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NEUROMARKETING - A SCIENTIFIC TOOL TO HANDLE CONSUMER BRAIN INFORMATION

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Abstract: *The article addresses a relatively new topic on the Romanian market, namely Neuromarketing as a field of scientific research that has a wide applicability in business. Neuromarketing is an emerging field, being located on the border between psychology, neuroscience, marketing and neuroeconomics. It is of great interest to marketers, as it can bring considerable information about the mechanisms underlying the consumer behavior and the decision-making process. This paper first outlines a brief overview comprising definitions of the concepts which will also be later used in the article like neuroeconomics and neuromarketing. It also documents the evolution of the market over the last century until today and explains how the use of neuromarketing techniques can help the further development of the domain. The second section of the paper explains and reviews the findings of a primary neuromarketing case study which was conducted in partnership with a multidisciplinary research group. The data were collected with the use of an EEG headset and were used as the basis of real business decision making.*
Keywords: *Neuromarketing, Neuroeconomics, EEG, Paradigm, Customer behaviour*

Introduction

The human mind and the functioning of the brain are the focus of a subfield of science known as neuroscience. Neurobiology, psychobiology,

neuropsychology, psychophysiology, and cognitive psychology are the most important. Essentially, the primary goal of neuroscience is to fully comprehend how the brain, mind, cognitive processes and subconscious functions work.

Concerned with the limits of economic agents' rationality, behavioral economics theory investigates both the effects of psychological, cognitive, emotional, cultural, and social factors on economic decisions made by individuals and institutions, as well as the consequences of these effects on market prices, yields, and resource allocation, as well as the impact of different types of behavior in various environments with varying experimental values. In recent years, the term behavioral economics has been increasingly used in American writings to describe behavioral models that integrate perspectives from psychology, neuroscience, and microeconomic theory, models that cover a wide range of concepts, methods, and fields of analysis (Ariely &Berna, 2010).

As a result, the study of behavioral economics focuses on the analysis of how market decisions are made and the identification of the mechanisms that determine public choice, discussing the three major theoretical themes as follows (Alvino & Franco, 2018):

- Heuristics: people use mental shortcuts or thumb rules to make 95 percent of their decisions.
- Framing: is the collection of anecdotes and stereotypes that comprise the emotional filters on which people rely to understand and respond to events.
- Inefficiencies in the market: include incorrect pricing and irrational decisions.

Neuroeconomics is well-prepared to regulate the concept that defines how to make decisions by identifying mental states. Neuroeconomic models are activated and improved by psychological outcomes and are grounded in biological processes, according to the research *Can Neuroscience Assist Us in Constructing Better Patterns of Economic Decision-Making?*, published in *Frontiers in Behavioral Neuroscience* (2017) (Lazaroiu & all, 2017). When the results of separate procedures are consistent with a normal mechanical clarification of what generates the choice, as interpreted by a computer model, this is considered progress in neuroeconomics.

Neuroeconomic experiments combine advanced imaging and brain stimulation tests from cognitive neuroscience with microeconomic systems and advanced game theory tests from economics. According to research, neuroeconomics aims to use additional information obtained from brain investigations in conjunction with the decision-making process in order to better understand the thinking / decision-making process and use future results to improve economic models.

Neuroeconomics is the study of how people make decisions based on values and how those decisions are transmitted neuronally, cognitively, and behaviorally (the greatest progress has been made in understanding the sense of stimulus-reward and how the brain discerns to assign them value).

Neuromarketing, also known as *avant-garde marketing*, is a growing field that uses neuroimaging techniques such as nuclear magnetic resonance, electroencephalography, and magnetoencephalography to study and define consumer responses to various marketing stimuli. As a result, brain activity in specific areas of the brain can be monitored and measured to determine how consumers make decisions, highlighting the link between the decision-making process and the areas of the brain involved in receiving marketing stimuli.

The term itself is based on a nineteenth-century theory known as the neuron doctrine. Although neurons account for only 10% of brain mass, such specialized cells, according to this theory, form the primary mechanisms of thought. Knowing that the human brain only uses 2% of its energy for conscious activities, concentrating the majority of its resources on the subconscious, it becomes clear that verbally rendering buyer reactions to a specific product is impossible. Thus, the vast majority of human thoughts and emotions are the result of subconscious activity, making it extremely difficult to find reasons for the act of acquisition and/or consumption through the lens of conscious intervention.

So, similar to neuroscientists who can accurately determine which areas of the brain are active at any given time, what we present below are truths about how branding and marketing messages work on the human brain, how our inner psyche reacts to stimuli at a much deeper level than conscious thinking, and how our behavior is controlled by unconscious thinking - usually the exact opposite of what we think we react and behave.

Literature review

Daniel Kahneman, a psychologist, was awarded the Nobel Prize in Economics in 2002 *for his integrated perspective on psychological research in economics*, particularly *in human judgment and decision-making under uncertainty* (Declerck & Boone, 2016).

Ten years later, in the field of behavioral finance, economist Robert J. Shiller was awarded the Nobel Prize in Economics for his empirical analysis of *asset prices*. Economist Richard Thaler was awarded the 2017 Nobel Prize in Economics for his significant contribution to behavioral economics by

establishing that *people are predictably irrational in ways that defy economic theory*.

Outstanding research in the theory and analysis of economic behavior (Kahle & Lynn, 2013) demonstrates that better knowledge necessitates a better understanding of how decisions are made. Similarly, while maintaining the rigor of economic analysis in defining the value-based decision, it turns out that a superior understanding of how decisions are made generates higher expectations about the options that have already been selected. As a result, it is hoped that the association of imaging techniques with the economic model will provide explanations for how individuals choose a strategy when confronted with a wide range of possible options (Boksem & Smidts, 2015).

In defining value-based decision-making, neuroeconomics maintains the rigor of economic analysis while admitting that decision-making is evolutionary and not always optimal. Psychological outcomes activate and improve the descriptive capacity of neuroeconomic models, which are grounded in biological processes (Di Domenico & Ryan, 2017). There is talk of economic prosperity in the second half of the twentieth century, which led to the development of the phenomenon of shopping much more than anyone could have predicted. The recorded purchase rate was significantly higher than in any previous reference period. The open stores served more the companies' desire to take customers away from competitors than the new markets, and customers had to make an effort not to buy. The result, as agreed upon by all experts in the field, has been that sales were „dangerously" high for a long time: too many products for sale, more and more diverse, too many advertising channels, and research that would be a concern for future attempts to substantiate the interdisciplinarity of marketing science on the Romanian market will be established in the paper *Deceptive and subliminal advertising in the slimming product market*. *Romania Case Study*, published by Ed. Addleton Academic Publishers in New York (Stefanescu & Olivia, 2014).

Furthermore, marketing and advertising researchers (Davidson & Irwin, 1999) have observed for several decades the limitations imposed by traditional market research methods, such as analyses that focus on finding an answer in the post-rational stage.

Another method for obtaining useful information in the field of advertising, which is frequently used for research and market research, is to conduct an opinion poll, a survey for a specific store or merchandise district, or simply inquire (over the phone or in person) about what customers have seen, done, or intend to do. Some studies, on the other hand, attempt to decipher both the processes and relationships of affiliation, attraction, love, and friendship, as

well as prosocial behavior, which includes all individual acts that have a positive impact on society. Another area of study in psychosociology is aggression and violence, which has extremely negative effects in social relations in general, as well as in family life and professional life, disrupting all spheres of activity, including economic (Rubinstein A, 2008)

We're talking about attitudes - self-esteem, prejudice, which are present in everything we do, think, or feel; and persuasive communication - which has been intensively studied in order to decipher the factors and conditions on which the success of a sender's attempts to persuade the receiver to change his attitude toward certain people, goods, ideas, situations, and so on depends. Furthermore, the individual's conformity to the value system of the group to which he belongs plays a significant role in group cohesion and integration (Constantinescu & all, 2019).

Consent or assent, as a form of influence and social integration, becomes a process by which the individual is psychologically „seduced" so that he can then be „manipulated." Thus, stereotypes and prejudices against specific social groups distort the individual's reduction to the status of a simple representative of a social group, which is sometimes necessary and justified, and sometimes superficial and unjustified.

From a scientific standpoint, our efforts and abilities to understand our own selves, as well as the selves of other individuals and groups of which we are a part, can be studied in a complex thematic field of social psychology known as social cognition, terminology that experts use. Psycho Sociologists scientifically investigate the set of cognitive processes by which each of us forms, spontaneously and unpredictably, partially unconsciously, a set of representations and concepts about social reality, on the basis of which we adapt our behavior to various situations (Stefanescu M., 2017).

Only in recent years has science enabled the development of an effective device that can „decode" customer thoughts: neuromarketing - techniques developed by cognitive psychology and neuroscience specialists that are used to analyze and understand people's reactions to products and promotions (Bondrea & Stefanescu, 2014).

Researchers in the United Kingdom and the United States have focused more on the field of neuromarketing, and it has been studied more and more in recent years, gaining supporters all over the world (Ries & Ries, 2005). There are currently more than 60 neuromarketing agencies in the world, with approximately 31 in Europe.

After six years of research, Stanford University psychiatrists and computing experts, along with neuroscientists and engineers, were able to

replace the light-blocking structure of brain-blocking lipids with a technique that uses ingredients such as acrylamide, bisacrylamide, and formaldehyde to make those areas transparent in April 2013. The method, known as CLARITY (Clear Lipid-exchange Anatomically Rigid Imaging / immunostaining-compatible Tissue hYdrogel), has already been approved and allows for repeated and high-resolution analysis of the brain without sectioning it (Hao & all, 2018). The human brain's „transparency" sheds light on future years of neuromarketing research.

Furthermore, recent research presented with scientists, based on an experiment that used brain scanning, can highlight a person's thoughts, a figure recently seen by him, or memories updated at that time (Stefanescu M, 2017).

One of the world's leading neurologists, Virginia Valentin (2000), began his career as a marketer. He has spent a long time studying how emotions affect our brains, memory, and decision making. According to research, emotions are more inextricably linked to our major cognitive actions: learning, memory, and decision making, rather than being separated from rationality. Thus, emotions symbolically acquire the valences of that yellow marker that „emphasizes" the important aspects of the human mind, information that our brain cannot make decisions without (Valentin & Gordon, 2000).

Methodology

In the course of an experimental neuromarketing project called „The Sound of Wine - consumer preferences in a wine degustation," I was a member of an interdisciplinary team led by the Polytechnic University of Bucharest between 2019 and 2020.

The study focused on brain waves (EEG) surveillance for five amateur subjects not specialized in wine tasters (oenologists) in order to assess how wine type is chosen during a tasting process. In order to assess whether these variants meet the individual preferences of a particular wine brand, the team looked at variations in Alpha, Gamma and beta brain waves.

Subjects (Participants)

The study included 5 male volunteers, all of whom were amateur wine drinkers between the ages of 30 and 50. There was no history of neurological disease among the volunteers, and they did not use drugs or psychiatric medications. According to the Helsinki Declaration, the study was approved by the ethics committee of the University of Pharmacy Bucharest. Volunteers were informed

about the study and were asked to sign a consent form. The EEG hardware and software for brainwave analysis were created as part of the project.

Methodology for research implementation

Three types of wine brands were chosen for the study. The wines were chosen based on the same type of Cotnari semi-dry grapes, production years 2008, 2015, and mass production 2020.

The wine tasting methodology consisted of four steps that were repeated for each wine.

Step 1: Volunteers rinsed their mouths with water and took a 15-second break.

Step 2: For 30 seconds, the volunteers were exposed to a glass of white wine.

Step 3: Volunteers were required to smell the wine twice, once for a stationary glass and once after spinning the wine in the glass for 5 seconds.

Step 4: The volunteers then tasted the wine, taking 1-2 small sips to fully appreciate its flavor.

The volunteers completed a questionnaire at the end of each wine tasting to conduct a general evaluation of the wines.

The volunteers' brain activity was monitored for 15 minutes while the methodology's four stages were implemented.

EEG Examination

The team's experience gained in the development of the Brain Fingerprint project, which demonstrated that „the brain never lies," was used to develop the EEG analysis software application, and research in this project was used to implement a prototype for a new system „lie detector" type.

Six electrodes in the international system 10-20 located on the frontal and central cortex (Fz, F1, F2, FCz, FC3, FC4) were used in the neuromarketing study. To reduce the complexity of the EEG sensors, we will try to use only the FP1 and A1 electrodes in the future.

Throughout the study, the EEG equipment simultaneously monitored and recorded the activity of δ, θ, α, β and γ brain waves. The brain waves and their cognitive state are described in Table 1.

Table 1: The brain waves and their cognitive state

Brainwaves	**Frequency**	**State of Mind**
Alfa (α)	8-12 Hz	Representing the state of creation, relaxation and visualization that is very beneficial to the generation of vitality and creativity. It is the ideal condition for solving problems
Beta (β)	12-27 Hz	Representing a state of alertness and concentration, keeping the individual sharp and focused. At this time, the brain will be more conducive to the work of message analysis and preparation
Gamma (γ)	> 27 Hz	Representing learning, memory, language processing and the state of consciousness that will disappear from anaesthesia to deep sleep
Theta (θ)	3-8 Hz	It represents one in the state of deep relaxation, meditation and good memory. It usually occurs when an individual enters a light sleep or a conscious dream. It is related to the relief of stress and the memory of long-term memory
Delta (δ)	0.5-3 Hz	Representing an individual in a state of healing and good sleep, usually accompanied by the release of growth hormone

Source: Ismail et al. (2016)

A team of doctors and marketing experts analyzed the spectral data of the brain waves monitored and acquired for each volunteer during the four stages of the methodology. Because theta and delta brain waves can only be stimulated during sleep, only alpha, beta, and gamma brain waves were chosen for analysis.

Results and discussions

Three T1, T2, and T3 tests were carried out in relation to the three rounds of wine tasting. The statistical analysis of three pairs of alpha, beta, and gamma brain wave samples was used to determine the dominant activity of brain waves during the three tasting rounds. Table 2 displays the test results.

Table 2. Test results

Round	Brainwaves	Limit Lower/ Higher	Water Avg Obtained Freq	Wine 2008 Avg Obtained Freq	Wine 2015 Avg Obtained Freq	Wine 2020 Avg Obtained Freq
T1	alfa	7-19.9 Hz	7.4 Hz	23.2 Hz	20.5 Hz	18.5 Hz
T2	beta	15-29.9 Hz	21.6 Hz	20.5 Hz	25.5 Hz	45.5 Hz
T3	gamma	30-99.99 Hz	68.8 Hz	112.4 Hz	90.6 Hz	69.7 Hz

There was a significant difference in beta oscillation activity for each volunteer after tasting the three types of wine, according to the results. Following the initial global analyses, comparative analyses were conducted between wines to determine their impact on beta oscillations. When compared to table wine, the results show an accelerated decrease in beta oscillations for old wines (e.g., quality, color) (general). There were no significant changes in the alpha and gamma oscillations, which remained nearly constant. The old wines (2008 and 2015) were mostly preferred by the volunteers, while the table wine (2020) was less so. The tests revealed an increase in beta wave activity for wines of lower preferred quality and a decrease in beta wave oscillations for wines of higher preferred quality.

Figure 1 depicts the calculation of the unilateral bispectrum of a univariate EEG time series using the fast Fourier transform (FFT) and an autoregressive model-based method (AR). A bispectrum is a third-order spectrum that corresponds to the third moment (asymmetry) of a time series. Asymmetric nonlinearities in the input time series can be detected using the resulting bispectrum.

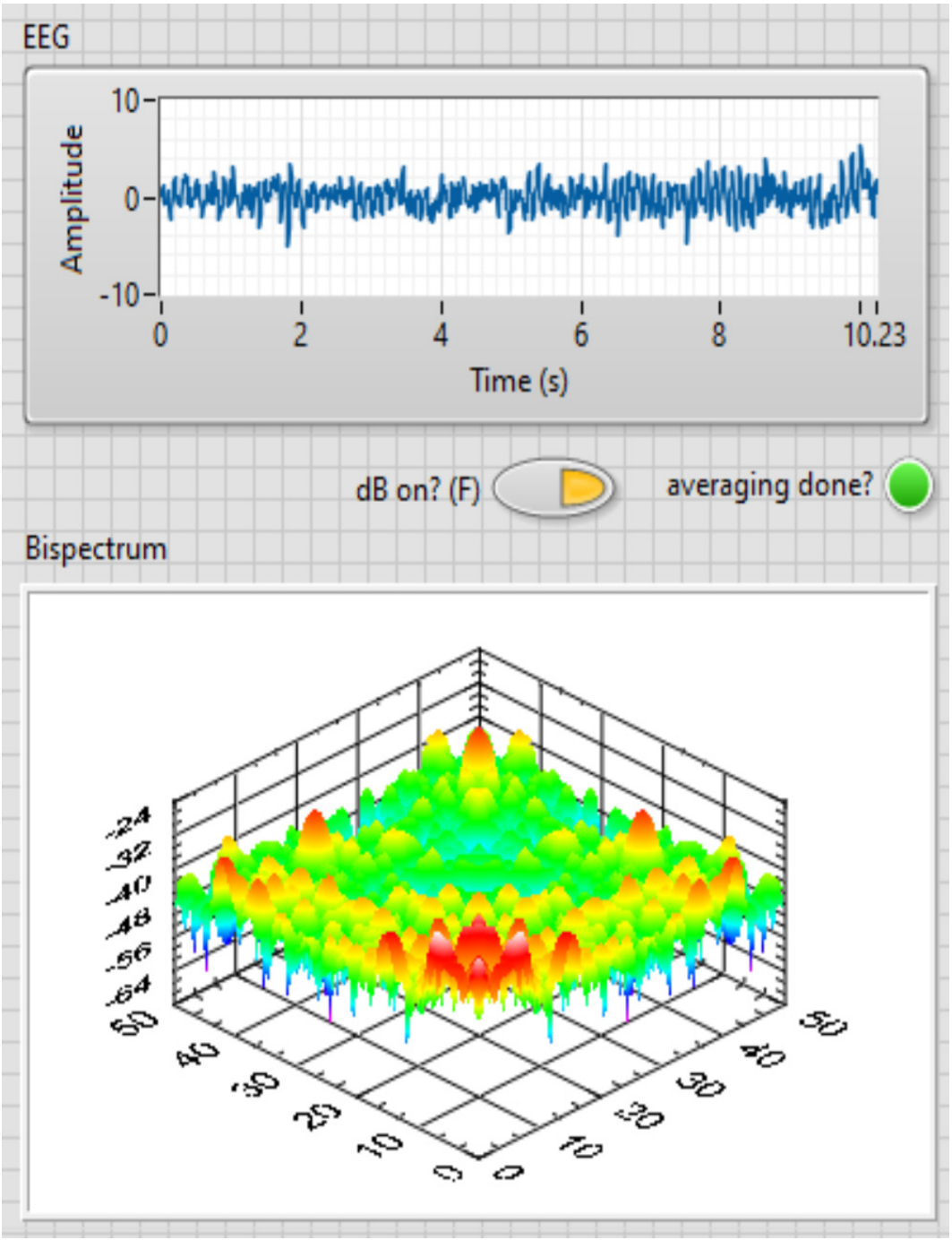

Figure 1. Calculating the unilateral bispectrum of a univariate EEG time series, using the fast Fourier transform (FFT) and the method based on the autoregressive model (AR).

The purpose of this study was to determine the contribution of brain waves to the study of the consumer profile in terms of his preferences and behavior. Following a comparison of the three alpha, beta, and gamma brain waves, we discovered that changes in beta oscillations during the experiment could be related to individual preferences for a specific wine (wine tasting). The findings show that changes in volunteers' perception during wine tasting have an effect on brain oscillations. As a result, tasting different qualitatively differentiated wines (their age) may influence the visual and gustatory cognitive process, as well as people's preferences for a specific quality of them. The results confirmed that the beta wave oscillations increased in intensity based on the consumer's individual preferences, and the decrease in activity of the beta wave oscillations indicated the consumer's preference for a specific type of wine based on its quality (age).

During the wine tasting in the T3 test, a musical (auditory) stimulus was introduced. When a musical stimulus was introduced, there was a significant correlation of gamma waves with the oscillating activity of decreasing beta waves, which determined the consumer's preference for a higher quality of wine.

The findings of this study cannot be applied to watching a movie, for example, because it employs different cognitive processes (visual and acoustic attention), which differ from the cognitive reactions used in wine tasting (olfactory and gustatory sensations). It's possible that the oscillations of beta waves that characterized volunteers' cognitive preferences during wine tasting behave differently in response to the visual and acoustic stimulation of watching a movie (advertisement).

EEG data could be used to gain a better understanding of how cognitive mechanisms (both neural and psychological) work to define consumer behavior when interacting with a specific product. The findings from this study to identify consumer cognitive behavior during product interaction are still in the research phase; current research focuses on basic research to understand the consumer's emotional mechanisms. Therefore it is necessary to carefully examine the results achieved by using EEG tools in the evaluation of the cognitive (emotional) state of a consumer. In reality, many of our perceptions of branded items as consumers appear to be based on complicated subconscious patterns (patterns) of action that develop in our minds in the form of „reasons" for pleasure or constitute a reason for generating pleasure or, simply, triggers that reason enough: we like it „just because." In this context, emotions play an important role in the consumer's decision-making process, accounting for approximately 50% of his final decision.

Conclusion

Neuromarketing tools include methods and techniques created and developed by neurology and cognitive psychology specialists in order to identify people's reactions to various products, as well as specialized tools for observing the human brain's reactions to various marketing stimuli and its electrical activity. Brain waves, as measured by the EEG, do not lie. They don't hesitate, they don't give in to peer pressure, they don't hide their pride, and they don't say what others want to hear.

There are still debates about these rational-emotional relationships today, especially since the conventional view holds that we should not be influenced by emotions when making decisions. We learn through experience, and we improve through repetition. Human thoughts and emotions are the result of this subconscious activity, so the actions triggered by them cannot be explained in a conscious context, which is why most market research fails to reveal the true preferences of the subjects involved. According to new research, the consumer's response to advertising is based on cognitive efficiency rather than marketing manipulation.

New research in the field of highlighting the negative effects of advertising on the human psyche is emerging. The findings explain why direct exposure to repeated advertisements increases consumers' preferences for advertised products, particularly those advertisements for which consumers are the last to be informed (aware) of their very repetitiveness (that they have seen them before). The human brain devotes the majority of its resources to the subconscious, while conscious action consumes only 2% of its energy.

Future neuromarketing research using EEG analysis will consider delta oscillation variations, and alpha, beta, and gamma brain waves will be divided into two categories of lower (low) and upper (high) values.

The integration of neuromarketing in marketing is a long process because this field is still in its infancy. Performing neuromarketing analyzes can determine the consumer's profile from a cognitive point of view, the analysis of brain waves, but it can also use Affective Computing systems and systems for detecting emotions in the voice. Currently, in the EU, the use of personal data and data obtained through neuromarketing are regulated by GDPR legislation. This aspect leads to people's reluctance for such marketing studies.

Finally, instead of concluding, *I propose the following reflection scenario:*

2050: Individual connectivity to the Internet (IoT) will make information abundant, from diverse sources (e.g., sensors, scanners, colleagues), highly granular (information flows being associated with individuals, time and space),

and intimate (biometric elements, thoughts - by brain scanning and affective computing).

Data availability and progress in processing capabilities (graphics processors, quantum computer) will lead to a qualitative leap in understanding emotions. Sophisticated markers for emotion detection and analysis and their interpretation will be widely available. These devices perform facial and gesture recognition - brain computer interface - and will be incorporated into portable devices (smart phones, headphones - Brain Fingerprint, smart video cameras). In such a scenario, the population will be made up of „emotionally transparent" generations, with a greater desire to share emotions through „emotion-oriented" or „directed emotion" gadgets. People will look for new experiences using complex social networks, different from the existing networks. The Internet of emotions, part of the IoT, will fully enter the daily life of the population. Interpersonal communication will be achieved almost exclusively through brain waves transmitted via IoT. Socialization will focus on the virtual side, people becoming part of artificial intelligence. The advantage of this communication system will be the detection of the real feelings of the interlocutors, and the language between the brains, brain to brain, will no longer be able to be disturbed by hidden intentions. Will the lie disappear?

In the general context, companies and politics will seek to integrate this technology into their current activity. Economically, companies will seek to provide emotional experiences, while governments will explore opportunities to understand citizens' emotions and gain feedback to develop better policies, but also to achieve political victories.

However, the impact of IoT communication on the population can have different directions: some will try to exploit the opportunities of new technologies, others will be concerned about the threats that emotional relationships can generate in all areas, personal and professional: in relationships with parents (emotional control) , employment („emotional analysis"), education (emotion-based learning methods), healthcare (monitoring and personalization) and last but not least in the decision-making process (emotion-based policy - neuromarketing / mind control).

Brain-to-brain communication, using Artificial Intelligence, will allow humanity to develop its „seventh sense" in terms of emotional intelligence.

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