities, are fundamental for the modern scanning of cerebral processes (Hass, 2001: 9).

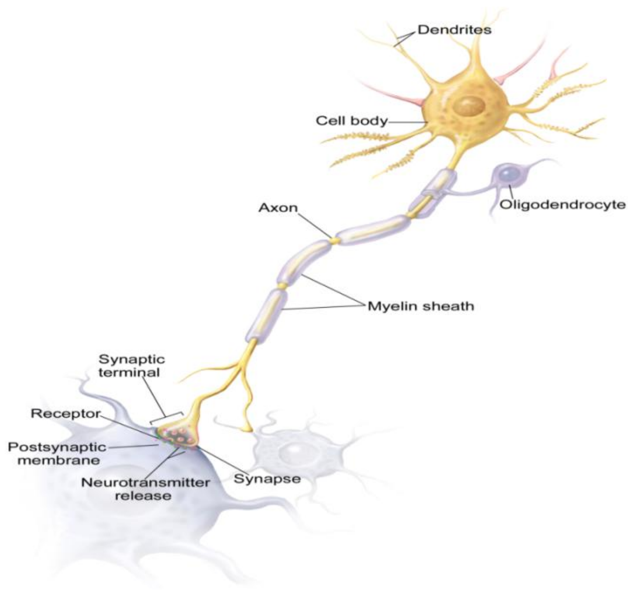
The results of early neurophysiological recording on humans were unsuccessful for several reasons. For example, the subject was sitting with a bunch of silver electrodes glued to the head, which was not so comfortable, so even smaller shifts in the head spoiled the results. Berger soon realized the problem; he acquired a larger device and began to put the subjects in a lying position, and the results were not missed. He formed experiences from failure and successful attempts, and among other things, he explicitly demanded that in the course of the EEG recording, in order to eliminate interference, some other devices would be shut down, X-ray machine, for example, even if it is located in another building! (Milett, 2001: 522-542).

The pioneering works of early researchers, stone are the foundation of today's neuromarketing. Now it's a dynamic, young science in full swing. Thanks to the extraordinary development of technical resources, researchers are able to deeply engage brain processes and have an insight into what consumers really think and feel.

3. The basis of the structure of the human brain

Man's brain is a functional neuron organization, capable of ensuring the harmonization of the organism with the external environment, coordination of constant and rapid reactions to environmental stimuli. The electrocerebral activity that can be registered from the patient's head is based on the potential difference or the synchronized electrical activity of a large number of nerve cells that form the electric field. The neurophysiological basis of bioelectric potentials of the cortex is in the very structure of the brain, that is, the natural trait of neurons to generate bioelectric potential-electric current (Tatum & al., 2008: 11-16). The nerve cell or neuron represents the basis of the building of the nervous system, while the human brain is the highest evolutionary range. Compared with Australopithecus, an early Pliocene era of approximately 450 cm2 of the brain, Homo sapiens tripled the volume reaching about 1345 cm2 (Holloway, 1996: 74-125). It is believed that the brain of an average adult man has a mass of about 1400 gr. and contains up to 100 billion neurons, (Suzana Herculano-Houzel claims about 86 billion), each of which has the ability to achieve thousands of interconnections (Nowakowski, 2006: 12219-12220; Herculano-Houzel, 2009). One of the founder of the American Anthropometric Society, Edward Spitzka, rang the brains of well-known figures (otherwise donated AAS) by the brain's criterion. The first on the list is Russian writer Turgenev, 2012 grams, while at the end of the list Joseph Gall, the mass of the brain is 1198 grams (Spitzka, 1907: 175-308). Gall and associate Christoph Spurtzheim are the pioneers of phrenology, that is, of the shape of the skull and bump on the surface of the skull, drawing conclusions about the character and behavior of personality, or ability (Grinfild, 2007: 23-25).

The specificity of the building of the nerve cell is reflected in its nerve extensions, nerve fibers, important in intercellular communication. There are two types of these sequences, numerous branches or dendrites, and one longer nerve spine, neurite (cylinder) or axone. Dendrites are numerous, branched - associated with the crown of reddening, (dendritic decomposition), and end with dendritic spines or thorns, receptive spots during synaptic exchange (Figure 1).



Picture 1: Neurons and synaptic terminal.

Source: US National Library of Medicine - Department of Health and Human Services.

Neurons have the ability to communicate with each other by exchanging electro-chemical pulses, and this feature significantly differentiates nerve cells from other cell types. The brain is organized in such a way that there is a functional unity of the nervous system by the networking of the nerve cells, but there is no histological continuity, that is, the brain mass cannot be said to have tissue properties, as there are no physical connections between the neurons. The truth is that there is a point of minimal physical contact between adjacent cells known as the connexion, where the intercellular transfer of the nerve impulse is carried out, during which its basic electrical nature is not changed, and that is the dendro-dendritic transduction. Neuron cortex in a calm state shows a negative potential, about -70mV in relation to extraterrestrial space, a sleeping potential, or a membrane potential. The stimulated neuron is activated, and the depolarization process begins.

By opening the sodium channel in the cell membrane, Na + ions enter the cell, causing a change in its potential, ie a positive charge. When this process reaches the tolerance threshold point, the generated electrical signal additionally accelerates the input of the Na + ion (Hodgkin cycle), and the achieved charge of the charge is called the action potential. The process of generating the action potential lasts about one millisecond, after which the sodium channel is closed, the potassium channel is opened simultaneously, and the K-ion exits outside the cell, then the potassium channel is closed, thus completing the depolarization process. The cycle ends with the cell actively ejecting Na + from the cell, inserting at the same time K +, (a process known as a sodium-potassium pump). In the reflection period, the process of restoring the cell to rest, the neuron is unable to receive the next impulse (Barnett & Larkman, 2007: 192-197). Unlike this type of intercellular communication, the nerve impulse transmitted through the axon to the dendritic neighborhood cell, in the inability to overcome the synaptic process, changes its electrical nature and continues its journey as a chemical impulse with the help of a neurotransmitter that binds to the corresponding adjacent cell receptors. The chemical mechanism of this type of nerve transduction starts at the end of the axon, where there is a networked web of nerve fibers - teledendron. Here, the terminations of the cortical axons fibers expand into synaptic vowels filled with chemical mediators, which play an important role in the intercellular, synaptic transmission of the impulse (Kostović, 1979: 14-22).

Intercellular communication is accomplished by transmitting the generated signal, action potential, neurofibrils along the axon to the axon terminal located in the teledendron. This ends the path of the electrical impulse, it cannot overcome the synaptic process and pass to another neuron, therefore activates the vouchers, they expel the chemical mediator in the synapse, which starts the process of axo-dendritic, chemical neurotransmission. A freed mediator, a specific neurotransmitter, binds to the receptor - ionic passages on the cell membrane of the postsynaptic neuron. This action results in the opening of ionic passages and positively charged ions (usually Na +, K +, Ca2 +, if the excitatory reaction, or Cl-, if it is inhibitory) enter the postsynaptic cell producing the synaptic potential - that is, they perform transduction of the nerve signal. The connection between the neurotransmitter and the postsynaptic cell breaks down, the neurotransmitter partly diffuses back into the mother's - presynaptic cell, partly decomposes under the influence of the enzyme, so the synaptic gap is cleared and the neurons are ready for the next impulse. (Stufflebeam, 2008).

As a result of neural activity, electrodes placed above the surface of the brain cortex can register the appearance of bioelectric potentials, that is, the resulting currents in the vertically arranged columns of the pyramidal cells have a sufficiently strong electric field which is registered as an EEG activity (Ribarić, 1987: 65).

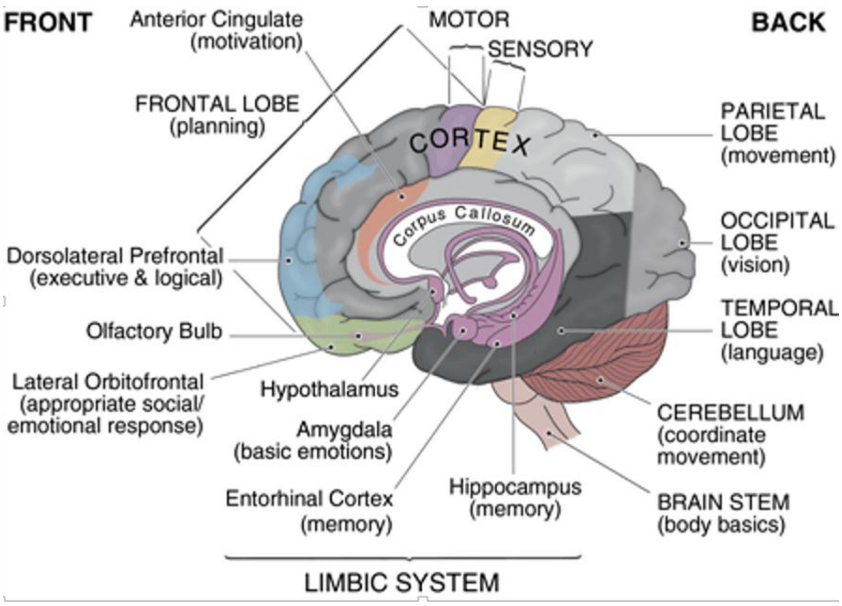
4. The cytoarchitectural and functional division of the cortex

The brain as the most complex structure monitors the vital functions of the organism, manages cognitive processes, stores memory, emotions, processes sensory information from the environment, and more. In the structure of the human brain, the dominant bark (cortex) is a longitudinal fissure divided into two rather symmetrical parts-hemispheres. Hemispheres are interconnected by a number of nerve fibers (comminuted fibers) and this structure is called corpus callosum (Kolb & Whishaw, 2009: 3). Brains of the brain with other brain regions connect billions of fibers, as well as with sensory organs and spinal cord, crossing that way cortex with other parts of the body (Stockley, Oxlade, Wetheim, 1999: 302).

Numerous roots and furrows (gyrus and sulcus) characterize the surface of the human cortex, and following its morphology, it is noted that each hemisphere is divided into four areas, lobus of the brain, and these are (Bin, 2013: 9-10)

- Frontal lobe
- Temporal lobe
- Parietal lobe
- Occipital lobe

The anatomical, frontal lobe is separated from the parietal Roland fissure, which simultaneously separates the foreground area of the cortex (anterior part) from the posterior (posterior). The temporal topographical domain of the cortex is separated by Sylvia's friction from the parietal and frontal part, while the line of delimitation of the occipital region is less pronounced (Davey, 2011: 153). In Fig. 2 shows the cortical regions listed.



Picture 2: Cortex Regions.

Source: MIT Biology, Overview Nervous System-Brain.

Functionally, the basic activities of the cortex can be distinguished, since the anterior part of the cortex deals with the process of planning and perform the activity, while the last (posterior part) is responsible for receiving and processing sensory information (Fix, 2008: 6). In particular, the frontal lobes play a decisive role in higher cognitive functions, organizing willing movements, planning and assessing the consequences of activities, making choices during choosing, or adapting to socially acceptable standards of behavior. It also plays an important role in integrating long-term memory stored in other brain regions, as well as memory associated with emotional-derivative activities of the limbic system (Figure 2), visual search and understanding of visual inputs. Furthermore, the frontal lobes play a role in the development of personality, understanding of speech, the formation of linguistic memory, the creation and production of speech expression, (Broca area), attention control-including selective attention, time coding of the signal, etc. (Stockley, Oxlade, Wetheim, 1999: 303-309).

The temporal lobe allows the reception and interpretation of audio information, speech understanding and word meaning (Wernicke's area), selective audible attention, face recognition, emotional responses, is part of the process of storing long-term memory, including autobiographical data, information and locations of certain events (Fix, 2008: 6).

The parietal area provides spatial orientation, willing motor activity or practice, recognition and treatment of somatosensory signals (signals coming from the body), enabling the writing of text, then drawing - by coordinating visual and somatosensory control, perception, conceptual processing of numbers, etc. (Brownsett & Wise, 2010: 517-523; Cappelletti, Lee, Freeman & Prince, 2010: 331-346).

Occipital, (nasal) lobes allow a correct understanding of visual stimuli, interpretation of the color vision, third-dimensional perception, motion, and other essential visual aspects for real perception of the environment. Provides the ability to read and understand read, object recognition, and simultaneously visual tracking of multiple objects (Grill-Spector, Kourtzi & Kanwisher, 2001: 1409-1422).

This functional organization of the cortex Krstić Nadezda comments and argues that the presented tasks of the cortical regions act inhomogeneously because the division is made according to the constructs of functions, that is, the ability (thinking, memory, speech, attention, etc.) that do not in themselves represent the natural, basic elements mental structures, but before a different, functional combination of these elements. Therefore, a functional division into regions represents the worst possible way of conceptualizing cortical functions in general, and in cerebellar neuronal cortex most often presents through basic functional areas (Krstić, 2013: 23-25):
- Motor areas
- Sensory areas
- Associative areas
- Limbic system

Motor areas, motor cortex, play a key role in the reconnaissance of motor actions and are divided into the primary motor cortex, premix and supplementary motor cortex (Mitz & Wise, 1987: 1010-1021). The basic function of the secondary motor crust is that, by projecting in the primary, it regulates and interacts with the activation of its neurons, thus ensuring the harmony and coordination of fine motor movements (Krstić, 2013: 23).

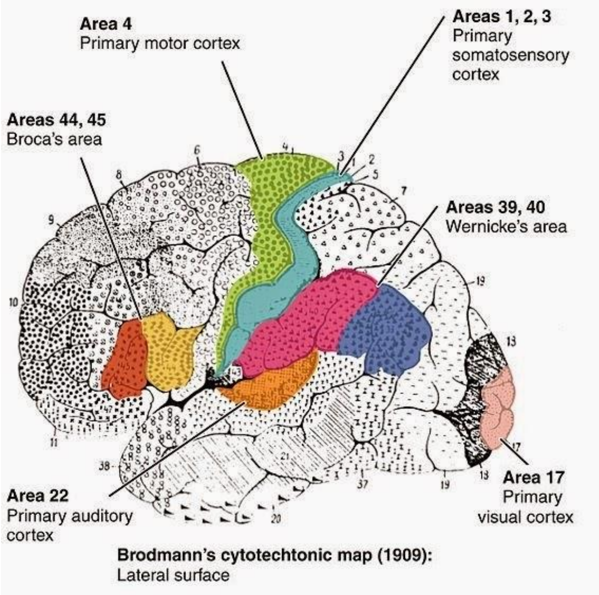
Sensory areas receive information via afferent neurons, and are able to represent qualitative and quantitative aspects of the received stimulus, whether they are internal, body signals (somatosensory), or they are stimuli from the environment. The received information is processed in special specialized areas for each of the sensory modalities. Somatosensory signals are represented in the parietal corium, the auditive signals are temporal, while visual stimuli are perceived in the occipital cortex (Perves & al., 2004: 188).

Associative areas, or associative cortex, performs the most brain functions, gives meaning to processed information, analyzes signals from all regions - including subcortical ones. This integrated information generates aspects of behavior and complex mental processing (learning, willing movements, problem-solving). Associative areas are responsible for fine motoring (writing, playing an instrument), verbal understanding and expression, or the production of speech (Perves & al., 2004: 613).

The limbic system is a brain structure two-sided located around the thalamus, but this is not a unique system (there is still no consensus on the final list of elements that enter the composition), but rather a collection of more functionally joined structures. The structures of the limbic system combine the functional concept in charge of numerous brain activities; support emotional processing, motivational aspects behavior, long-term memory, learning, etc. (Rajmohan & Mohandas, 2007: 132-139).

The complexity of the cerebral organization as well as the different approaches to the observation of the cortex (anatomical, physiological, neurochemical) open the possibility of division according to different criteria, according to the microanatomy of neurons and their organization, the morphology of cells in a certain region and intercellular networking. For this reason, Krstic adds: "It is considered that combining cytoarchitecture with a description of tissue characteristics is the best way of dividing bark into meaningful organizational elements" (Krstić, 2013: 26).

Korbinian Brodmann (1868-1918), one of the pioneers of Neurology, published in 1909 the capital work: Vergleichende Lokalisationslehre der Grosshirnrinde and the Principal Dargestelt auf Grund des Zellenpanes, (Olry, 2010: 2112-2113), the human-brain cytoarchitecture map, or localization in the cerebral cortex, showing 43 regions numbered in Arabic numerals (Figure 3). Zilles & Amunts cites: "Each cortical region on the human map is marked with numbers between 1-52, but the regions numbered 12-16, and 48-51 are not shown on the map. Brodman explains this emptiness by the fact that some regions cannot be identified in the human brain, but are well developed in other mammalian species (Zilles & Amunts, 2010: 140).



Picture 3: Brodman's cytoarchitectural map of the human brain.

Source: Neuroscience, (Zilles & Amunts, 2010: 142).

This approach to the cortex of the cortex has been demonstrated today, more than a century after publication, as superiors, so most neurologists and neuromarketing researchers use Brodmann's map for the localization of neuroscience data (Zilles & Amunts, 2010: 139).

Neurophysiological research methods

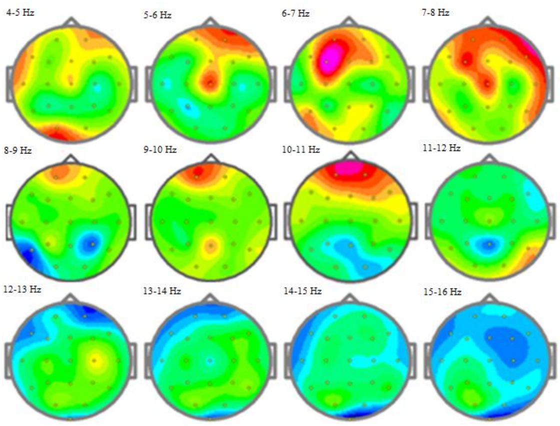
Neuromarketing uses different methods, tools, and techniques to measure consumer responses and behaviors. This involves various procedures, from a relatively simple and inexpensive approach, such as eye movement monitoring, facial expression analysis, and behavior monitoring experiments to very complex techniques, and can, therefore, be grouped together (Wang & Minor, 2008: 197-232).

*Biometric techniques based on the use of various sensors that accompany certain changes to consumers, for example, body movements, measuring the rhythm of breathing-exhalation, heartbeats, or recording electromyography (EMG).

*Neurometric techniques, monitor changes in brain signals, or measure electroactivity, and are mainly used: electroencephalography-EEG, positron emission tomography PET, as well as magnetic functional resonance - fMRI.

EEG is a neurophysiological method that identifies the electrical activity of the brain, that is, the dynamic changes occurring on the membranes of the cortical nerve cells. This technique measures the electrical voltage generated as a result of the movement of the ions between cells, in fact, bioelectric intercellular potential. Ribarić interprets the neurophysiological basis of electroencephalography, as a process of electrocerebral activity that is registered from the head or from the surface of the brain cortex, occurs in brain cortex cells modified by the activity projected into cortex from other brain structures (Ribarić, 1987:57). Tools and methods used in neuromarketing analysis of rapidly developing the ability to better visualization of the consumer subconscious response to stimuli from the environment or the use of modern software enable the visual display of brain regions involved in 2D and 3D format. (Picture no. 4).

Spectral power of μV^2, theta, alpha and beta band



Picture 4: Sorce Tanasic, 2017: 117.

The EEG device detects bioelectric changes using electrodes distributed on the examinee's head. There are international standards for placing electrodes on the main part - the most commonly used is the 10/20 standard, as well as 10/10, which is an extended version of the 10/20 standard, by increasing the number of electrodes. Electrodes of the head are not able to detect any electrical change in the cortex. It is thought that at least 6cm2 synchronized electrical activity of the cortex is needed to generate the potential, or wave, which can be registered with the EEG device (Misulis & Head, 2003: 43). This is the oldest neurophysiological measurement method, developed from galvanometers used by pioneers in this research field. Technological improvement of the devices in the last few decades has enabled a revolution in the techniques of EEG recording. Digital signal processing provides additional possibilities for manipulating EEG data, allowing a flexible combination of different methods in data analysis and their image display (Niedermeyer & Da Silva, 2005: 137-138).

Similar to EEG devices, magnetoencephalography (MEG) also measures the activity of the cortex, but this technique is based on the discovery of changes in the magnetic field of the bark of the big brain. Both of these techniques are able to measure real-time changes in milliseconds. The high-speed reaction, allowed the high frequency of use of the device which is completely harmless to the respondents, low cost, and operational simplicity, have imposed EEG as a widely accepted research method worldwide (Towle & al., 1993: 1-6).

The position emission tomography-PET is based on the biological properties of the cells that communicate in neural networks of the brain using small electrical discharges. During these bioelectric activities, an appropriate electric field is generated that can be detected and its intensity measured in certain regions of the brain, which actually represents activity - a cerebral response to the environmental stimulus. PET technique is used to measure these signals associated with local brain activity. Before accessing the measurement it is necessary to inject the radioactive liquid into the bloodstream of the subjects as a tracer. As activity in certain regions of the brain increases, so will the blood concentration in them. This change in blood flow is detected using a PET scanner. The device reproduces a three-dimensional image of functional cerebral processes, thanks to gamma radiation detected by the inserted tracer (Ter-Pogossian & al 1975: 89-98).

The core of the magnetic resonance device is a cylindrical tube, that is, an extremely powerful electromagnet, most commonly a power of about 6T (Tesla), which is about 100,000 times stronger than the Earth's magnetic field. Respondent is immovably lying on a mobile table, and the appliance gently sets it apart in the tube. FMRI is used to display a part of the brain that is activated in a specific mental process, during which the flow of blood changes as well as the percentage of oxygen in it (oxygenation). These changes take place slowly, and therefore this technique (including PET) is not suitable for monitoring changes at a time scale, but it is therefore remarkable for accurate locating change. It is able to precisely locate the brain changes of an area of only one square millimeter. The special software enabled a full picture of these brain activities on the computer screen (Huettel, Song & McCarthy 2009: 46-238).

CONCLUSION

Neuromarketing's science is articulated as a combination of marketing, medical knowledge, and the latest brain scanning technology, which enabled the insight into bioelectric potentials of the brain. Prior to neuromarketing, the credibility of traditional research techniques was based on the degree of accuracy and honesty of respondents' answers. By developing neuromarketing, the observer is able to unambiguously detect changes by recording brain activity from the scalp of the respondents and identify the engaged brain region as a result of a particular stimulus from the environment. Changes in the nervous activity induce variations in cerebral metabolism, hemodynamic and electromagnetic signals, which can be measured by one of the following neuromarketing techniques. Improving understanding of neural mechanisms in decision-making and insight into individual differences in behavior and personal preferences enables marketers to significantly promote more effectively.

Early researchers, pioneers in this field, had profoundly humane motives to deal with this research. Mistakes in electro-energetic waves of brain activity were discovered, all in an attempt to discover and explain, for example, epilepsy or some other anomalies. All of their spiritual and creative potentials were hired to help people. Marketing and psychology co-operation resulted in subliminal marketing, then neuromarketing. There remains a question in which direction these techniques, measures of their use and abuse will be directed, and how should they withdraw the clear boundaries between these areas.

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