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Neurological Analysis of Consumer Behavior in Shopping Malls Using EEG

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Abstract

Today, shopping centers go beyond purchasing based behavior. As intangible variables, effective social factors also affect consumer behavior. These variables cannot always lead to purchasing but create a potential customer who is exactly exposed to promotional incentives. It should be noted that identifying these intangible factors can only be extracted through non-self-reporting methods. Thus, the use of neuroscience techniques can be a necessity. This study was an exploratory research that applied electroencephalographic tools to record brain signals through EPOC+ 14-Electrode Wireless EEG device. The signals were cleared using EEGLAB Software through ASR Method. The population consisted of two groups of three people (control and experimental group). The seven elements of the shopping centers proposed by Arpita Jare were used to provide stimulus. Thermal map analysis for F3 and F7 electrodes and correlation between the seven elements and brain waves showed that control group had a significant behavior in comparison to experimental group due to their interest in shopping centers (P-Value <.05). Results showed that consumer behavior in shopping centers is not affected by tangible factors such as product brand but social and cultural interactions and intangible elements are also effective that are hidden from marketers and designers' view.

***Keywords*:** Shopping Centers, Electroencephalography, ASR

1. Introduction

Purchasing has penetrated as a daily activity in human social processes (Miller, 2013). Purchasing behavior has obtained through social interactions and concept/basis of the situation. It is assumed that markets are the focal point of popular entertainment which contribute to the economic and social environment of cities (Robertson, 1995), these findings helped to the study of Hernandez & Jones (2005) and Padila & Eastlick (2009). They are culture index and entertainment centers which help to meet consumer satisfaction according to desirability and excitement of their needs. Several past researches have tested this particular atmosphere related to store facility criteria that help to support the market and its attraction (Horweel & Roges, 1981).

There is a certain characteristic which is considered as the main criterion of life and living in a being, city, building, or space. Although, the characteristic is considered slight, it is able to create a spiritual basis. In fact, the characteristic has been repeatedly expressed as the concept of "sanctity" (Essawy et al., 2014).

Although many architects, theorists, and critics have attempted to provide a comprehensive, integrated, and/or even objective definition for this ideal concept, they are still only able to identify frameworks, criteria, and features that express the presence of the characteristic in a specific building or space (Khare, 2011).

In recent years, sales of consumer products have greatly increased in the form of retail. Given the population growth and consumer tendency to purchase from shopping centers, we are witnessing the increasing growth of shopping centers. Available statistics show that more than 260 commercial centers either are under construction or have recently been completed throughout the country (Abdi & Ahmadian, 2014).

The main difference between a market and a shopping center is that a market is more about purchasing, while modern malls and shopping centers are meant to go shopping. "Window-shopping" is one of the most important concepts in the area of shopping center

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management. Boudler established the concept of window-shopping in the 19th century. He called someone a window-shopper who considered the street as his/her living place and enjoyed that space but he/she did not belong to goods or anything else (Abdi & Ahmadian, 2014).
Shopping centers are the results of industrialization and a kind of twentieth century architecture. These centers have been around in Europe and the United States for nearly 200 years. They have been known in many Islamic countries for their dimensions, applications, and arrangements (Taylor & Cosenza, 2002). However, changes in social and cultural structure of urban residents, particularly, the impact of entering various technologies into urban life are things that have made shopping centers a different space from previous years and centuries (Wesley et al., 2006). Therefore, urban health and prosperity can be measured with the conditions of its shopping centers and empty and low customer shopping centers are a sign of poor urban economy. On the other hand, the existence of active and lively shopping centers suggests an active city with booming economy (Michon & Chobet, 2004).
Shopping centers are also considered as a kind of spatial appearance of social action in addition to the economic aspect. They are very attractive to the commonalty, who has the purchasing power, as similar as other public centers such as stadiums, cultural centers, and conference centers (Jackson, 1996). Residents of the city come to shopping centers when the main business and administrative activities are closed. This causes nightlife and movement on the streets, sidewalks, and parking, which itself forms a kind of interaction and social life in the urban space.
Shopping centers have played a major role in creating and expanding the tourism environment and have practically materialized urban tourism marketing (Saghaei, et al., 2012), so that shopping centers are among the most attractive places in the city for tourists. Shopping centers are strongly attracting pedestrians and cars traffic. This leads to the creation of urban nodes. People access to shopping centers is also high so improving their facilities is necessary.
As the main tourist attraction, shopping centers and markets emerge in touristic cities and metropolises. They become attractions which are built by human. On a global scale, tourists attract shopping in some cities and metropolises. Given aforementioned, the study of consumer behavior in shopping centers includes both t economic dimension and social/cultural dimension **(**Saghaei, et al., 2012**)**.

2. Brain Imaging

In recent years, the interest has been increased in using brain-imaging techniques in analyzing brain responses to commercial stimuli such as studying purchase intention using hemodynamics. Such an interest has also acknowledged with the probability of relating observed brain activation with the target commercial stimulus in order to achieve results about the adequacy of such stimuli in terms of interest or emotional interaction in the studied sample. Standard marketing techniques, which has been obtained so far, are often included the use of in-depth or focused group interviews while customers are connected to the product, and before they start their work in mass (ad pre-test) or after that (ad post-test) (Vecchiato et al., 2011).
However, it is now recognized that word of mouth pre-test is judged biasedly and prejudicially by the respondents' cognitive procedures during the interview. It is also noted that the interviewer has a great impact on the respondent's remembering. Keeping all of these studies in mind, neuroscientists have been studied the brain activity collected during watching TV commercial by measuring variables related to cognitive and emotional interference. In fact, there is a lot of hope that neural imaging technology will be able to solve some of problems that marketers face such as marketing simplification procedure and saving money by providing transaction with the most efficient costs and profits. In fact, neural imaging reveals information about customer preferences, which is not achieved through routine interviews (Lockley et al., 2006).

Many scientists have been focused on reaching the gold standard in measuring emotions in their research, which is obtained from a three-dimensional and discrete perspective. The scientific evidence of measurement suggests that emotional measurement is one of the most annoying problems in the emotional dimension (Garrett et al., 2003).
There are several basic dimensions for organizing an emotional response. The most common assumed dimensions are both capacity and arousal. The capacity dimension along with a special state of dissatisfaction (e.g. being sad) is the opposite of pleasure and happiness. The arousal dimension along with intense states of arousal (e.g. surprising) is opposite to a state of low arousal (being silent) (Ohme et al., 2009).

3.The Capabilities of the High Resolution EEG in Neuromarketing

Thanks to the high resolution EEG techniques we tracked subjects' brain activity during visualization of the commercials: in such manner it is possible to obtain a global measure of the reconstructed cortical signals by means of a simple graphic tool which allows us to distinguish the activity of different cortical areas. The above mentioned results allow us to comment temporal and spatial events observed.
In fact, the observed phenomena suggest an active role of the prefrontal and parietal areas in the coding of the information possibly retained by the users from the TV commercials. A statistical increase of EEG spectral

power in the prefrontal (namely Brodmann areas BA 8, 9) and parietal areas is in agreement with the suggested role of these regions during the transfer of sensory percepts from shortterm memory to long-term memory storage. The results suggest a strong prevalence of a 'common' prefrontal bilateral (involving BA 8 and 9) activity in all the subjects analyzed during the observation of the TV commercials. In addition a stronger involvement of the left frontal areas has been noted, in agreement with the HERA model (Tulving, 1994) in which such hemisphere plays a decisive role during the encoding phase of information from the short-term memory to the long-term memory, whereas the right hemisphere plays a role in the retrieval of such information. It must be noted, however, that the role of the right cortices in storing images has been also recognized for many years in neuroscience (Braeutigam et al., 2002, 2005).

As presented in previous works performed both with EEG analysis and MEG recordings (Astolfi et al., 2008c; Ioannides, 2000), the observed phenomena suggest an active role of the prefrontal and parietal areas in coding of the information that will be retained by users from the TV commercials. In particular, activations of these cortical areas can be associated with attentional and memorization processes. As shown in the previous Figures, peaks of activity emerge at the beginning and at the end of clip. In these periods subjects' attention is more focused on what he/she sees, in particular when they watch scenes showing meeting moments and the advertised product. Instead, in the middle of the TV clip, we observed a peak of activity only when subjects watch a person utilizing the advertised product. These processes could reflect memorization of significant frames' sequence which would help the subject to understand the whole video clip and messages provided. Climax of this elaboration will be achieved in the last film segments of the sequence when the meaning of the commercial will be completely understood.

The present result intends to stress the useful properties of the High Resolution EEG technologies. In particular this tool is able to help us in observing and analyzing the temporal trend of the cortical activities thanks to a high temporal and spatial resolution. These features allow us to distinguish with a certain precision changes of activation of ROIs corresponding to different cortical areas, by means of a graphical representation on an average brain model. Our analysis focused attention on tracking of human brain activity with different time resolution, all offering the same spatial resolution able to discriminate activation's intensity of Brodmann areas.

The reconstruction of the cortical activity by means of the high resolution EEG technique and by combining the above statistic treatment of our data, allowed us to track subjects' brain activity during visualization of the commercials. In such a way for each film segment of a clip it was possible to distinguish cortical areas that were significantly activated when compared to the observation of the documentary. This could be useful in the evaluation of the cortical responses to particularly type of visual solicitations, performed by film or commercial clips, that at the moment is a field largely unexplored by neuroscience.

4. Recording and Analysis of the Cerebral Activity

The cerebral activity was recorded by means of a portable 64-channel system (BE+ and Galileo software, EBneuro, Italy). Informed consent was obtained from each subject after explanation of the study, which was approved by the local institutional ethics committee. All subjects were comfortably seated on a reclining chair, in an electrically-shielded, dimly-lit room. Electrodes positions were acquired in a 3D space with a Polhemius device for the successive positioning on the head model employed for the analysis. Recordings were initially extra-cerebrally referred and then converted to an average reference offline.

We collected the EEG activity at a sampling rate = 256 Hz while the impedances kept below 5 kΩ. Each EEG trace was then converted into the Brain Vision format (BrainAmp, Brainproducts GmbH, Germany) in order to perform signal pre-processing such as artefacts detection, filtering and segmentation. Raw EEG traces were first band pass filtered (high pass = 2 Hz; low pass = 47 Hz) and the Independent Component Analysis (ICA) was then applied to detect and remove components due to eye movements, blinks, and muscular artefacts. These EEG traces were then segmented to obtain the cerebral activity during the observation of the TV commercials and that associated to the REST period.

Since we recorded such activity from fifteen subjects, for each proposed advertisement we collected fifteen trials which have been grouped and averaged to obtain the results illustrated in the following sections. This dataset has been used to evaluate the cortical activity and calculate the power spectral density (PSD) for each segment.

Besides, we separately analysed two more traces derived from the previous one. Each EEG trace has been band pass filtered two more times in order to isolate the only spectral components in the theta band and those located between the beta and gamma band, that we call in the following the extended beta band (high pass = 13 Hz; low pass = 45 Hz; beta) from the whole EEG spectrum. All segments were exported in binary format and then converted for further data processing performed with in-house MATLAB software.

These filtered theta and extended beta filtered traces have been employed to calculate the Global Field Power (GFP; Lehmann and Skrandies, 1980) for each segment, then converted in z-scores in order to extract cerebral indexes following described. Since for the phenomena we would like to investigate a clear role of the frontal areas have been depicted (Summerfield and Mangels, 2005; Werkle- Bergner et al., 2006) we used the frontal electrodes to compute the GFP indexes used in the following of this study. The filtered EEG signals were subjected to the computation of the Global Field Power by taking into account the signals that
comes from the following frontal and prefrontal electrodes of the 10-10 International System: F3, F4, AF3, AF4, F7, AF7, F8, AF8, Fz, AFz.

5. Recording and Analysis of the Cerebral Activity

We initially calculated statistical spectral maps for each subject, each TV commercial, in the four frequency bands. Since we transformed the PSD data into Z variables, it has been possible to group the single subjects activities according to the answers which they gave during the interview. In this way the cerebral activity recorded during the observation of the advertisements has been considered as belonging to the groups RMB and FRG or LIKE and DISLIKE. The cortical maps depicting the statistical contrasts between RMB and FRG conditions as well as the LIKE and DISLIKE conditions were then generated for each frequency band considered.
All the statistically-activated areas of each subject were mapped on a common cortical representation through such transformation. For display purposes,
we represented the results obtained from the average brain model created with the BRAINSTORM software freely downloadable from internet
(http://neuroimage.usc.edu/brainstorm/). In particular, the average brain model was used to display the cortical areas that are statistically significantly activated during the different experimental conditions in all the subjects analyzed.
The EEG signals gathered during the observation of the commercial ads were subjected to the estimation of the cortical power spectral density by using the techniques described in the Methods section. In each subject, the cortical power spectral density were evaluated in the different frequency bands adopted in this study and contrasted with the values of the power spectral density of the EEG during the observation of the documentary through the estimation of the zscore. These cortical distributions of the z-scores obtained during the observation of the commercials were then organized in two different populations: the first one was composed by the cortical z-scores relative to the observation of commercial videos that were remembered during the interview (RMB group), while the second was composed by the cortical distribution of the z-scores relative to the observation of commercial videos that were forgotten (FRG group). A contrast has been made between these cortical z-score distributions of these two population,and the resulting cortical distributions in the four frequency bands highlight the cortical areas in which the estimated power spectra statistically differ between the populations.
Figure 1 presents four cortical maps, in which the brain is viewed from a frontal perspective. The maps are relative to the contrast between the two population in the theta (upper left), alpha (upper right), beta (lower left) and gamma (lower right) frequency bands. The color scale on the cortex coded the statistical significance: where there are cortical areas in which the power spectrum does not differ between the two populations, a grey color was employed. The red color was employed when the cortical areas present a statistically significance power spectral activity greater in the population that remembered the commercial videos (RMB) with respect to the other, while the blue color coded the opposite situation (i.e. the power spectral activity in the group that forget the commercial videos is greater with respect to the brain activity in the group that remembers the ads).
Figure 1 presents an increase of cortical activity in the theta band that it is prominent on the left pre and frontal hemisphere for the RMB group. The
statistical significant activity in the alpha frequency band for the RMB group is still increased in the left hemisphere although there are few zones in the frontocentral and right prefrontal hemisphere where the cortical activity was prominent for the FRG group. In the beta band there are spots of significant increase of cortical activity for the RMB group when compared to the FRG group on the left pre and frontal hemispheres, while increase of cortical activity in the FRG group is scarcely present on the right hemisphere.
Finally, in the gamma band is observed a significant increase of cortical activity in a large zone of the pre and frontal hemispheres in the RMB group when compared with the FRG one.

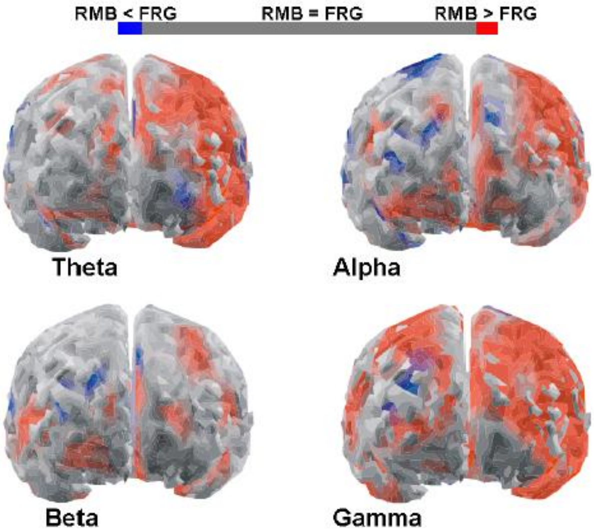

Fig. 1. Figure presents four cortical z-score maps, in the four frequency bands employed. Colour bar represents cortical areas in which increased statistically significant activity occurs in the RMB group when compared to the FRG group in red, while blue is used otherwise ($p < 0,05$ Bonferroni corrected). Grey colour is used to map cortical areas where there are no significant differences between the cortical activity in the RMB and FRG groups

Figure 2 presents the contrast between the LIKE and DISLIKE groups in THE four frequency bands considered in this analysis. Same convention of Figure 1 is used. The significant incr ease of the frontal activity in the theta band is clearly visible (in red) in the LIKE group when compared to the DISLIKE one, in the upper left part of the Figure 2 . Scattered increased of cortical activity on the left hemisphere is also present in the DISLIKE group (in blue). In the alpha frequency band (upper right of the Figure 2) significant increase of cortical activity is present on the left hemisphere and on the orbitofrontal right hemisphere in the LIKE group when compared to the DISLIKE one. The cortical activity in the beta band is greater in the DISLIKE group in the prefrontal left areas when compared to the LIKE group (lower left of Figure 2), while the gamma frequency band (lower right of the Figure 2) presents a statistical increase of the activity of the pre and orbito-frontal cortical areas rather bilaterally for the LIKE group when compared to the DISLIKE one.

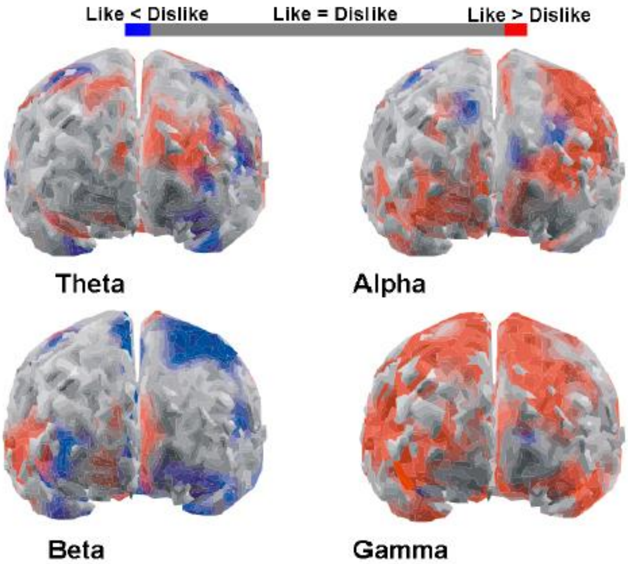

Fig. 2. Four cortical maps for the groups LIKE and DISLIKE. Same conventions than in the previous Figure except the use of red colour to code the cortical areas in which the brain activity of the LIKE group is significantly higher than the activity of the DISLIKE group. The blue colour is used to map brain areas in which the activity of the DISLIKE group is significantly higher than the activity of the LIKE group.

6. Patterns of Functional Connectivity

In a different study (Astolfi et al., 2008c) we also studied the cortical activity andconnectivity occurring during the observation of TV commercials by the techniques of high resolution EEG and by the use of the functional connectivity estimates performed with the Partial Directed Coherence (PDC, (Baccalà and Sameshima, 2001; Astolfi et al., 2007a)). The extraction of significant descriptors of the estimated brain networks with the PDC was obtained with the use of particular graph theory indexes (De Vico Fallani et al., 2007). In order to estimate only the functional connectivity between cortical areas, a segmentation of fourteen Brodmann areas, thought to be of interest for this study, were considered as Regions of Interest (ROIs). Bilateral ROIs were the primary orbitofrontal and prefrontal areas, including the BA 8, 9, 10, as well as the Anterior Cingulate Cortex (ACC), the Cingulate Motor Area (CMA) and the parietal areas (BA 40, 5, 7). The labels of the cortical areas also have a postfix characterizing the considered hemisphere (R, right; L, left).

The analysis of 'where' the differences between the analyzed conditions occurred in the brain performed by the statistical mapping of power spectra was corroborated by the investigation on 'how' the different cortical areas are interconnected with the use of Partial Directed Coherence (PDC). In order to achieve our purpose, we analyzed the changes of incoming and outgoing flow for each ROI, according to the connection of the Granger's causality, by means of tools employed in the graph theory (De Vico Fallani et al., 2007). In fact, it is well known that a connectivity pattern can be treated as a weighted graph, where the nodes are the ROIs considered and the weighted arcs between nodes are the estimated connections between ROIs obtained by applying the PDC on the cortical data. It is then possible to apply tools already validated and derived from the graph theory to the estimated connectivity graphs during the task performance. In the following, the graph is described by N nodes (equal to the number of the ROIs considered here), and each arc of the graph from the i-th node toward the j-th node will be labelled with the intensity of the PDC value and will be described as wij. The NxN matrix of the weights between all the nodes of the graph is the connection matrix W. In particular, we would like to use the indices related to the strength of the estimated functional links between the cortical areas to characterize the behaviour of the estimated network during the visualization of the spot. Such indices will be described in the following. The simpler attribute for a graph's node is its degree of connectivity, which is the total number of connections with other points. In a weighted graph, the natural generalization of the degree of a node i is the node strength or node weight. This quantity has to be split into in-strength S-in and out-strength S-out indices, when directed relationships are being considered, as in the present case with the use of the PDC values.

These indexes are define in the following:

$$S_{in}(i) = \sum_j w_{ij} \qquad (1)$$

represents, then, the amount of all the incoming arcs from the graph toward the node i-th, and it is a measure of the inflow of the graph toward such a node. A similar measure can be derived for the outflow from the i-th node of the graph, according to the following formula where the same conventions for (2) yields:

$$S_{in}(i) = \sum_j w_{ij} \qquad (2)$$

Note that in this case the sum is upon all the outgoing weighted arcs that move from the i-th node towards all the other nodes of the graph.

7. Research Methods

In the current research, six people were purposefully selected to record brain waves so that three of the subjects were not interested in shopping centers in Tehran and the other three were interested in purchasing in these centers. Sampling method was convenience sampling in the research. EPOC+ 14-Electrode Wireless EEG was used to record brain waves. Automatic speech recognition (ASR) method with EEGLAB software was used to remove noise. For the current research, 14 electrodes have been studied (AF3, AF4, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8). The subjects were set in front of the monitor on a chair under free conditions. They were tested based on the elements presented for characteristics of shopping centers in the form of image and sound in accordance with the relevant variable and its description provided by Arpita Khareh (2011). These variables are as following:

7.1.Aesthetics

It was concluded that the physical and social environments of shopping centers are effective and important in purchasing behavior. Physical and social variables include decor, noise, aromas, lighting, physical layout, color, hall, heating, cleanliness. Physical factors strongly affect consumer emotional and psychological processes, which in turn affect purchasing behavior. Most market managers have realized that the market environment is very important in attracting buyers and plays a significant role in evaluating consumers.

The physical and social environment around the shopping centers is one of the important features affecting purchasing behavior. In this regard, factors such as location, decor, noise, atmosphere, light, overall physical layout, and the presence of other sellers in the

shopping environment can affect customer purchasing behavior. The atmosphere of store is combined with other emotional and cognitive elements. Environmental factors include the following: Overall store layout, interior, color, lighting, aisle, heating, store size, crowds, music, and cleanliness. Social and physical factors affect emotional and psychological attraction and ultimately customer purchasing behavior. Most managers of shopping centers have realized that the atmosphere of shopping center is considered as the most important factor for attracting shoppers to shopping centers and plays a very significant role in evaluating the products offered to customers.
In the test design, market environment has been provided through pictures, videos, and lighting.

7.2. Escape

It was concluded that markets are an environment for refreshment, escape from loneliness, stress reduction, escape from bad weather, and traffic.
Shoppers seek relief from tensions and worries of everyday life by attending shopping centers. Therefore, it is neccessary that the environment of shopping ceenters is such that it can positivitvely affect customer mood. Attending shopping centers is not only for family shopping, but also for having fun and entertainment at a very low cost. By providing a special and impersonal space, the shopping centers allows customers to be present in the crowd so they can communicate with other shoppers and watch their purchasing. Empirical customer involvement enables them to free from the barriers of everyday life so they can free themselves during the purchasing. In fact, shopping centers provide the conditions for customers to escape from these barriers, which enhances the hedonic of shopping.
For the test, market conditions have been preovided through interviews in specific environmental conditions such as pollution, heat and cold, and showing videos.

7.3.Flow

It was concluded that markets affect consumer emotions in terms of present motives so that consumers feel they are in another world and they lose tarck of time. These motives include cinema and theater, recreation centers, and gaming areas.
Attractive motives in shopping centers are influenced by the following: diversity, entertainment, social factors, recreation, fashion, convenience, and relaxation. Losing sense of time occurs due to the presence of recreational faciclities in shopping centers that act as sensory stimulants. Shopping centers are considered to be a part of a variety of social and leisure activities through which customers lose tarck of time. Some shopping centers have cinemas and theaters, restaurants, entertainment centers, and gaming areas where customers can visit after shopping to relax in these areas.
For the test, these factors have been provided through interviews, videos, and pictures about entertainment facilities.

7.4. Exploration

It was concluded that markets are an environment for discovering and testing new and diverse products with global brands, price classification, etc.
The variety of stores in shopping centers positively affect creating excitement in customers. Customers' choice of retailers is influenced by factors such as atmosphere, noise, welfare facilities during the purchase and a favorable shopping experience. The range of stores in shopping centers like branded showrooms, apparel stores, bookstores, household products, and entertainment areas allows customers to clearly examine their products.
Topics have been provided through pictures and interviews about brands and their discovery.

7.5.Role enactment

It was concluded that roles like mother and father, spouse, husband, and student affect the role identity of consumer behavior in markets. Shopping motives are controlled by the role of consumers and the role they must play in society. Visit to the markets is motivated by enacting social roles. Consumer behavior in the marketplace is classified according to social roles.
Most executive activities are based on pre-learned behaviors that can be predicted as part of a particular situation or as a specific social role such as a mother, housewife, spouse, or student. Each person internalizes the desired behaviors based on necessity so he/she is encouraged to participate in the predicted activities. Shopping motives are controlled based on the role of customers in society and their commitment to their families. Attendance at shopping malls is often done with the aim of playing specific social roles. Different customers visit shopping centers for different reasons. In most cases, shoppers attends in shopping cenetrs based on their responsibility in the form of father, mother, or spouse.
Images of social role has been provided in shopping centers for subjects.

7.6.Social

It was concluded that some shopping styles may be the result of direct encounters with friendsl; an opportunity for social interaction and visiting others, which will increase shopping in markets.

Shopping centers provide favorable conditions for establishing social relations. Shopping centers attract number of customers by creating social stimuli, variety of stores, and different products. "The presence of some shoppers in shopping centers can be due to direct encounters with other friends (e.g. encountering women neighbors in the supermarket)." Providing conditions for socializing and meeting other people during the shopping process is offered in shopping centers.
Images of social relations has been provided in shopping centers for subjects.

7.7.Convenience

Research has shown that convenience has a strong effect on market choice. Selecting products under one roof centrally reduces costs (travel time, effort). The researcher also described that welfare facilities have the greatest impact on selecting shopping centers. " Choosing a variety of products can largely reduce costs and extra time spended for moving from one store to another, which also makes shopping easier." Shopping centers are often vast and shoppers can access the products they need on one floor.
Subjects were provided with convenient shopping conditions through videos and interviews.
In order to study the emotional impact of shopping centers elements, F3 and F7 electrodes were selected for processing according to the frontal position. In addition, correlation was examined using MINITAB 17 software given the production of quantitative CSV data.

8. Results

The thermal map was extracted according to the position of electrodes on the head for both groups of subjects. Then, the band map and the type of frequency were identified according to the thermal position.
Figure 3 and Table 1 show the control group. Figure 4 and Table 2 show the experimental group.

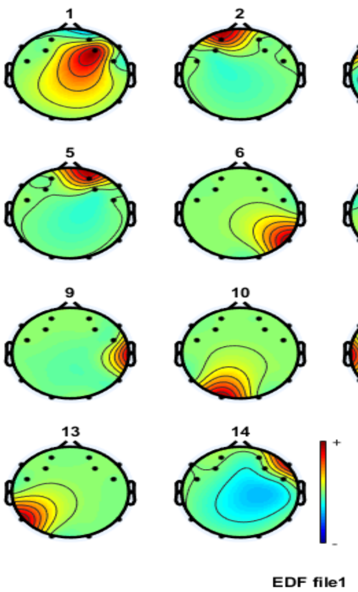

Fig. 3. Thermal map of F3 and F7 situations for the control group

Table 1
Frequency band intensity of the control group

Variables	Rang of R3 (Hz)	Rang of R7 (Hz)	Brainwave type%				P-value
			δ	Θ	α	β	
Aesthetics	.3-11	.5-9	12	38	39	11	.002
Escape	4-21	3-17	11	51	29	9	.001
Flow	.3-7	2-8	9	39	41	11	.000
Exploration	5-15	3-12	3	35	41	21	.001
Role enactment	.7-12	.3-18	1	41	51	7	.000
Social	2-14	5-14	22	36	37	5	.002
Convenience	8-21	2-9	21	31	41	7	.000

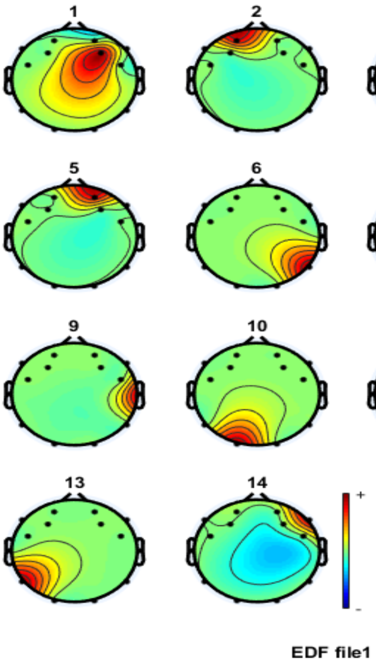

Fig. 4. Thermal map of F3 and F7 situations for the experimental group

Table 2
Frequency band intensity of the experimental group

Variables	Rang of R3 (Hz)	Rang of R7 (Hz)	Brainwave type%				P-value
			δ	Θ	α	β	
Aesthetics	2-14	1.5-12	34	33	12	21	.072
Escape	.7-15	1-12	23	39	21	17	.094
Flow	2-12	4-13	13	30	32	25	.004
Exploration	7-15	4-14	36	21	12	31	.065
Role enactment	3-14	5-12	24	40	29	7	.001
Social	.5-10	1-15	28	29	31	12	.083
Convenience	4-12	1-16	27	33	29	11	.071

Results show that the control group showed significant behavior with respect to brain electroencephalography (P-Value <.05) according to the variables of shopping centers.

9 Conclusion

Study the research results in order to analyze customer behavior to improve commercial goods, it can estimate customer behavior to some extent with the help of neural marketing. Given lots of competition in advertising and sales of commercial goods, customer internal information or customer secrets can be accessed at a lower cost by using this method. It has always been noted in neural marketing that the actual customer behavior is sometimes very different from their apparent behavior. Thus, the use of neural marketing methods can tell us this fact.

The results showed that shopping centers can create a place in customer mind, in which any brand can be developed. Arpita (2011) considers the elements related to consumer behavior in shopping centers beyond purchasing behavior. In the current research, this importance has been studied with the alpha wave which enthusiasts of these centers primarily imagine the space quiet and have a sense of calm in it. Essawy et al. (2014) also studied the spaces and the importance of its nostalgia through basic nerve studies and identified results beyond the obvious factors. Therefore, marketers and interior designers must pay attention to the importance of space, facilities, and social and cultural infrastructure.

The control group, which was interested in shopping centers, showed significant behavior towards all factors. However, the experimental group showed significant behavior just towards the flow variable and role enactment. Therefore, factors of unattractiveness can be identified in these people through in-depth interviews with brain electroencephalogram. Then, the adjacent facilities in shopping centers can be designed in order to attract this group.

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