Use of EEG as a Neuroscientific Approach to Advertising Research

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Abstract

This exploratory work intends to give an overview of the tools that neuroscience has brought to marketing, how they can help consumer research and to clarify results that have been presented to the academic community but still deserve further validation. We also studied how ads are perceived in the brain (Advertising Research) and tried to "bring to light" what private corporations have been doing in neuromarketing.

In recent years research in neuromarketing has been multiplying. We revised some of that recent work, and the cornerstones of neuromarketing research. Questions about validity and reliability have been raised. Doubts about the utility of neurosciences in marketing still persist, and fear about whether neuroscience can be used in an invasive way against privacy principles still endures. We intend to give some guidelines for future research and present results that can help validate the neuroscience tool we are using, the electroencephalogram (EEG).

We recorded the EEG of 20 participants, all men, right-handed, and in between 20-29 years, while they were viewing 30 TV commercials, divided into 5 blocks that appeared in random order. We analysed the results by doing frequency analysis and a LORETA analysis.

We concluded that the ad that received better score on the questionnaire had more emotional processing neural circuits activated than the ad that received worse scores, and that EEG is a valid technique in Advertising Research. However, more research is needed for the study of the brand itself and how it influences the perception of an ad.

Keywords: Neuromarketing; Consumer Research; Advertising Research; electroencephalogram (EEG); LORETA

1. Introduction

In recent years neuroscience has been experiencing a rapid development, as new brain imaging techniques appear, and old ones improve (Lee, Broderick et al. 2007).

In this thesis we intended to apply a well known neuroscience technique into Marketing, which is becoming commonly known as the field of Neuromarketing. The focus of the study is on how brain responds during the visualization of short advertising movies. Using the electroencephalography (EEG) we will study the main brain regions being used during the stimulus, and also the frequency bands.

1.1. Neuromarketing

In early days, marketing was considered to be only advertising, distribution and selling of an industry (Adcock, Halborg et al. 2001; Kotler and Keller 2008), but now because of the use of other academic areas like social sciences, psychology, sociology, mathematics, economics and more recently neurosciences, it evolved and it is recognized as a more comprehensive science. Contemporary approaches give different dimension of marketing such as: relationship marketing where customer has the lead role, business marketing, and social marketing where society benefits it is what matters (Adcock, Halborg et al. 2001). With the current decline of advertising power and brand's rising competition the new marketing challenge is now how to create consumer value receiving value in return (Engel, Blackwell et al. 1995). Marketers have turning to Neuromarketing has a possible solution on discovering how to create that value.

Neuroscience intends to gather knowledge about the structure and function of the brain. A specific branch of neuroscience is cognitive neuroscience that tries to understand the neural mechanisms behind thoughts like

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reasoning, emotion, memory, decision making, and so on. Neuroscience has been applied in marketing to help in notions of positioning, hierarchy of effects, and brand loyalty (Perrachione and Perrachione 2008). So, neuromarketing is a branch of the general field of neuroeconomics, which is an interdisciplinary field that combines economics, neuroscience and also psychology, to study the brain function in decision-making situations (Kenning and Plassmann 2005).

Despite all the advances in neuroimaging, marketing research is still unaware of its huge potential. In fact, this has caused some controversy along its still brief history, on the basis that neuromarketing is only interesting in "finding the buy button in the brain" (Lee, Broderick et al. 2007). Because of that, while neuroeconomics for the last two decades have been importing knowledge from psychology ("*Behavioural economics*") and neuroscience, neuromarketing only very recently did so (Camerer, Loewenstein et al. 2005).

Today modern economy is based on Bayesian maximization of expected utility, in which humans (*homo economicus*) are equipped with unlimited knowledge, time and information-processing power (Bechara and Damasio 2005). However, new neuroscience evidence suggests that emotional processing is important in decision-making. The somatic marker hypothesis, formulated by Antonio Damasio, is a response to the rejection of emotion in economics, and proposes that: man is not completely rational, he too has emotions and our decisions are not only guided by knowledge and reasoning; in fact emotion can be beneficial in decision-making when it's integral to the task; and decision with uncertainty has different neural circuits than with certainty (Damasio and Sutherland 1995; Bechara and Damasio 2005).

The application of neurosciences in marketing is huge and has its advantages. First, until neuromarketing appeared, the traditional methods used by marketing were mostly based on self-assessment measures that rely on the ability and willingness of the participant to report correctly their attitudes, their behaviours, or how they feel, which are less powerful and explanatory than once believed (Fugate 2007). Moreover, many effects that are determinant in decision and influence behaviour are not perceived consciously making them impossible to report. But neuroscience methods can go deeper to the underlying biological and chemical processes which will give us a better view of psychological and behavioural processes, allowing finally to have a more direct view into the ultimate "black box" (Hubert and Kenning 2008; Harmon-Jones and Beer 2009). Thirdly, the participants cannot bias or influence the results, as they have little to no influence on the measurement of brain activity (Camerer, Loewenstein et al. 2005; Hubert and Kenning 2008). Furthermore, physiological responses can be collected at the moment of the experience instead of some traditional methods where the results are obtained after the stimulus (Lee, Broderick et al. 2007). And last, new theories about brain mechanisms can be studied and existing ones can be reassessed. Ultimately, neuroscience's goal is to understand how human brain produces behaviour (Glimcher 2004), and neuroeconomic and neuromarketing's goal is helping out in what classical economics theories have failed to explain: how human behaviour, their characteristics and the way they think influence decision-making.

Advertising research is one of the many fields of marketing research, and where neuroscience has been helping out. The goal of advertising research is to improve the efficiency of advertising, whereas the goals of advertising are to influence: consumer's decision; response to products; and consumer's experiences (Kenning, Marci et al. 2008). In this particular study we wanted to know how the brain works during the visualization of TV commercials, which can be considered a sub-area of neuromarketing, consumer neuroscience. Two main "*visions*" exist: ads work rationally; and effective ads trigger emotion. Recent studies confirm that emotional responses are essential to the effectiveness of an ad, and are essential in consumer decision-making (Ambler, Ioannides et al. 2000).

The use of EEG and other techniques on the study of the reaction to TV advertising has already been addressed, from the study of asymmetries on the brain (Davidson and Hugdahl 1996; Ohme, Reykowska et al. 2010), to the study of long-term memory and development of new methods like steady-state visually evoked potential (SSVEP) (Rossiter, Silberstein et al. 2001), attention, emotional processes, and functional brain mapping (Wang and Minor 2008).

1.2. Objectives

During the experiment built for this study, we intend to test briefly explore the following areas:

– confirm if the EEG is a reasonable valid and reliable technique on the localization of activated brain's structures during the visualization of short commercial movies;

– identify the key moments of a TV commercial;

– understand how brand perception influences when watching ads of the brand;

– differences between ads that have different scores (better score vs. worse score).

Neuromarketing is still a young field and in a growing stage, much more research is needed. General theories are yet to be created, validation is yet needed for some psychophysiological techniques, for how brands are perceived in the brain, and what mechanisms are really involved is still unknown. It is on these areas that we propose our work, hoping to create helpful guidelines for future researches. This work intends to add knowledge by using EEG and the three CNS measures (non hemispheric brain wave analysis, brain lateralization, and brain imaging analysis), and we aim to validate not only EEG as able to make the three CNS measures but validate the use of EEG in marketing research, specifically in advertising.

2. Experimental Design

2.1. Participants

We selected 20 male participants aged from 20 to 28 years (mean age = 23.05 ± 1.045), all right-handed, and mainly students from the university. We chose only right-handed individuals because of differences that occur in brain lateralization between right- and left-handed. With these constraints we obtained a homogenous group in terms of gender, age and laterality, which is important in experiments like this.

2.2. Procedure

In the beginning of the experimental design of this study we followed some guidelines given by Harmon-Jones and Beer (2009). After informing the participant about what was going to happen we started the preparation time. During this preparation time, we cleaned the face of the participant with an exfoliant (Nuprep™), in the forehead, in the earlobes, and the places where the vertical electro-oculogram (VEOG) and horizontal electro-oculogram (HEOG) electrodes would go. These electrodes are made of tin (Sn) or silver/silver chloride. This procedure is essential for the removal of dead skin and the decrease of the impedance of the skin on those places. Afterwards we used alcohol to remove the excess exfoliant.

The electrode placement system we used was a 10-10 system. That is an expansion of the 10-20 system, where the first frontal electrodes are placed 10% of the total length (measured from the nasion to the inion) above the nasion, and the rest of the electrodes are spaced 10% between them. The cap we used had 64 channels and its size was Medium (54 to 58 cm of head circumference). It is also important to mention the reference used. We opted to use a common average reference, although we placed electrodes on the earlobes, because we were going to analyze the data with LORETA and this method recalculates the data to a common average reference (Murray, Brunet et al. 2008). After the placement of the cap we would fix it with a band around the participant's chest.

Because the electrical activity of the brain is so low (10 μV to 100 μV) we need to have very low impedance on the electrodes of the cap. The recommendation in the literature (Harmon-Jones and Peterson 2009) is that impedance must be kept lower than 5 kΩ, and to do so we filled the sensors with gel (ELECTRO-GEL™).

Finished with the electrolyte filling, we presented the stimuli. It was necessary to use the software E-Prime 2.0 to make the presentation and synchronization of the stimuli with the EEG. During the presentation of the TV commercials, the subjects were isolated from anything that could distract them, and seated 1 meter apart from the computer screen. The computer screen had 19 inches and a screen refresh rate of 74 Hz. It is important to notice that the refresh rate of the monitor is higher than the frame rate of the videos (18 frames per second), so no frames were lost during the presentation of the videos. It is also important to mention the sampling frequency used for the EEG record was 500 Hz. After the presentation we would take off the electrode cap, and the participant washed his head. Then the participant was asked to answer a questionnaire, again in the computer. The questionnaire consisted of closed answers, with a Likert scale. The questions were about the brands they saw in the TV commercials and whether they liked it or not (1 – hate it, 2 – didn't like, 3 – indifferent, 4 – like it, 5 – love it). We also did another questionnaire about the TV commercials, again with a Likert scale (1 – hate it, 2 – didn't like, 3 – indifferent, 4 – like it, 5 – love it).

2.3. Paradigm

The paradigm of the experiment consists of five blocks of six different TV commercials each one. The TV commercials have approximately 30 seconds each. Between each video there is an inter-stimulus of the duration of 6 seconds. This inter-stimulus is a black cross. The order of appearance of each block is random. Each block has six TV commercials. In total there are 30 videos.

2.4. Filters

During the recording the software we used performed an online filter, rejecting the 50 Hz, corresponding to the frequency of the electricity in cables. Then we did Raw Data Inspection excluding all amplitudes in the recording lower than 0.5 μV. In this step every trial did not have this type of artefact. Thirdly we used an infinite impulse response (IIR) filter, the Butterworth Zero Phase filter type, with low cut-off of 0.3 Hz, time constant of 0.5305 seconds and 24 dB/octave, and with high cut-off of 40 Hz and 24 dB/octave. After the filters we used an Ocular Correction ICA, allowing the correction of the artefacts due to eye movements like blinks and saccades. We used this algorithm in a semi-automatic mode, so we would always see first what was going to be eliminated. This is crucial because sometimes these algorithms can eliminate components of the EEG that are not necessary. After that we applied an Artefact Correction. Finally we applied a Baseline Correction on the segments. The baseline correction uses the points of the inter-stimulus and subtracts on the segment of the stimulus.

3. Results and Discussion

This section will be divided into the three analyses we have done, where in each section the most important results will be presented and discussed.

3.1. Spectral Analysis

First, we did a basic statistic analysis of the questionnaire about the TV commercials that the subjects saw. The best ad was the Licor Beirão 2 that had the best mean (4.125), and the worst was Optimus 2 that had the worst mean (2.625). We also did a t-test (pair) for these ads, obtaining the values shown in the following Table I.

Table I Values of the t-test between the ads Licor Beirão 2 and Optimus 2.

	Mean difference	DF	t-Value	P- Value
Licor Beirão 2, Optimus 2	1.7502	19	6.254	<0.0001

For this first analysis we studied two ads that according to the questionnaire were the most opposite and had different responses (Licor Beirão 2 and Optimus 2). We applied a Fast Fourier Transform with a Hanning window of length 10%, with a resolution of 0.031 Hz, giving us the power (μV^2) of each frequency. The software which we worked with allowed us to create brain mappings of the frequency spectrum (see Figure 1and Figure 2).

By visualizing the brain mapping of the frequencies, we can see that the video Licor Beirão 2 has a bigger activity of the theta waves in the midline frontal. According to (Aftanas and Pavlov 2005) theta activity is related with increased approach-related behaviour and working memory. Theta waves have long been associated with emotional processes. Some studies conducted with children have shown that rhythms of 4 Hz seemed to be related with pleasure. However they do not have been reported in the adult EEG (Niedermeyer and Lopes da Silva 2005). Further information about theta waves will be given later, but for now it is important to retain that indeed it is believed that theta waves are correlated with emotions and limbic regions.

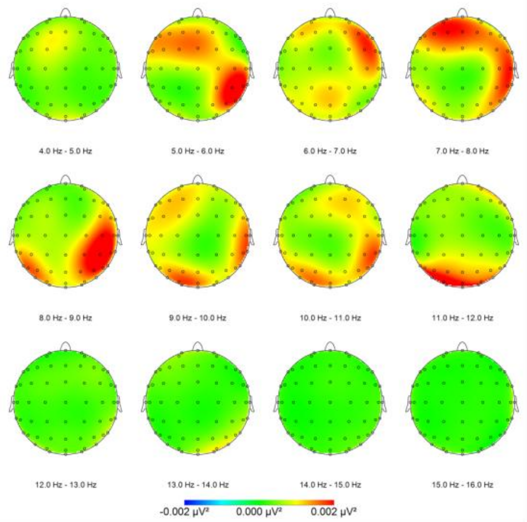

Figure 1 Brain mapping of frequencies for the average of the participants who gave positive scores for the ad Licor Beirão 2.

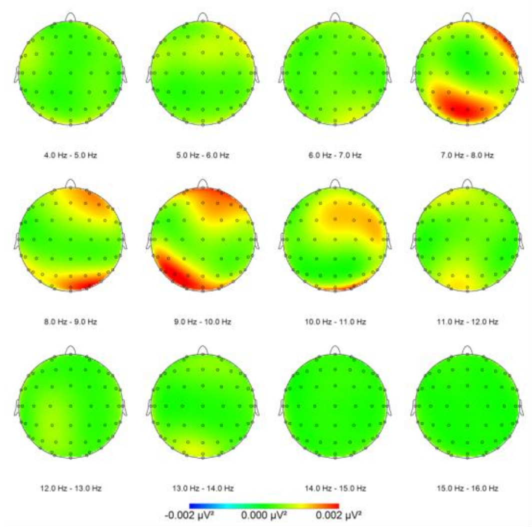

Figure 2 Brain mapping of frequencies for the average of the participants who gave negative scores for the ad Optimus 2.

As we can see for the ad Optimus 2 no significant theta activity occurs. This was somehow expected as the ad Optimus 2 received the worst scores and the ad Licor Beirão 2 the best. As for the alpha band, the ad Licor Beirão 2 has more activity in all the spectrum of the band, nonetheless for both ads there is alpha activity majority in occipital regions. It is believed that the origin of alpha rhythms can be localized in the primary and secondary visual areas of the occipital cortex (Feige, Scheffler et al. 2005). So it is expected to see occipital alpha rhythm, but how the visual stimuli used influenced that activity is still unclear. The amplitude of those rhythms do not only depend on visual stimulation, but also on visual imagery, vigilance, and visual attention, moreover what structures are responsible for alpha rhythm fluctuation and their role is not yet described (Feige, Scheffler et al. 2005).

Additionally we analysed the second questionnaire. Like previously we did some basic statistics. It was selected one brand that received extreme scores, and obtained the differences of the frequencies activated in the brain scalp. Sagres was a perfect case for the extreme scoring, with four participants giving maximum score (5) and other four giving low score (2). We obtained for the Sagres 1 video for the participants that gave the best scores and the worst scores the following brain maps of frequencies represented in the Figure 3 and Figure 4.

With this analysis we intended to infer if there would be any significant difference in the brain maps between the participants who dislike and like the brand Sagres when viewing an ad of that brand.

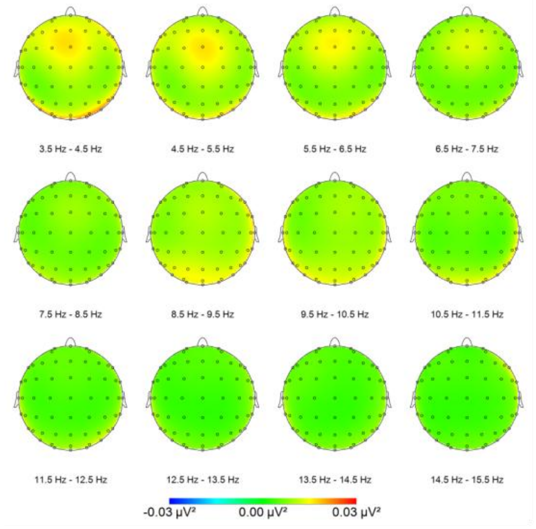

Figure 3 Brain mapping of frequencies for the average of the LS group for the ad Sagres 1.

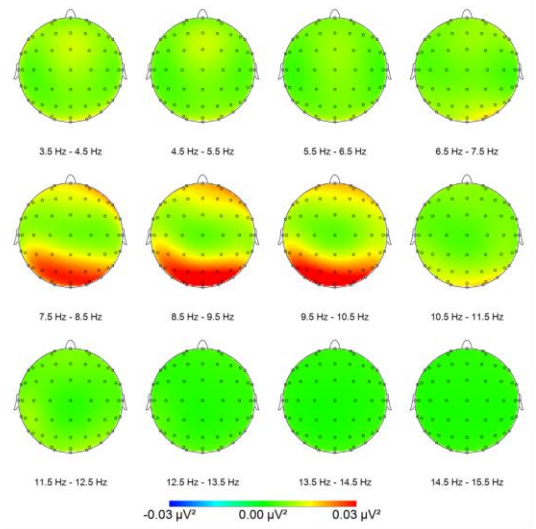

Figure 4 Brain mapping of frequencies for the average of the DLS group for the ad Sagres 1.

We observe only significant differences in the alpha band. The group DLS had greater activity in the occipital cortex for the alpha rhythm. As mentioned previously the alpha rhythm origin is believed to be the occipital cortex, for visual areas. Moreover it is known that alpha rhythm is related with decreasing of information processing ("idling rhythms") (Feige, Scheffler et al. 2005). So we can interpret these results by saying that the group DLS had less attention to the ad and was not so interested when watching it resulting in the increasing of alpha rhythms in the occipital cortex. However, one thing we should have in mind before coming up with conclusions is the group size.

3.2. Asymmetries Analysis

We exported areas of the frequencies power density calculated with the FFT for three different frequency bands (Alpha, Theta and Beta). After that we normalized the data using the natural logarithm function, which can be done because power values are positively skewed (Davidson, Ekman et al. 1990). Then we did a t-test comparing the differences between the theta power and the beta power of the videos Licor Beirão 2 and Optimus 2. In this case we used an average of all the electrodes for both wave rhythms (seeTable I).

It is interesting to find that both theta and beta have a greater activity when subjects were watching the Licor Beirão's ad. As mentioned, theta waves have been correlated with emotions and limbic regions of the brain. Slow waves like theta are related with processes like emotion and memory. In particular, theta activity in the midline frontal is related with low anxiety and increased approach-related behaviour, and with working memory (Aftanas and Pavlov 2005). The septo-hippocampal complex is responsible for the generation of theta frequencies (Schutter and van Honk 2006). So if in fact the video of Licor Beirão 2 had more emotional content this could explain the results. Furthermore, theories like Memory-Affect-Cognition (MAC) theory suggest that emotion plays an important role on the memorization. Therefore, if an ad appeals more to the emotions ("affect") that ad would be also more remembered. Once again further questionnaires would be necessary to explore this theory. As for beta waves, they are related to alertness, focus, and task management (Young 2002). This shows us that the video of Optimus did not receive so much attention as the video of Licor beirão, and thus possibly explaining why the disparity of scores.

It was also studied asymmetries for the brand Sagres, choosing the commercial Sagres 1. The same initial procedure of exporting and normalizing done for the previous ads was employed here. Between the subjects who classified the brand negatively and positively (the DLS and LS groups defined previously) it was analysed the statistical difference between the theta power and the beta power between the two groups (see Table II).

Although the mean difference is according to the expected (more theta and beta waves for the group that liked the brand), the P-Value is bigger than 0.05 and therefore no statistical significant information can be extract from the table. It is only feasible to make assumptions based on the possibility that more participants would do the experiment and the mean difference would remain the same. If these happened, confirmation that a person who does not like a brand has less emotional brain structures being activated when watching an ad than a person that likes the brand would be possible to make. Of course this is a strong statement. But studies, like McClure, Li et al. (2004), concluded that knowing a brand and having preference for that brand can override the sensory information. The work mentioned used two familiar cultural drinks, and showed that when not knowing the brand structures responsible for sensory information processing were more activated, but when the brand was showed other structures were more activated, like the DLPFC and midbrain.

Table II Values given by the t-test of the average of the theta power and of the beta power in all electrodes between the two ads

		Mean Difference	DF	t-value	P-Value
Theta	Licor Beirão 2, Optimus 2	0.525	19	9.799	<0.0001
Beta	Licor Beirão 2, Optimus 2	0.954	19	15.017	<0.0001

Table III Values given by the t-test of the average of the theta power and of the beta power in all electrodes between the two groups

		Mean Difference	DF	t-value	P-Value
Theta	DLS, DL	-0.087	3	-1.575	0.2134
Beta	DLS, DL	-0.185	3	-1.072	0.3623

3.3. LORETA

In this last analysis we used the method Low Resolution Electromagnetic Tomography (LORETA) by resorting to the software sLORETA (available free online) developed by the "father" of this method, Roberto D. Pascual-Marqui and his co-workers. With this analysis we are interested in finding the differences between two ads with extreme scores, one with the best ones and another with the worst. Like before we chose the Licor Beirão 2 and Optimus 2 commercial. We contrast the regions of the brain being more activated for each ad against an average of one second of the inter-stimuli. The average was calculated for each participant, using their EEG signals during the inter-stimulus of six seconds. We segmented each video in intervals of one second, and exported that data for the software. The tutorial of the software guides us through the initial steps. First, we need to transform the electrodes system we use into the Talairach electrode coordinates. Then we can make the sLORETA transformation matrix. We are ready now to perform a tANOVA. This step is essential to see when the two experimental conditions (during the video and during the inter-stimulus) differ. Only then we can obtain the images of the sLORETA that indicates us what regions of the brain are being more activated when compared to the inter-stimuli.

We started by analysing the video of Licor Beirão. We decided to show only three moments. These moments were considered to be the key instants of the ad. By previous knowledge, we already know that the initial, final and the moments with the product are the most important in the recognition of an ad (Astolfi, Fallani et al. 2008). Based on this we selected the first second, one second that would go from 3000 ms to 4000 ms and a second that would go from 2500 ms and 2600 ms (see Figure 5).

In the first second it can be seen that one of the activated regions is the Fusiform Gyrus. One of the functions of the fusiform gyrus is face and body recognition. Actually, studies show that fusiform gyrus has a specific region that is selectively activated by faces (Kanwisher, McDermott et al. 1997). As we can see in the Figure 5 A) on the first second two people appear with focusing of their faces. Thus, it is understandable and reasonable to see this region being more activated. Also, BAs 18 and 19 related to visual association, to shape recognition and attention start being more activated. Again understandable since the participants were watching a video, furthermore, areas like the primary, secondary and associative visual cortex will be activated through the entire ad. It is interesting to see an activation of the Limbic Lobe, Parahippocampal Gyrus since the first second of the video. This cerebral region is responsible for encoding and recalling places (Aguirre, Detre et al. 1996). In this second the two people enter on a pub so that's why this region was being activated, the participants were recalling or recognizing the space as a pub.

After the 3rd second the attention is drawn to another actor. A very characteristic Portuguese sound from bullfights can be heard as the attention is drawn to the newcomer. A representative frame of this sequence is shown in the Figure 5 B). During this second, regions of the Temporal Lobe are activated. The Temporal Lobe is involved in auditory perception. This activation can be explained by the sound heard on this sequence of the video. It can be seen that frontal regions of the brain in BAs 6, 7, 8 and 9 start being activated. BAs 8 and 9 and parietal BA 7 have been correlated to the memorization process of an ad. Prefrontal and parietal regions play an important role in coding the information that it will be remembered by the subjects from the ads (Astolfi, Fallani et al. 2008). So the sequence from this ad can be identified as a key moment on the recognition of the ad. Whether this moment would be remembered afterwards requires another study and all new paradigm that we did not explore. It can also be seen that limbic regions, particularly the cingulate cortex, are activated. The anterior cingulate cortex (ACC) is believed to interact with other brain structures as a part of the circuit responsible for cognitive and emotional processing (Bush, Luu et al. 2000), which leads us back to MAC theory and others like the somatic marker hypothesis of Damasio.

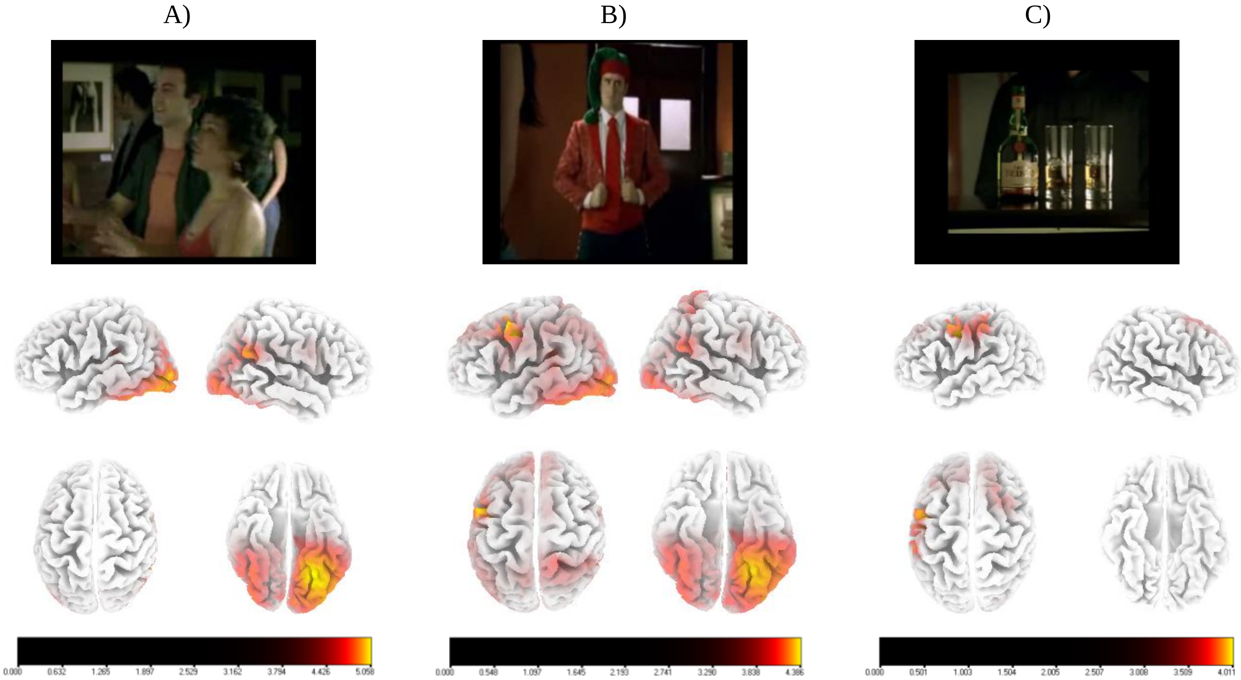

Figure 1 3D images of the cortex with the regions being more activated for the three moments. Each moment is represented by a frame. A) First second of the ad. On the top a frame take from that second and on the bottom a group of four views of the cortex (left, right, top, bottom, from the left top to the right bottom). This structure is common to the following sub-parts of the figure. B) From the 3rd second to the 4th of the ad. C) From the 25th second to the 26th second of the ad.

Both theories brought back to economy the importance of emotions in decision-making. If in fact, emotions play a key role in decision and are so important in the process of memorization, and because the results show activity on structures responsible for emotional processing (like the VMPFC as claimed in Damasio hypothesis), and because of what has been said until now, we can allege that this moment will be memorable and probably important in the recognition of the ad. Moreover, we can allege about the effectiveness of this ad, because studies have shown that attractive ads lead to a stronger activation in the VMPC that is important in the integration of emotions in the decision-making process, and in the nucleus accumbens (reward stimulus) (Kenning and Plassmann 2008).

At last, we are interested in viewing what happens when the logo of the brand or the product appears, represented in Figure 5 C). The logo of Licor Beirão does not appear alone, it appears on a bottle (Licor Beirão is a Portuguese liquor) and it starts coming into sight at the second 22 being clearly visible after the second 23. It is interesting to see that regions of the cingulate cortex are being activated during these moments of the ad. The cingulate cortex makes part of the limbic lobe and it is involved in emotion formation and processing. Santos (2008) also reported in his work the activation of the Paracingulate Cortex when viewing brand logos, making a correlation with the Theory of Mind. The Theory of Mind is the ability to understand others as psychological beings that have mental states like desires, beliefs, emotions, intentions, and so on (Meltzoff 1996). The medial frontal cortex (MFC) plays an important role in social cognitive processing, such as the ones explained by the Theory of Mind like self-reflection and person perception (Amodio and Frith 2006). What the results show is that in the moments where the brand appears structures like Brodmann areas 8, 9, 10 and 32 (belongs to the MFC) are more activated. This confirms that watching brand logos trigger the same brain structures used when there is self-reflection or when making inferences about others' thoughts, which is in accordance with Santos (2008). Therefore, it can be said that brand have a social intrinsic value and that can be use to categorize others, confirming what other studies have theorized: brand is more than just a logo, or a name, or a colour or a shape (McClure, Li et al. 2004; Schaefer, Berens et al. 2006; Koeneke, Pedroni et al. 2008).

Next, we wanted to compare the last results with the TV commercial of Optimus. So, the same procedure done before was applied to the ad Optimus 2. As before, it was selected three moments of the ad: the first second, one in the middle and one in the end were the brand appeared (see Figure 6).

Starting by analysing the first second, it can be seen that fewer regions are being relatively activated (remember that this are activations when comparing to the inter-stimulus) than in the ad of Licor Beirão. The Temporal Lobe is being activated corresponding to the short high pitch noise that it is heard on the beginning of the ad. It is also interesting to see that there is more activation on the right hemisphere, which could mean that there is retrieval of episodic information (HERA model).

Contrasting the results for the two ads, whereas for the video Licor Beirão 2 the Occipital Lobe is more activated, for the video Optimus 2 it is rather the frontal regions. An explanation is the poor visual stimuli that the video has during the first second.

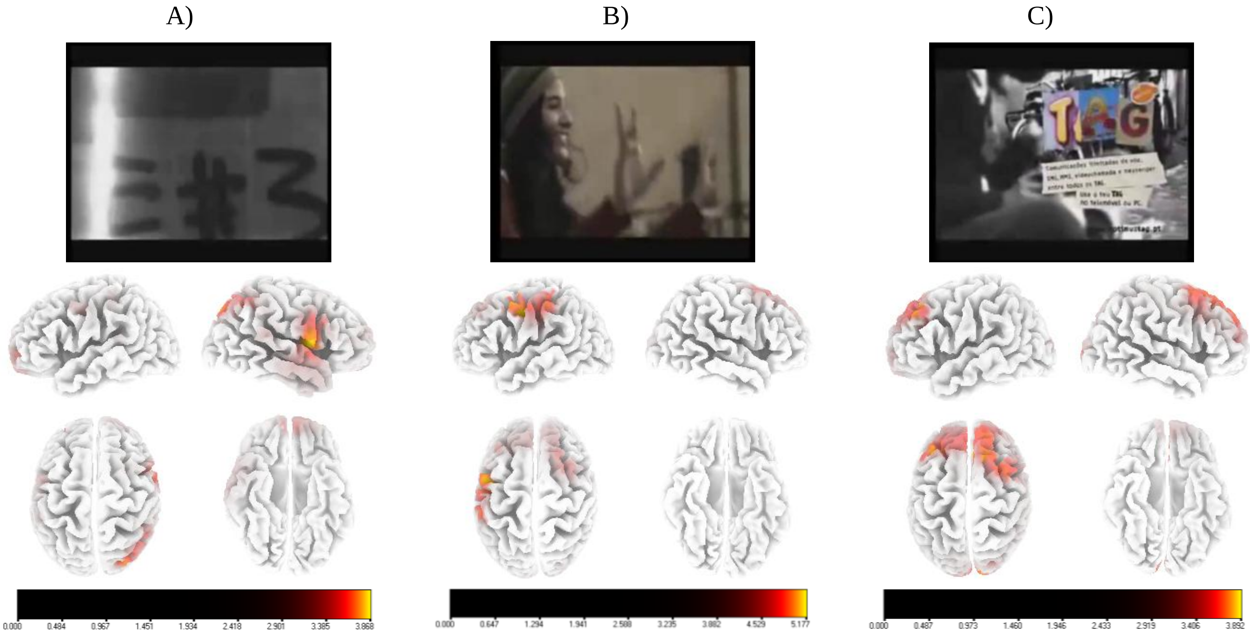

Figure 2 3D images of the cortex with the regions being more activated for the three moments. Each moment is represented by a frame. A) First second of the ad. On the top a frame take from that second and on the bottom a group of four views of the cortex (left, right, top, bottom, from the left top to the right bottom). This structure is common to the following sub-parts of the figure. B) From the 25^{th} second to the 26^{th} of the ad. C) From the 29^{th} second to the 30^{th} second of the ad.

The second instance chosen was randomly picked because we did not notice any special moment in the ad. Unlike the other ad that introduced a sudden change, in this ad there is always the same girl speaking. We decided to choose the second from 25 to 26. However, we should also refer the brain regions being activated until this second. Parietal Lobe and Superior Frontal Lobe are the regions more activated. According to works, cognitive content produce stronger in posterior parietal areas and superior prefrontal cortex activation, whereas affective content produces activity in orbitofrontal and retrosplenial cortex, amygdala and brainstem (Ioannides, Liu et al. 2000). So, it can be assumed that so far this ad has more cognitive content than affective. The second instance is one of the fewest moments where there is slightly more left hemisphere activation than right. Also some parts of the cingulate cortex are activated. In this second, shown in the Figure 2 B), it can be seen that the girl is happy, explaining this activations.

The last second it is the appearance of the brand, as shown in the Figure 2 C). There are words under the logo of the brand, and we can see that the background it is not black, so there are a lot of other stimuli when the brand appears. The Occipital Lobe, from 28000 ms until 30000 ms, starts to be activated. As it is known, one of the functions of the Occipital Lobe is reading. The fact that this region only starts to be activated when the logo and the words under appear suggest that the participants were reading. Again, some regions of the Cingulate Cortex are activated just like when appeared the logo of Licor Beirão. The interpretation is the same as given before. However, the regions activated for this ad are fewer than for the Licor Beirão. To interpret these results we should clarify that the brand Optimus received many indifferent scores. On the other side, Licor Beirão it is a rather negative brand. When comparing positive brands with indifferent brands it has been found that the positive ones activate neural circuits responsible for emotional processing, the same described in the somatic marker hypothesis proposed by Damasio, whereas the indifferent did not (Santos, Brandão et al. 2007). Those results were only not generalized for negative brands because of the lack of statistical significance. However, in this case we found that some of those regions responsible for emotional processing are indeed activated for Licor Beirão and are not for Optimus. This may be another confirmation that brands have emotional content. We are not generalizing only because the logo does not appear isolated so we cannot be completely sure that this activation is not due to other stimulus. Overall, the ad of Optimus had less emotional neural circuits being activated than Licor Beirão. The only question remaining is if that led to a worse score of the ad and had influence on the effectiveness of the ad.

4. Conclusions

This work was essential in providing key tools and knowledge about fields like neuromarketing, consumer behaviour and advertising research. These tools and knowledge will be undoubtedly useful for future works. The results obtained, given the limitations that we had and the novelty of this field, are considered to be satisfactory.

The first result obtained showed that the video Licor Beirão 2 had greater theta activity in the midline and frontal cortical regions than the video Optimus 2. We concluded that this could mean more emotional content in the first ad. Both had also alpha rhythms activity in occipital regions, congruent with the fact that this rhythm is known to be originated in the occipital cortex.

Secondly, the same analysis was done for the Sagres ad, but dividing the participants into two groups: Dislike Sagres (DLS) and Like Sagres (LS). The aim was to see differences between the two groups when viewing the same ad. No differences were seen in theta rhythms, but there was more alpha activity in the occipital cortex for the DLS group. The interpretation given was that, because alpha waves means less activation of those regions, maybe that group was not so focused on the video. However, we concluded that more participants would be necessary to come up with a clearer and a more significant result.

Next we decided to do a combined analysis of the two questionnaires. An unpaired t-test was performed by dividing the questionnaire about the brands into three groups for each brand: Dislike the brand (DL), Indifferent (I) and Like the brand (L); and comparing the scores given by each group to an ad of that same brand. It was concluded that the participants who like the brand tend to give better scores to the ad of that brand, but some ads received better or worse scores whether they dislike it or not (e.g. Licor Beirão and Optimus, respectively). Therefore, this analysis can also show that in fact Licor Beirão ad is an effective one and Optimus ad not.

The next analyses were about asymmetries in the brain, using alpha, theta and beta bands. First, were studied alpha power asymmetries for the ads of Licor Beirão and Optimus. The results here were not conclusive. The asymmetries that other studies found were not perceived here. However, another study from Davidson et al. (1990) obtained the same results, concluding that analysing the whole video would not work. For the same ads we analysed the theta and beta power dominance for the entire brain cortex. The results show that Licor Beirão had more theta and beta power. In this case we were not looking for asymmetries but for dominances of specific wave rhythms. We concluded that the video of Licor Beirão had more emotional (affective) content, because of theta waves, and that participants were more focused and alert to this video, because of beta waves. In general it can be said that this video provokes an approach-related reaction when compared with the ad of Optimus.

Again the same procedure was performed for the two groups of the brand Sagres. The results for the alpha band were again inconclusive. Although, in the study of the brand Sagres the results were not conclusive, it would be interesting to further explore this issue. Further study of the differences between the group that dislikes a brand and the one that likes the brand, when watching a commercial is necessary and interesting. As it was said, one of the reasons a significant result did not appear may be due to the small group of people (only four for each group). Future research with more participants, with focus on one brand and showing just one commercial of that brand is necessary.

The last analysis used the software sLORETA for the identification of brain structures that were activated. The results showed that there was a possible key moment in the ad of Licor Beirão, that might be more recognized. In general the ad Licor Beirão 2 had more activation in sites like the prefrontal region and cingulate cortex, confirming that indeed Licor Beirão’s ad had more emotional content. The ad of Optimus did not have so many limbic regions being activated, but rather the Parietal Lobe was more activated indicating that the video was more cognitive. To infer about the recall of the ad, and establish a correlation with the higher emotional or cognitive content further studies are necessary using another paradigm that includes a posterior questionnaire.

We also analyse the moments when the brand’s logo appeared. Interestingly, some regions activated were the same as in the study of Santos (2008) that used only images of logos and divided into three groups: positive, negative and indifferent. It was concluded that, although the results were similar, we cannot separate the logo from the context of the ad, thus is not completely sure what provoked those similarities. We have found that there was an ad that had better scores and had more emotional processing neural circuits activated, and that there was an ad that had worse scores and less emotional processing neural circuits activated. Now it is necessary to explore if the ad that better scored was more effective in the long-term and if that effectiveness is due to more emotional content.

5. References

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