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Contents, animation or interactivity: neurophysiological correlates in App advertising

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Abstract

Little is known on the effects of contents, animation and/or interactivity in app banners. To understand the impact of these proprieties, a multimethod neuroscientific experiment was conducted. Subjects were asked to use a news app (with articles on actuality, health and environment), programmed by the research team with randomized stimuli on a smartphone. 4 types of ads, obtained from the 2x2 matrix made by crossing the proprieties of animation (static/dynamic) and interactivity (interactive/not interactive) were proposed. Cortical oscillations and autonomic indices were monitored using electroencephalography and biofeedback on millennials (n=18). Findings showed that dynamic banners and the actuality theme evoked an increased theta band activity in the left hemisphere, interpreted as higher emotional engagement. Also the increase in beta and alpha activity for actuality contents may reflect a bigger attraction of users' selective attention. Thus, firstly animation should be present as a leading element in the ad. Secondly the platform selection should not be delegated to the Demand Side Platform.

Keywords: electroencephalography; biofeedback; app advertising; digital; neuromarketing

1. INTRODUCTION

Since World Wide Web has reached the mass population, it has undergone a significant transformation. The first phase, called Web 1.0, started in the middle of the '90s, largely characterized by static websites and low level of interaction. The user experience mainly consisted of hypertext navigation, emails and search engines. Instead the 2.0, starting in 2004, is characterized by high interaction, participation and sharing and we now find: social networks, smart devices, wiki technology and peer to peer mechanisms. Changes are not only tech-related: from a psychological point of view, the web is not a cyberspace anymore, where you can simply log in and log out, but a cyberplace: something based on a space, consisting of socially constructed symbolic processes (Galimberti, Brivio & Cantamesse, 2010). Due to the ubiquitous connectivity of smartphone, companies can anytime and anywhere reach users and mobile marketing and app advertising are now a solid market.

Mobile Marketing Association (MMA) has classified the existing types of app ads in the report "Mobile Advertising Guidelines. Version 5.0". In-app display advertising units are classified as: *banner ad*, an image, text or combinations of these, placed in any position of the app; *rich media*, a form of ad which, if touched is activated and can interact by performing actions such as enlarging and changing color saturation and *interstitial ad,* a full screen advertisement, generally placed in the opening or closing window of the app. We decided to focus only on ads that are showed while app content is displayed. According to literature, two very impacting variables for advertising are: dynamicity, defined as "*a series of images superimposed on one another to create an illusion of motion*" (Kalyanaraman & Oliver 2001) and interactivity "*process of communicating and / or modifying content and / or its form with or through which responds to both the communicator's needs by including hypertext" (*Macias, 2003). Dynamic banners are able to attract more attention and reduce banner blindness (Bayles, 2000), to lower the heartbeat and increase SCL and arousal (Detenber, Simons & Bennett, 1998). Also interactivity has a strong persuasive impact on the user (Sundar & Kim, 2005). Some authors (e.g. Liu & Shrum 2002), point out that the effects of it are not always proven, questioning its use. Given the difficulties of studying ads efficacy, also because the experience of users cannot always be measured via verbal and/or self-report methods (Davidson, 2004), adopting a neuroscientific approach leads to obtain real time and accurate data. Further, phenomena falling below the threshold of awareness can be investigated. Several studies were conducted on advertising using different neuroscientific methods, such as: eye-tracking, biofeedback and EEG (e.g. Balconi, Stumpo & Leanza, 2014). However, none of them have focused on app advertising. It's interesting to specifically put focus on

Millennials because they are one of the favorite marketing target and they differ from other generations for frequency and intensity of app usage. According to the 2017 U.S. Mobile App Report, millennials generation has an average daily time of fruition higher than other generations. 50% of Millennials monthly uses 21 or more apps.

The main aim of the present research is to understand how user experience is influenced by dynamicity, interactivity and type of content, using a multi method neuroscientific approach. We hypothesize that dynamicity and actuality contents may elicit a more emotional response and attract more attention thanks to their inherent nature. We also expect to not observe an adding effect between dynamicity and interactivity caused by limited cognitive abilities.

2. METHOD

2.1 Participants

18 healthy subjects, 15 females and 3 males (M_{age} = 23,5, SD = 2,834, Age Range: 18-28), with normal or corrected-to-normal visual acuity, were recruited for the study. Inclusion criteria were: age, the study focused on the Millennials population, defined as the ones born between 1980 and 2000, having a minimal previous experience with smartphones, apps and more in general touch screen technology and not working/have worked in the marketing field. All participants voluntarily submitted to the experiment after being informed about the study objectives expressed by the informed consent. Research was approved by the Ethical Committee institution where the work was carried out.

2.2 Procedure

Participants were asked to use a fictious mobile app, programmed by the research team, where a list of news was showed with 3 different type of content: actuality, health and environment. After having opened one article, the randomized ad stimuli were exhibited always in the same position and in the same size. The ads types were four, one per subject, obtained by the 2x2 matrix made by crossing the proprieties of animation (static and dynamic) and interactivity (interactive/not interactive). A maximum number of 3 articles was put and no time limitation was set. During the experiment brain activity (alpha, beta, delta and theta bands) and autonomic indices (pulse volume amplitude, blood volume pulse, skin conductance level and skin conductance response) were monitored using electroencephalography and biofeedback.

2.3 EEG recording

EEG recordings were performed with one 15-channel EEG system (LiveAMP, Brain Products, München, Germany) with electrodes positioned over Fp1, Fp2, F3, Fz, F4, C3, Cz, C4, P3, Pz, P4, T7, T8, O1, O2, following the 10/20 international system (Jaspers, 1958). Data were acquired using a sampling rate of 500 Hz, with a frequency band between 0.01-40 Hz, analyzed via Analizer2 (Brain Products GmbH. Gilching, Germany). Portion of the data which contained artifacts were removed to increase specificity. Blinks were visually monitored and ocular artifacts (such as blinks and eye movements) were corrected using an eye movement correction algorithm using a regression analysis in combination with artifact averaging (Sapolsky, 2004). Finally a standard ICA analysis was applied (Jung et al., 2000). The EEG data were bandpass-filtered (0.1–40 Hz, 48 dB/octave roll-off), and frequency power data were computed by fast Fourier transformation (FFT) for standard frequency bands: delta (0.5–4 Hz), theta (4–8 Hz), alpha (8–12 Hz), and beta (14–20 Hz). Data analysis considered lateralization (left and right hemisphere) and Regions of Interest (ROI): frontopolar (Fp1, Fp2), frontal (F3, F4), central (C3, C4) and parietal (P3, P4).

2.4 Autonomic Data Recording

A biofeedback device (Biofeedback xpert 2000, version 7.01, Schuhfried GmbH, Mödling, Austria), connected via Bluetooth to a computer, was used to record autonomic activity. The electrode (4 mm diameter Ag/AgCl electrode, was positioned over the medial phalanges of the second fingers of the nondominant hand. Recorded indices were: Skin Conductance Level (SCL), Skin Conductance Response (SCR), Pulse Volume Amplitude (PVA), Blood Volume Pulse (BVP), Heart Rate (HR).

2.5 Statistical Analysis

A set of repeated measure ANOVAs were distinctly applied to the dependent measures of frequency bands (delta, theta, alpha, beta) with the following 3 within-subjects factors: Content (3: actuality, health , environment), ROI (4: frontopolar, frontal, central, parietal), Lateralization (2: left right hemisphere) and 3 between-subjects factors: Dynamicity (2, dynamic/static), Interactivity (2: interactive/not interactive) and Gender (2: male/female). Also, for autonomic measures (SCR, SCL, BVP, HR) repeated measure ANOVAs were run for each parameter with Content (3) as within- subjects factor and Dynamicity (2, dynamic/static), Interactivity (2: interactive/not interactive) and Gender (2:male/ female) as between-subjects factors. For all ANOVA tests, degrees of freedom were corrected by Greenhouse–Geisser epsilon when appropriate. Post-hoc analysis (contrast analysis for ANOVA, with Bonferroni corrections for multiple comparisons) was successively applied. The size of statistically significant effects has been estimated by computing partial eta squared ($\eta 2$) indices.

3. Results

3.1 EEG

Alpha Band. ANOVA indicated a significant effect for Content ($F[3,15] = 4.579$, $p \leq .049$, $\eta 2 = 0.478$) in the alpha band activity. Post-hoc comparisons showed a significant ($p \leq .008$) decrease alpha activity (increased brain response) for Actuality (M=0.389) compared to Environment (M=0.713) and a significant ($p \leq .014$) decrease between Environment (M=0.713) and Health condition (M=1.211).
Beta Band. ANOVA indicated a significant effect for Content ($F[3,15] = 12.628$, $p \leq .0002$, $\eta 2 = 0.716$), in the beta band activity. Post-hoc comparisons showed a significant ($p \leq .037$) difference between Actuality condition (M= 0.453) and Health one (M=.440), between ($p \leq .022$) Actuality (M=0.453) and Environment (M=0.256).
Theta Band. ANOVA indicated significant interaction effects for Content × Lateralization ($F[3,15] = 6.082$, $p \leq .029$, $\eta 2 = 0.549$). Post-hoc comparisons indicated a significant ($p \leq .032$) increased theta left activity (M=7.06) compared to the right one (M=6.843). Furthermore another significant interaction found was for Content × Lateralization × Gender × Dynamicity ($F[3,15] = 5.477$ $p \leq 0.037$ $\eta 2 = 0.053$). Post-hoc comparisons found significant ($p \leq 0.02$) differences in males in health condition for dynamic banners with an increase in left activity (M=0.644) compared to the right one (M=0.609).

3.2 Biofeedback

SCR. ANOVA indicated a significant effect for Content ($F[3,30] = 4.916$, $p \leq .022$, $\eta 2 = 0.330$), for SCR activity. Post-hoc tests showed a significant ($p \leq .020$) difference between Health condition (M=.006) and Actuality one (M=.0045), and a difference ($p \leq .038$) between Actuality and Environment (M= -.003).
PVA. ANOVA indicated a significant effect for Content ($F[3,30] = 0.043$, $p \leq .043$, $\eta 2 = 0.291$) for PVA activity. From post-hoc tests it was highlighted a significant ($p \leq .005$) difference between Actuality condition (M= 80.197) and Environment one (M=74.054).

4. Discussion

This work aimed at studying effects of different factors on user experience and app advertising efficacy, via a neuroscientific multi-method approach. Specifically dynamicity, interactivity and type of content were investigated. Concerning theta band, statistics showed an increased activity in the left hemisphere for dynamic banners and for Actuality condition. Both alpha and beta activity showed a more significant brain response to actuality contents compared to health and environment conditions. Finally, biofeedback data confirmed the previous results: SCR is higher in the Actuality and Health conditions, compared to the Environment one, and PVA is increased in Actuality condition compared to Environments. Primarily, the increased activity in theta band for dynamic banners and the actuality condition may be correlated to emotional processing (Pizzagalli, Shackman, Davidson & Richard, 2003). Furthermore, a stronger activity in the left hemisphere was associated to more effective stimuli, which better attract attention (Weinstein & Weinstein, 1980). The animation is therefore an important. Secondly, concerning alpha and beta activity, statistics showed an increased brain response to the Actuality condition confronted to Health and Environment ones. As demonstrated by some studies (e.g. Klimesch et al., 1999) these bands are involved in the attentional processing. For biofeedback results, the increase in SCR and BVP for Actuality condition can be linked to higher arousal (Dawson et al., 2000) and emotional situations (Balconi & Bortolotti, 2012). Results can be therefore interpreted as follow: the user's attention is significantly impacted by the kind of content showed on the platform. Data leads to two practical consequences for the marketers: animation should be present as a leading element in the ad stimuli. This could be achieved by involving the company creative department.

Secondly, but not less important, the platform selection should not be completely delegated to the Demand Side Platform. In fact, we suggest a qualitative analysis of the hosted contents on the platforms, that could be added in the marketing process while studying the campaign target, finding a good match.

References

Balconi, M., & Bortolotti, A. (2012). Detection of the facial expression of emotion and self-report measures in empathic situations are influenced by sensorimotor circuit inhibition by low-frequency rTMS. *Brain Stimulation*, *5*(3), 330-336. doi: 10.1016/j.brs.2011.05.004.

Balconi, M., Stumpo, B., & Leanza, F. (2014). Advertising, brand and neuromarketing or how consumer brain works. *Neuropsychological Trends*, 16(16), 15-21. doi: 10.7358/neur-2014-016-balc.

Bayles, M. J. (2000). Just how blind are we to advertising banners on the web. *Usability News*, *2*(2), 520–541.

Davidson, K. W., MacGregor, M. W., Johnson, E. A., Woody, E. Z., & Chaplin, W. F. (2004). The relation between defense use and adaptive behavior. *Journal of research in personality*, *38*(2), 105-129. doi: 10.1016/S0092-6566(03)00054-0.

Dawson, Michael E., Anne Schell, and Diane L. Filion (2000), "The Electrodermal System," in *Handbook of Psychophysiology*, John T. Cacioppo, Louis G. Tassinary, and Gary G. Bernston, eds., Cambridge: Cambridge University Press, (*200–223*).

Detenber, B. H., Simons, R. F., & Bennett, G. G., Jr. (1998). Roll' em: The effects of picture motion on emotional responses. *Journal of Broadcasting and Electronic Media*, 42, 113–127. doi: 10.1080/08838159809364437.

Galimberti, C., Brivio, E., Cantamesse, M., & Ibarra, F. C. (2010). Intersubjectivity as a Possible Way to Inhabit Future Cyberplaces. *Annual Review of Cybertherapy and Telemedicine*, *154*, 9-13.

Jung, T.P., Makeig, S., Humphries, C., et al., 2000. Removing electroencephalographic artifacts by blind source separation. Psychophysiology 37, 163–178.

Kalyanaraman, S., & Oliver, M. B. (2001). Technology or tradition: Exploring relative persuasive appeals of animation, endorser credibility, and argument strength in web advertising. In *annual conference of the association of education in journalism and mass communication, Washington, DC. 33,* 7-17.

Klimesch, W., Doppelmayr, M., Schimke, H., & Ripper, B. (1997). Theta synchronization and alpha desynchronization in a memory task. Psychophysiology, 34, 169–176. doi: 10.1111/j.1469-8986.1997.tb02128.x.

Liu, Y., & Shrum, L. J. (2002). What is interactivity and is it always such a good thing? Implications of definition, person, and situation for the influence of interactivity on advertising effectiveness. *Journal of advertising*, *31*(4), 53-64. doi: 10.1080/00913367.2002.10673685.

Macias, W. (2003). A preliminary structural equation model of comprehension and persuasion of interactive advertising brand web sites. *Journal of interactive advertising*, *3*(2), 36-48. doi: 10.1080/15252019.2003.10722072.

Pizzagalli, D., Shackman, A. J., & Davidson, R. J. *(2003).* The functional neuroimaging of human emotion: Asymmetric contributions of cortical and subcortical circuitry. *K. Hugdahl & R. J. Davidson (Eds.), The asymmetrical brain (511-532) Cambridge, MA, US; MIT Press.*

Sundar S. & Kim J. (2005) Interactivity and Persuasion: Influencing attitudes with information and involvement., *Journal of Interactive Advertising*, 5(2), 5-18. doi: 10.1080/15252019.2005.10722097.

Sapolsky, R. M. (2004). Social status and health in humans and other animals. Annual Review of Anthropology. 33, 393–418.

Weinstein, S., Appel, V., & Weinstein, C. *(1980).* Brain-activity responses to magazine and television advertising. *Journal of Advertising Research, 20*(3), 57-63.