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Monitoring consumer responses to online advertising via neuro-marketing techniques: an exploratory study

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Abstract. Neuromarketing is a widespread research methodology in marketing, and nowadays is being employed also for the assessment of digital communication: however, no experimental research has been conducted on a website banner. This paper assesses the effects of this kind of digital stimuli on the consumer audience by using neuro-marketing techniques. Specifically, the research aims to verify consumers' responses to a website banner in terms of attention, cognitive effort, interest and emotion by carrying on an exploratory experiment on a pilot sample of Italian consumers. The study was approached in four stages. In the first step, a selected brand has been analysed as a case study in an industry that has only recently entered the digital touchpoint; in the second step, a digital stimulus has been selected; in the third step, an experimental protocol was developed and tested; finally, the above-mentioned neuro-marketing experiment has been carried out. Results show that the effectiveness of the banner is linked to its position on the web page, but this is not enough: for better effectiveness, it has also to be framed properly in the website navigation design.

Keywords: attention, interest, cognitive effort, emotion, neuromarketing
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1. Introduction

Neuromarketing is a discipline that combines neuroscience, marketing, and psychology to better understand consumer behaviour and preferences; it has grown rapidly in recent years and has become increasingly popular in the commercial sector: however, it has also shown potential for use in the public and non-profit sector (Cherubino et al. 2019).

For instance, one area where it can be applied in the public and non-profit sector is in social advertising and Public Service Announcements (PSA) (Caratù, 2022): Martinez-Levy et al. (2022) examined the use of message framing and non-conscious perception in non-profit advertising, using neuromarketing research techniques, and found that the emotional content of advertisements had a significant impact on the perceived effectiveness of the message. This suggests that non-profit organizations could benefit from using neuromarketing techniques to develop more effective communication campaigns that appeal to donors and other stakeholders.

Another area where neuromarketing can be applied in the public and non-profit sector is in healthcare services. Demir (2022) explored the use of these techniques in health services, particularly in the context of patient satisfaction and loyalty. The study found that neuromarketing techniques such as facial coding and eye-tracking could be used to assess patient emotions and preferences, which in turn could be used to improve the quality of care and patient satisfaction. This suggests that neuromarketing could be used to design more patient-centred healthcare services that meet the emotional and cognitive needs of patients.

In addition to advertising and healthcare, neuromarketing can also be applied to public communications and dialogic accounting. Levallois et al. (2021) investigated the emergence of neuromarketing in online public communications from 2002 to 2008, finding that neuromarketing techniques such as fMRI and EEG were being used to study consumer behaviour and decision-making processes in the context of public policy and social issues. This suggests that neuromarketing could be used to better understand the public's attitudes and preferences on a range of issues, such as climate change or social justice: by measuring brain activity and other physiological responses, neuromarketing can provide insights into how individuals process and respond to these issues, which can inform public policy and advocacy efforts.

Neuromarketing can be used also by non-profit organizations that want to improve accountability and transparency. In this sense, Grossi et al. (2021) propose the use of dialogic accounting, which involves engaging stakeholders in two-way communication to improve accountability and transparency. Neuromarketing techniques can be used to measure stakeholder responses to such communications, which can help non-profit organizations to better understand the effectiveness of their efforts and to make improvements.

Finally, Caratù et al. (2022) suggest that social neuromarketing can be used to promote healthy behaviors and to support public policies that encourage such behaviors. For example, neuromarketing can be used to understand how individuals perceive and respond to nudges, which are small changes in the environment designed to encourage certain behaviors. This information can be used to develop more effective nudges that support public health goals.

Therefore, in the last years neuroscience has increasingly been used both by private and public institutions to test the efficacy of their marketing tools, also in the digital field. The present research is an exploratory study of neuromarketing in the private sector that, however, can be useful to give insights and managerial implications also for public institutions and non-profit organizations and marketing campaigns.

1.2 Neuromarketing and digital advertising

Attention, cognitive effort, interest and emotions have been and still are key topics for economics and marketing researchers (Guerreiro et al., 2015), within many branches of the fields (Westbrook & Braver, 2015; Cherubino et al., 2016) and also in the digital one.

In fact, the modern digital environment - with its visual components including pictures and video - is critical in shaping the consumer's response which in turn influences their behavioural intentions. Every day, people are stimulated by over 5,000 advertising messages of different types (Subramanian, 2015), and most of these come from the digital environment in the form of banners, remarketing or sponsored posts and it is more and more difficult to capture the consumers' attention and engage them in a memorable experience (Scott *et. al.*, 2019). In this frame neuromarketing techniques are particularly indicated for capturing "smart insights" and help firms to design successful customer experience (Noci, 2018).

Among them, the eye-tracking technology provides an objective way to collect data about attention and visual behaviour (King, Bol, Cummins, & John, 2019). It is the most known neuromarketing technique for the study of visual attention and perception in marketing research to evaluate the effectiveness of visual advertisements (Kim, Hwang, & Fesenmaier, 2005; Morgan, Hastings, & Pritchard, 2012).

As consumers spend on average more than six hours a day on the Internet (Global web index, 2019), the contents of digital marketing should be designed in a way that consumers are engaged in a captive "humanised" form of digital entertainment. Indeed, the development of digital marketing represents an interesting context where analysing consumers' response to marketing stimuli, because it aims to create an environment that can engage the cognitive and emotional state of the consumers, attract their attention, involve them emotionally and convince them to make a particular behavioural response, such as a purchase or a download (Hollebeek, & Macky, 2019).

Therefore, the use of neuromarketing for assessing a digital stimulus would be appropriate to explore the aforesaid parameters and, in fact, neuromarketing nowadays is being employed also for the assessment of digital communication in all its forms and on different platforms (Mancini et al., 2021; Mancini et al., 2022a; Mancini et al., 2022b)

Coherently, an experimental A/B test of neuromarketing has been conducted on a website banner, which – given to the homonymous phenomenon of the "banner blindness" (Benway, 1998; Burke et al., 2005; Lapa, 2007), are less prone to capture the consumers' attention and engage them in a memorable online experience (Scott *et. al.*, 2019).

We know in fact that, in the field of digital marketing, findings of previous studies revealed how to better design a website, a landing page or advertising (Haesner, Chandra, Steinert, & Steinhagen-Thiessen, 2018; Jahanian, Keshvari, & Rosenholtz, 2018; Lamberz, Litfin, Teckert, & Meeh-Bunse, 2018; Sari, Ferdiana, Santosa, & Nugroho, 2015; Vidyapu, Vedula, & Bhattacharya, 2019), while some literature (Goodrich, 2011; Shaouf, Lü, & Li, 2016) has examined the impacts of web advertising on consumer reactions using survey-based instruments or quasi-experiments (Raggiotto et al., 2020; Scarpi et al., 2019). However, still a gap remains in the theoretical understanding of how the visual design of website page can influence behavior in terms of attention, effort, emotion and interest. Eye tracking studies analysing consumers' online behaviour, especially in mobile search, are limited (Ahn et al., 2018; Cortinas et al., 2019, b, Hautala et al., 2018; Huddleston et al., 2018; Kessler & Zillich, 2019; Tupikovskaja-Omovie & Tyler, 2019). Even less are the studies that combine eye-tracking with the other neuromarketing techniques, such galvanic skin response (GSR) to measure the consumer's overall experience (Mañas-Viniegra, Núñez-Gómez, & Tur-Viñes, 2020), and are mostly concerned about consumers' reactions to Instagram contents (Rúa-Hidalgo et al., 2021; Fondevila-Gascón, et al., 2020). To bridge this gap, the current study used a neuromarketing experiment to verify the effectiveness of a website banner, by integrating in a pilot neuromarketing experiment the eye-tracking and GSR with the elecroencephalogram (EEG) and by using the A/B test methodology, traditionally used in marketing research. This research, therefore, has the objective of assessing the effectiveness of a banner of a specific business website (in terms of attention, interest, effort and emotions, so by using neuromarketing techniques) in different positions: the actual and the one suggested by the literature review. Also, the image slider of the same website has been assessed with the same technique, so as to understand if the mobile experience of the company is well-coordinated and the ADV elicit positive responses from the audience. To do so, an experiment was conducted using eye-tracking, electroencephalography (EEG) and galvanic skin response (GSR) in addition to a self-administered questionnaire. Findings contribute to enhancing literature in digital advertising by suggesting how to position a banner on a homepage and how to develop a captive user experience.

The paper is structured in the following way. Section 2 reviews the relevant literature on the use of eye-tracking in marketing and user experience, Section 3 describes the research methodology,

including the case study analysed and the research setting. Section 4 presents the study results. The final section discusses the findings and the implications of our study. Limitations and future research are analysed in the final part of the paper.

2. Background

2.1 Eye-tracking fundamentals

Eye-tracking is an advanced technological tool that can measure visual behaviour and return a series of information about the movement of the eyes in a specific environment or on an image or on a film in terms of direction of gaze, number of fixations, time to first for fixation, and reveals higher validity in data compared to conventional methods – (Schiessl et al., 2003; Van der Laan et al., 2015). Particularly, the measurement of the ocular movement through an eye-tracker allows to analysis of the exploration phases, the fixation times, the vision path, the pupillary dilation strictly connected to a physiological activation and the ocular blink, or the closure of the eyelids, also it is connected to a state of activation and attention. The principle behind eye-tracking research is the so-called *mind-eye hypothesis*, according to which: what a person is observing reflects even what he/she is thinking about, or he/she is interested in (Hoffman, 1998). Precisely for this reason, this methodology is very useful for objectively and indirectly testing almost all visual stimuli in relation to brand recall (Ciceri *et al.*, 2020) and the kind of stimuli that elicit more engagement (for instance, according to Russo 2013 and 2017, faces in ADV often generate greater attraction and involvement, especially when they are in harmony with the product/brand). In marketing, attention is correlated with brand memory (Wedel & Pieters, 2000), with brand perception (Rosbergen et al., 1997) and with attitudes and decision making (Pieters & Warlop, 1999; Chandon et al., 2002; Glaholt & Reingold, 2011). Eye-tracking allows to have a substantial amount of data that can fall in two main categories: the qualitative data, like the ones centred on the graphic display of the visual behavior of one or more users (for example heat maps, heat maps that are colored differently depending on the of the duration and number of fixations or scanpaths, i.e. visual exploration paths), and quantitative data, for instance those fixed on the quantitative evaluation of numerical data (such as the number or duration of fixations). For marketing studies, the eye-tracker is widely used for website testing and user-interface problems (Tupikovskaja-Omovie & Tyler 2021; Boardman & Mccormick, 2021), or packaging studies (visibility of the brand and product name and characteristics), for materials advertising, for

product placement within television programs, films and video games (Boerman et al., 2015; Lee & Faber, 2007), and finally, for the reactions of subjects in shops or exhibition spaces (Huang, 2007).

2.2 Eye-tracking: a tool of neuromarketing to measure consumers response to a visual stimulus

According to Lee et al. (2007), neuromarketing refers to a sub-branch of marketing research that employs neuroscientific techniques to analyse consumer responses to certain marketing stimuli. More properly, neuromarketing is defined as a field of study that employs methodologies typical of neurosciences (e.g., eye-tracking, facial coding, galvanic skin response, electroencephalography) to analyze and understand the human behaviour related to market and economic exchanges.

This scientific method can be applied in different areas of marketing, such as *product design and packaging* (Piqueras-Fiszman et al., 2013; Kobayashi & Benassi, 2015; Stoll, Baecke & Kenning, 2008; Van der Laan et al., 2012; Modica, et al., 2018); *pricing* (Kenning & Plassmann, 2008; Simon & Dolan,1998; Kenning & Linzmajer, 2011); *in-store design*, (Popai, 2012; Cherubino et al., 2017); *professional services* (Dapkevicius & Melnikas, 2009; Fugate, 2008); *market research and advertising*, (Piwowarski, 2017; Yang & Smith, 2009; Nermend & Piwowarski, 2018; Young, 2002) and finally, also *web marketing* (Mouammine, Y., & Azdimousa, 2019). Here, it contributes to monitor and assess the consumers reactions to marketing stimuli on the web, as neuromarketing enhances traditional marketing instruments by drawing on innovative user-interfaces, applications and software that facilitate direct communication between the human brain and an external device (de Sousa, 2017).

Hence, the contribution of neuromarketing methods becomes significant for knowledge of consumer behaviour on the Internet. In particular, neuromarketing is well developed in testing the effectiveness of advertisements, by predicting how well a particular advertisement or stimulus is related to likability and sales. It can be used to analyse whether and how the structure and content of a website or app can attract web users' interest and preferences (Djamasbi, Siegel & Tullis, 2010; Qu et al., 2017; Adhami, 2013; Cho & University of Texas at Austin, 2004). The elements of marketing communication are an important component of Internet sites, which serve to build and strengthen brand awareness and to arouse a direct impact in the form of interactions with customers (Išoraite, M., 2016).

The goal of neuroscientific techniques (from cognitive neuroscience) is to understand how brain functioning mediates cognition and consumers' behaviors such as decision-making. With these

techniques, it is possible to understand the mechanisms on which many brain processes are based, like pleasantness (approach and withdrawal motivation), memorization, attention, process of reward, besides the important aforesaid emotional processing.

Neuromarketing techniques are also useful for analysing web users' browsing behaviour. Eye-tracking, for example, allows the researcher to obtain information on the movement of the eyes in a given period of time and on fixation points on the screen while the user is browsing. Such techniques allow the analysis of visual attention and can verify how the textual and visual content of a site or social network page is processed. Schindler (1986), for example, showed that more colourful advertisements attract more attention than those in black and white.

With the development of e-commerce, eye-tracking experiments are useful in analysing how the different positioning and sliding options influence perception of an image of a product. Indeed, with the use of small cameras that can track eye movement and eye focus, eye-tracking helps researchers to understand which parts of an advertisement are more visually appealing to test subjects. By way of example, users spend 80% of their on-screen time focusing only on the information shown over the "fold" – which is that portion of the web page that does not require any scrolling (Buscher, Cutrell, & Morris, 2009). There is also a predilection for the left side of the screen: 69% of the time spent on a page is occupied by looking at and reading information there. Combining these two findings, it is possible to imply (as Demand Generation, 2018 and Bode et al, 2016 suggest) that a company should position its logo or brand on the top left of the web page, as this increases the chances that the logo will be remembered by the user by 58.4%.

Web design, therefore, can exploit the knowledge produced by eye-tracking to influence the consumer through the use of appropriate elements on the web page, with the aim of improving the effectiveness of communication and the simplicity of website usage. These observations make it possible to understand a phenomenon called *banner blindness*, which is the tendency to ignore advertising (Benway, 1998; Burke et al., 2005; Lapa, 2007). One way for companies to prevent banner blindness may be to select design options and avoid situations where high-impact decision items have a negative effect on the overall user experience. Excessively intrusive elements, in fact, attract attention but at the same time decrease customer satisfaction – and this contributes to the emergence of negative side-effects; the priority should be to build positive relationships with customers. Because eye-tracking can determine user preferences (Currim et al., 2015) and because of its ease of application, it is used in various fields of e-commerce to ensure marketing messages do not inadvertently generate negative consumer attitudes.

2.3 *Attention, cognitive effort, interest and emotion*

Attention is one of those psychological concepts that appear at first to be simple but then quickly become quite complicated. Attention is a crucial element in decision-making, given the limited processing resources of the brain (Guerreiro, & Trigueiros, 2015). Two very different kinds of attention that researchers have identified are high attention, a state of alertness in which consumers are actively and voluntarily focusing and maintaining attention on a particular object, and low attention. The first concept is what consumers usually think of when they think of attention, while low attention involves much less active mental control. It consists of passively monitoring objects and events in the environment, often without much awareness of doing so.

High attention and low attention are related to, but different from, the concepts of top-down attention and bottom-up attention, which are mechanisms by which we can be brought to a state of high attention. It shouldn't be that surprising that high attention would be a lofty aspirational goal for most advertising. Specifically, attention refers to a set of cognitive operations that mediate the selection of relevant and the filtering out of irrelevant information from cluttered visual scenes (Kastner, McMains & Beck, 2009). Attention is a highly flexible mechanism that can operate on regions of space, on features of an object, or on entire objects. Attention is not exclusively governed by our cognitive rationale; it may appear as an automatic reaction (therefore, instinctive and emotional: that is why it important also to cross the data of the eye-tracker with the emotional index) to the environmental stimuli (Schupp et al., 2007). An observation method can be used to measure how many times (fixations) and for how long (fixation duration) consumers elaborate information in a particular environment using the non-invasive technique of eye-tracking, which is a tool that highlights the areas receiving the highest intensity of gaze. It provides a significant amount of data, both qualitative (e.g. "heat" maps coloured in accordance with the duration and number of fixations or scan-paths) and quantitative (e.g., number or duration of fixations). Using the eye tracker, it is possible to measure the visual efficacy and salience of a website's information, a product's label, the arrangement of a product in the supermarket shelves (Cherubino et al., 2017). In the digital field, the eye-tracker is widely used in website testing and user-interface problems, and in other fields for studies on packaging effectiveness (visibility of the brand and product name and characteristics), for advertising, for product placement within television programs, films and video games (Boerman et al., 2015; Lee & Faber, 2007), and also for measuring consumers' reactions in shops or exhibition

spaces (Huang, 2007). Although attention is only a part of the broader phenomenon of attention, it is still a key aspect of marketing to attract users/consumers and it leads them to action (choosing a product, a web page to visit, etc.) as also described in one of the first models developed on selective attention (Raymond, Fenske & Tavassoli, 2003).

Cognitive effort measures the cognitive resources used by a subject while watching an advertisement (or making something). It is the mental effort of the subject who performs a task, and it is calculated on the values of two cerebral parameters coming from the EEG measurements: the theta band of the med-frontal lobe (Cartocci et al., 2016 and 2017). A higher effort index implies greater task difficulty (Wisniewski et al. 2015). It is a variable of fundamental importance for consumers carrying out critical tasks, such as pilots, flight controllers and surgeons, who often have to carry out vital cognitive work for hours on end. In the marketing field, the effort index of great interest in studying consumers' reactions to packaging or products, for example. In web marketing, it can be applied to investigate the cognitive workload of users who browse a website. Researchers (Solomon et al., 1999; Jain, 2014) have shown that an attitude has three components: affect, behaviour and cognition (ABC). The ABC model of attitudes (Ostrom, 1969), which emphasizes the interrelationships between knowing, feeling and doing. Also, from the ABC model, in fact, it is possible to infer a correspondence between the variable affect/involvement and the neuromarketing variable emotion.

Emotions drive consumer choices and are very important in the decision-making process, and consequently also for the purchase decisions (Taylor, 2000).

Bagozzi, Gopinath, and Nyer (1999, p.184) defined emotions as "a mental state of readiness that arises from cognitive appraisals of events or thoughts […] often expressed physically (e.g., in gestures, posture, facial features); and may result in specific actions". Isaac and Budryte-Ausiejiene (2015, p. 403) defined emotions as "affective states characterized by occurrences or events of intense feelings associated with specific evoked response behaviors". In neuroscience, emotion can be directly measured by monitoring not only physiological signals such as heart rate (HR) and skin conductance (SC) but also electrical brain activity. One part of the brain that is crucial for the emotional response is amygdala: involved in the processing of negative emotions and unknown stimuli, as well as in aversive responses to inequity (Rilling and Sanfey, 2011). Emotions are accompanied by (bodily) reactions that are largely beyond an individual's control. These autonomic reactions include facial expressions (e.g., smiling and frowning) and physiological reactions (e.g., sweating), which are primarily caused by changes in the autonomic nervous system (Bagozzi, 1991; Winkielman, Berntson & Cacioppo, 2007). In conclusion, the variables mentioned above (attention, cognitive effort, emotion and interest) are key concepts in marketing (Van Doorn et al., 2010;

Hollebeek, Glynn & Brodie, 2014). They fall within the conceptual domain of engagement with digital stimuli, such as the web and social media. More recently, the focus has been on emotion (Fernandes & Moreira, 2019). In all these models, the variables of "affection" and "cognitive processes" are prodromes of the behavioural response of the customers. The study described in the present paper is in line with Van Doorn et al (2010) in exploring in depth so-called "consumer behaviour consequences" of a customer who has been exposed to an effective brand advertisement. Its novel contribution is to explore consumer responses in terms of sensorial, cognitive and emotional reactions to a specific digital stimulus via neuromarketing techniques. More specifically, this research measures the real-time responses when consumers are stimulated by a website banner and offers important insights for firms and digital marketing strategies. The study measures attention, effort and emotion with reference to a banner positioned on a website page.

Therefore, the following hypotheses are posited:

- Banner B generates greater visual attention than banner A
- Banner B generates lower cognitive effort than banner A
- Banner B generates higher interest (approach) than banner A
- Banner B generates more positive emotion than banner A

Finally, the main findings of paragraphs 2.1, 2.2, 2.3 are summed-up in Table 1

Table 1: Main findings of the literature review on neuromarketing

Findings	**Reference(s)**
The cognitive effort of a subject can be measured by EEG measurements, also in the frame of the ABC model of attitudes, which emphasize the interrelationships between knowing, feeling, and doing	*Cartocci et al., 2016; Cartocci et al., 2017; Wisniewski et al., 2015; Guerreiro & Trigueiros, 2015*
The part of the brain called amygdala is highlighted as being crucial for the emotional response: emotions, so, are crucial to the decision-making process and	*Solomon, 2009; Schupp, Junghöfer, Weike, & Hamm, 2003; Raymond, Fenske, & Tavassoli, 2003; Vecchiato et al. 2014*

can be directly measured by monitoring physiological signals (Heart Rate and Galvanic Skin Response) and electrical brain activity	
Another variable important in neuromarketing is the attention: eye-tracking can provide data on visual behavior (direction of gaze, fixation times, and pupillary dilation)	*Schiessl et al., 2003; Van der Laan et al., 2015*
Eye-tracking is a useful tool for testing (visual) attention also in relation to brand recall and engagement, since (visual) attention is strongly correlated with brand memory, brand perception, and decision making	*Ciceri et al., 2020; Russo, 2013, 2017; Wedel & Pieters, 2000; Rosbergen et al., 1997; Pieters & Warlop, 1999; Chandon et al., 2002; Glaholt & Reingold, 2011*
Eye-tracking can provide qualitative data such as heat maps and scan paths, as well as quantitative data such as the number and duration of fixations	*Tupikovskaja-Omovie & Tyler, 2021; Boardman & Mccormick, 2021*
Eye-tracking is widely used in marketing studies for website testing and web marketing, pricing and packaging studies, advertising materials, product placement, in-store design.	*Boerman et al., 2015; Lee & Faber, 2007; Huang, 2007; Piqueras-Fiszman et al., 2013; Kobayashi & Benassi, 2015; Stoll, Baecke & Kenning, 2008; Van der Laan et al., 2012; Modica, et al., 2018; Kenning & Plassmann, 2008; Simon & Dolan,1998; Kenning & Linzmajer, 2011; Popai, 2012; Cherubino et al., 2017; Dapkevicius & Melnikas, 2009; Fugate, 2008; Piwowarski, 2017; Yang & Smith, 2009; Nermend & Piwowarski,*

	2018; Young, 2002; Mouammine, Y., & Azdimousa, 2019.
Eye-tracking can be used to analyse whether and how the structure and content of a website or app can attract web users' interest and preferences.	*Djamasbi, Siegel & Tullis, 2010; Qu et al., 2017; Adhami, 2013; Cho & University of Texas at Austin, 2004.*

3. Materials and Methods

3.1 Participants and procedure

The study involved a total of 19 participants (16 women and 3 men) aged between 18 and 35 years. The authors selected the sample to be representative of the brand target market (Ciceri et al., 2020): sample size is actually a critical issue (in general in scientific research, and in particular in behavioural neurosciences, where besides the best practice it is not always possible to reach large experimental samples). Although, compared to traditional market research, the sample of the present study size may seem low, in consumer neuroscience studies it has been shown that the effect on a few people is representative of the effect on larger populations, clearly at the cost of measurement variability leading to a loss of statistical power (Vozzi et al., 2021).

Written informed consent was obtained from each participant after they had read an information sheet which explained the study. The experiment was conducted following the principles outlined in the Declaration of Helsinki (1975), as appears in its revision of 2000.

The experiment was conducted in May 2019 at BrainSigns labs (Industrial Neuroscience Labs), which is a spin-off of Sapienza University of Rome. All the participants were healthy and none had eyesight problems incompatible with eye-tracking sensors. According to the Code of Ethics of the Neuromarketing Science and Business Association (NMSBA), to protect the participants' privacy, data have been treated anonymously and aggregated and the experiment was conducted in compliance with these rules.

Before starting the test, each participant was asked to calibrate their gaze by observing the Google page as a baseline with a "neutral" value. The baseline test measures the neural and biometric values in a "rest" condition, or neutrality in terms of physiological and cerebral conditions. These parameters

serve as a reference (point 0) to understand the peaks of visual attention, cognitive workload, emotion and interest of the study participants.

The experimental procedure began with the visual presentation of a banner on an Italian beauty brand website (the stimulus). The experimental subjects were asked to look at the website so as to find the banner "daily promotions" on Wycon's website (task 1) and to observe the sliders inside the banner (task 2). The chosen banner was a call to click on the "daily promotions" to stimulate the purchase of selected products. A call to action like this represents a powerful marketing tool adopted by companies because it is able to attract attention and arouse interest so as to prompt action on the part of the viewer; that action is to click on the banner to be redirected to the landing page set up for the promotional campaign. The brand selected, "Wycon", is particularly interesting as a case because, in the beauty industry, product testing is still crucial to stimulate a purchase-oriented experience. For the study, the experimental subjects viewed Wycon's website on a Samsung S8 mobile phone. They viewed an experimental page produced using Axure (available at https://xa3heb.axshare.com/#g=1&p=sequenze), in which the banner was placed on the top left of the page rather than the middle right (see Figure 1, A). Because it is generally considered to be more captive, the alternative positioning was in the top left part of the homepage (see Figure 1, B). Participants were divided in two sub-groups to view the alternative versions of the web page (positions A and B, Fig. 1). Each participant was asked to perform two tasks: the first was to find the banner "daily promotions" on Wycon's website; and the second was to observe the sliders inside the banner (see Figure 2).

Figure 1– The banner in its original position on Wycon's actual web page (A) and the experimental alternative position (B)

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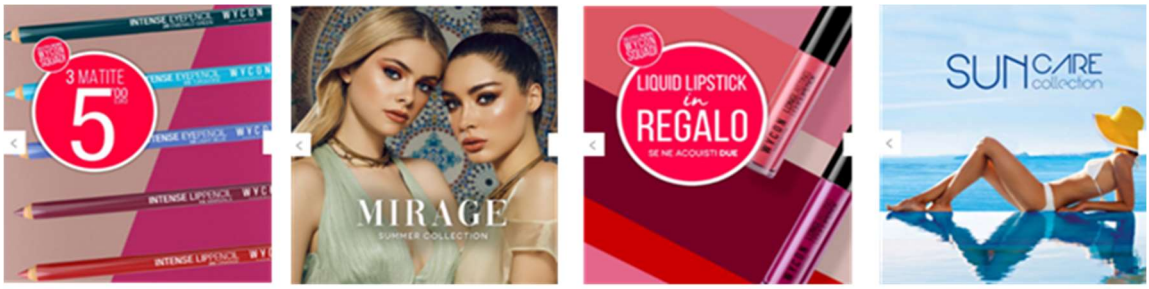
Figure 2 – Slider images from Wycon's website



3.2 Data acquisition

3.2.1 Neuroscientific recordings and signal processing

Figure 3 shows the experimental equipment used for this study (devices for eye-tracking, GSR and EEG). For a more thorough overview and understanding of the technical methods and materials used in the neuromarketing experiment, as well as the formulas, please see the Appendix.

Figure 3 – Experimental equipment

3.3 Neuromarketing indexes

To test the effectiveness of a website banner four neuromarketing indexes were measured while participants accomplished both task 1 and task 2: 1) *approach-withdrawal* measured the *interest* aroused by the banner in each position and the sliders' images; 2) *cognitive effort* measured the cognitive resources used during the tasks; 3) *emotional index* measured the degree of emotional involvement elicited by the two banner positions in task 1 and the different slider images in task 2; and 4) eye-tracking metrics measured the *visual attention* of participants during the tasks.

First, Approach-Withdrawal (AW) describes the participant's attitude to the stimulus (positive, approach; or negative, withdrawal) and it is employed to describe the interest aroused in participants (Davidson, 2000; 2004). AW is measured as the difference between the alpha band activity of the right and left prefrontal hemispheres (Davidson, 2000; 2004). The formula defining the AW index is therefore as follows:

$$AW = GFP\alpha\_right - GFP\alpha\_left \qquad (1)$$

where GFPα_right and GFPα_left stand for the GFP calculated among the right (Fp2, AF4, AF8, and AF6) and left (Fp1, AF3, AF5, and AF7) electrodes, respectively, in the alpha (α) band. Higher AW values imply approach, while lower values indicate withdrawal (Jones, 2004; Coan and Allen, 2003).

Second, cognitive effort measures the cognitive resources used to perform the tasks and it is measured in terms of the GFP in the theta band computed over all the frontal electrodes (Cartocci et al., 2016 and 2017). The higher this indicator is, the greater demand is the demand for cognitive resources for the execution of the tasks or for the perception of the stimuli during website browsing (Wascher et al., 2014).

Third, the *emotional index* describes the participant's emotional state while observing the stimuli. It was defined in relation to an effect plane constituted by two dimensions: the *valence*, which describes a continuum from the most negative to the most positive emotional states (e.g., anger-happiness); and the *arousal* (or physiological activation), which describes a continuum from extreme calm to excitement (Posner et al., 2005; Russell & Barrett, 1980; 1999). Anger, for example, implies more arousal than sadness, even though both emotions are deemed of negative valence.

In order to produce a mono-dimensional variable to reflect the emotional state of subjects, the Emotional Index (EI) is defined by combining the GSR and HR results (Vecchiato et al., 2014a) as follows:

$$EI = 1 - \frac{\beta}{\pi} \qquad (2)$$

where

$$\beta = \{3/2\,\pi + \pi - \vartheta \; if \;\; [\![GSR]\!]\_z\hat{} \geq 0, \;\; [\![HR]\!]\_z\hat{} \leq 0,$$
$$\pi/2 - \vartheta \; otherwise.$$

GSR_Z and HR_Z represent the z-score variables respectively of the GSR and of the HR; ϑ, in radians, is measured as arctang (HR_Z, GSR_Z). Therefore, the angle β is defined in order to transform the domain of ϑ from [-π,π] to [0, 2π] and to obtain the EI varying between [-1, 1]. This is the reason why it is possible to calculate β in two ways: according to the Equations 1 and 2 and to the affect circumplex (Russel and Barrett, 1999), negative (HR_Z<0) values of the EI are related with the negative emotions, while positive (HR_Z>0) values of the EI are related to the positive emotions – both spanning

the whole affect circumplex. The higher the value of EI is, the more emotional engagement is experienced by the participant, and vice versa.

Finally, in relation to the eye-tracker outputs, only the quantitative ones (based on numerical data) were assessed. These were:

a) *The fixation percentage*, which is the percentage of times that the user maintained visual gaze on a single location, or area of interest (AOI), and which typically ranges from 150 to 300 msec. It represents the relative engagement with the object.

b) The *time to first fixation (TTFF)*, which indicates the amount of time that it takes a respondent (or all respondents on average) to look at a specific AOI from the start of the stimulus.

TTFF is an indicator of the users' search (e.g., when respondents actively decide to focus on certain elements or aspects of a website or picture) and can actually indicate two kinds of searches: the first one is stimulus-driven and is characterized by a bottom-up flow of the eye-gaze, while the second one is attention-driven and is characterized by a top-down flow.

TTFF is a basic but important metric for eye-tracking, since it can give information on how are prioritized certain aspects of a visual scene (van der Laan et al., 2015).

The TTFF is correlated with the *CTR (click-through rate)* (the rate at which a banner is clicked, or the percentage of testers who viewed the AOI – the banner - and then actually went on to click the ad) and the *average time to click* (i.e. to click on the banner). .

3.4 Statistical analysis

As several research support (Ohme at al., 2010; Vecchiato et al., 2010; 2011; Plassman et al., 2015) independent t-tests are widely performed in marketing research as statistical tools for testing the results. The present research, therefore, has performed some independent t-tests to test the differences between the values of the indexes calculated for the two experimental groups in task 1 - A/W, Cognitive Effort, Emotional Index and Visual Attention (Percentage of Fixation and TTFF).

Also, other research supports the use of ANOVA in neuromarketing studies that have the same experimental design and scope of the present one (Cakiroglu et al., 2015; Zhang et al., 2017; Lee & Lee, 2018; Hsu & Yoon, 2018; Spence, 2020). Here, the ANOVA test was performed on the same indexes calculated for task 2, during the observation of the four slider images.

Additionally, it is common practice to use post hoc comparisons when significant interactions are found in ANOVA. Duncan's post hoc test (Duncan, 1955) is one of the options for performing these

comparisons. Therefore, Duncan's post hoc comparisons have been performed on the statistically significant interactions: here, a p-value of <0.1 is not very conservative, as it increases the likelihood of a type I error (false positive), but this threshold can be justified in studies with small sample sizes. Since in this research the sample is relatively small, a p value of <0.1 is taken to indicate statistical significance.

4. Results and Discussion

TASK 1: find the banner "daily promotions" on Wycon's website.

Version A of the banner was on the bottom right of the screen, while version B was on the top left. Version A captured a higher percentage of fixations, although this difference is not statistically significant (p= 0.38). However, both the menu (p = 0.1) and the image (p = 0.03) obtained a greater number of fixations in version B.

Banner B was seen more quickly, although this difference is not statistically significant (p = 0.3) (TTFF version A = 19.18; TTFF version B = 12.59).

Regarding the neurophysiological data, both versions generated a similar level of cognitive effort. However, version A of the banner generated a greater emotional involvement, as implied by the greater value of IE (p = 0.02), while version B generated greater approach behavior, indicated by the positive AW index, which was significantly higher than that for version A (p = 0.09, Table 3).

Furthermore, from the behavioural data (eye-tracker data on clicks) it emerges that - in order to land on the page with the "Deals of the day" - with version A 67% of the users clicked on the banner, while with version B only 44% did so.

Table 3: Results on task 1

	A	B	P
% Fixation Menu	0.06%	1.08%	0.1
% Fixation Banner	3.12%	2.23%	0.4
% Fixation Picture	17.25%	37.47%	0.03
Time To First Fixation (TTFF)	19.18%	12.59%	0.3
Workload	0.85	0.89	0.9
Approach-Withdrawal	-0.16	0.08	0.09
Emotion	0.15	-0.09	0.02

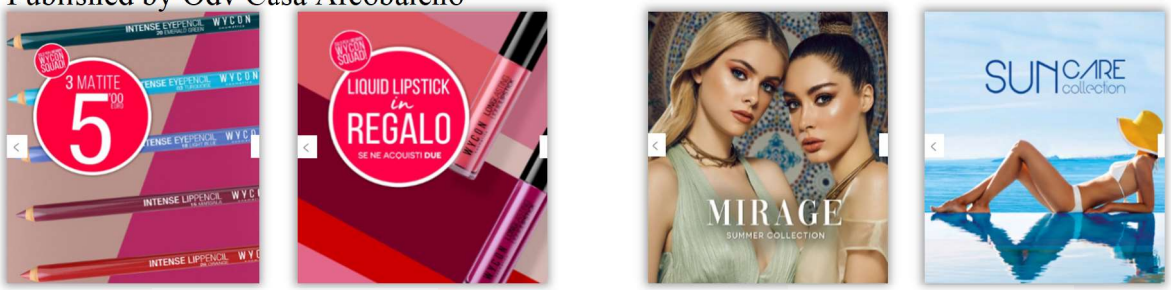
TASK 2: observe the sliders screen the banner

For the second task, participants were asked to watch 4 images sliding across the banner. These have been divided into two groups (see figure 4):

1) images that promoted offers through product representation (eye-pencils or lipstick)

2) images that promoted a new collection through the presence of testimonials (women).

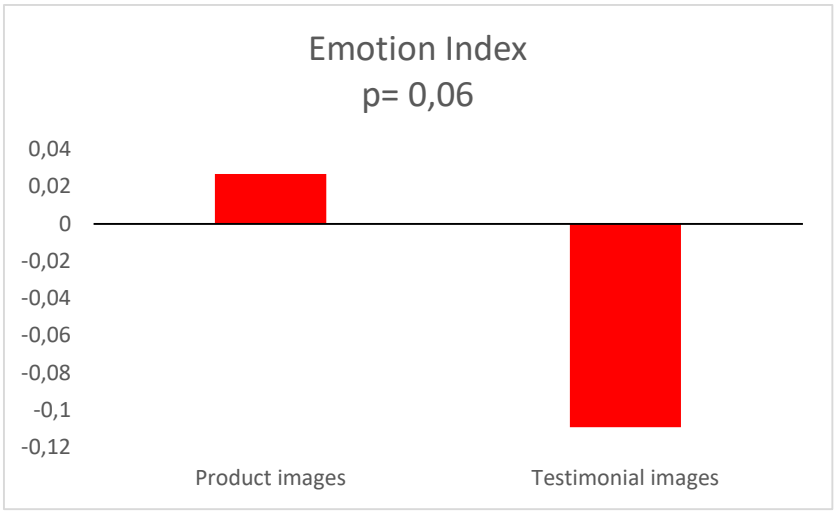
Figure 4- Grouping of slider images.



Product-centric images *People-centric images*

The two groups of images received the same percentage of fixations (p= 0.83) and required the same level of cognitive effort (p= 0.59). Both elicited low (negative) levels of Interest, but the level of Emotion aroused by the images containing the products was greater (tending to significance, p = 0.06) than the level elicited by the images with testimonials (which instead generated a negative emotion). See Graph 1.

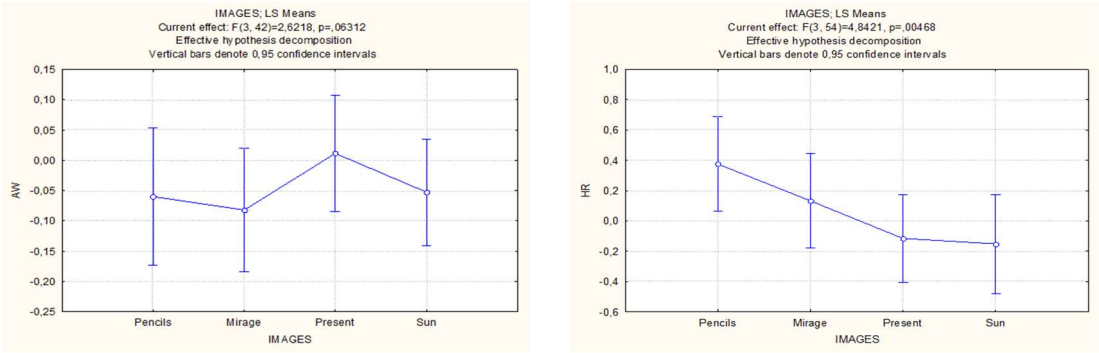
Graph 1 - Emotional Index produced by the slider images



Therefore, Wycon's communication with the use of human figures is not as effective as it should be (considering that faces often generate greater attraction and involvement, according to already cited Russo 2013 and 2017), while the offers - together with the presentation of the products - generated greater emotional involvement._Although the sample (n = 19) is small (but in line with neuromarketing literature suggestions and within the maximum number of 40 people: see Ohme et al., 2009; 2010; and Vozzi et al, 2021) an ANOVA was calculated on each set of results for the four images (Figure 5) to understand which one generated the greatest involvement. The results are as follows. _First, Approach-Withdrawal tended to significance, suggesting that the image "Free gift"

(referring to a lipstick) generated greater interest (F (3, 42) = 2.62, p = 0.06). This confirms that marketing strategies related to free samples are effective (Wang & Zhang, 2009). Second, Heart Rate (HR), which measures valence, was significantly modulated by the stimuli (F(3, 54)=4.842; p=0.005). The Duncan post-hoc test revealed that it was greater and positive for the image with the pencils ("Bundle Price") than for all the others - except for the image with the two women (Mirage).

Figure 5: ANOVA on the Approach/Withdrawal (Interest) and Heart Rate results for the 4 slider images.



Version A of the banner (on the right of the screen) was clicked more often than version B (in the upper left corner), which is counter to the expectation. Earlier general studies already cited in the literature review (Demand Generation) suggest that position A would be less visible than position B, and in fact the TTFF and the average time before clicking on the banner confirm this. Position B elicited more interest but less emotion (it must be said that banner B was placed over the slider of the homepage, where the daily promotions were shown, so the banner might well have been perceived to be a non-clickable label for something presented below it).

The results on task 1 afford some interesting insights, in line with the literature review suggestions. Firstly, images of faces (like Russo 2013 et 2017 propose) received a greater number of fixations but the images that showed promotional messages like "free gift" and "bundle pricing", elicited more interest and emotion. In particular, the bundle pricing on pencils aroused positive emotions, demonstrating that the price lever is a necessary condition for effective online advertising, as it compensates for the inability to test the product in person, in a context where the experience in store is still preferred by consumers. Indeed, according to the neuromarketing literature already cited, faces work in communication but they must communicate the product, otherwise (as in this case) there is the risk of arousing only a high cognitive effort in an attempt to understand it but not to be involved.

In other words, when eyes look at the product, the consumer response is greater (Russo, 2017). These results are consistent also with other studies cited in the background section (Olivero and Russo, 2013), which report that bodies and faces are effective only when the testimonial is in harmony with the product. This did not happen in the case of Wycon's website slider, where the advertisement for "Mirage" required an elevated mental effort, probably generated by the participant's attempt to understand the promotion when a face was presented without the product, while the "Suncare" promotion did not emotionally engage participants.

Secondly, as task 1 was completed on the screen of a mobile device, banner A was more captive likely because of the ergonomics of mobile navigation (Demand generation, Bode et al., 2018), where the thumb is usually used to click. Furthermore, other findings from the present study suggest that the ineffectiveness of a banner is due not only to its position on the screen, but also to the navigation context: in particular, the colours and the overlapping of information between two sections (the slider) and the banner "daily promotions" did not facilitate attention and interest or stimulate emotion.

5. Theoretical contributions and managerial implications

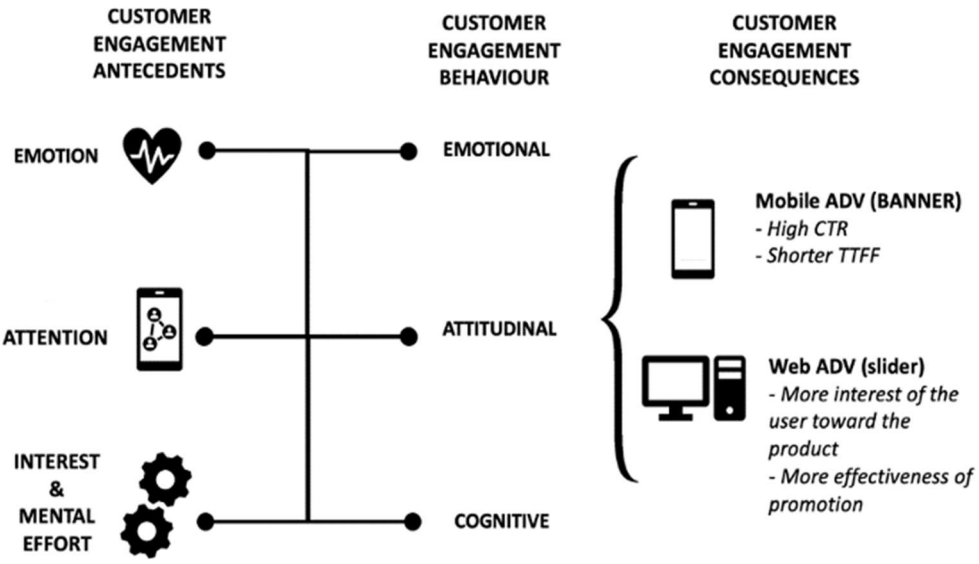
From a theoretical point of view, this paper enhances the existing marketing literature in 2 key ways.

1- Firstly, in the digital marketing literature, this study provides a better understanding of how online consumers may respond to a web banner in terms of attention, interest, emotion, and cognitive effort (Lee & Thorson, 2009). In this direction, it is important to mention that the added value of this research protocol relies on the opportunity to investigate the user's perceptions while dealing with banner ads by means of an integrated approach that includes the monitoring of several indicators at the same time. Interest, cognitive effort and attention represent psychological phenomena that can be hardly monitored by the use of traditional research techniques without distracting the user from its task. During the experimental session, all the indicators of interest were collected in the background, with no need to directly ask subjects to pause the task and reveal their perceptions about the banner.

The above-mentioned parameters have been incorporated in a theoretical framework (Figure 6), which also represents an attempt to employ digital neuromarketing within the framework of the Customer Engagement Behaviour (Van doorn et al., 2010) and the ABC model.. According to this theoretical framework it is possible to explore consumer responses in terms of sensorial, cognitive and emotional reactions to a specific digital stimulus via neuromarketing. In relation to the processing of a banner advertisement, the typical neuromarketing indexes of (visual) attention, interest, emotion,

approach-withdrawal and cognitive effort can be placed within the traditional ABC framework of antecedents, behaviour and consequences (emotional, attitudinal and cognitive responses) as shown in Figure 6.

Figure 6. Conceptual Model of Customer Engagement Behavior (Van doorn et al., 2010) adapted to incorporate neuromarketing parameters.



2- Secondly, the study extends previous studies on consumer experience by using a neuromarketing experiment, which can overcome the bias inherent in survey methods (Cherubino et al., 2019).

The main goal of neuromarketing, as a matter of facts, is to increase the likelihood of success for both advertisements and the products themselves.

In line with the main aim of neuromarketing, thus, the findings reported in this paper have some significant managerial implications that will help managers to improve their digital communication and create successful user experiences while making their advertising “captive” and effective. Results show that the effectiveness of the banner is linked to its position, but this is not enough. Indeed, the top left position is to be preferred, this is not always true because a lot depends on the navigation structure and design and thanks to the use of these technologies it is possible to objectively measure the navigation behavior of users. One must always frame it properly in the website navigation design. The results have interesting implications and suggestions for managers, which we can summarize as follows.

First, "**less is more**" is the way to be more captive: this means selecting the contents to communicate the essential (Chernev, 2003). Indeed, an inappropriate choice of colors and the overlapping of information in the same page may not generate attention and interest or stimulate emotion, while ensuring that the colours cause no confusion and there is no overlapping of information, placing the products side by side with faces, putting the banner above the crease of the eye and putting daily promotions on the home page may be good strategies for an effective communication in terms of interest, attention and emotion.

A second important implication might be phrased "price is king". A bundle price and free gift arouse greater interest and emotion. So, in a context where the in-store product testing is still important in the purchase choice, in the online environment a good price offer is necessary to balance the lack of product testing and stimulate interest and emotion.

This result is in line with the market trend, since, according to the 2020 annual report of the Italian cosmetic industry, online sales have increased (+27% YoY) and the motivations for this seem to be linked to price and special promotions.

6. Limitations and further research

This study has some limitations that need to be addressed.

First, this research used a neuromarketing experiment to capture real perceptions in terms of attention, interest, effort and emotions, but the sample size is insufficient to be able to generalize the results – being this an explorative study. Yet, the purpose of neuromarketing is precisely to obtain smart insights even from small samples because they are less subject to bias. Future research could continue to compare the tasks, considering the recent changes implemented by the company.

Further research could bring up the sample to the one suggested by neuromarketing literature (=40, see Vozzi et al., 2021) in order to deepen the analysis of the results with reference to the generation of the Millennials, who are the main target of the study.

Secondly, the sample comprised only Italian people. Therefore, further research could test people of other nationalities.

Thirdly: the research was conducted in a period in which summer was late in arriving and this could have created cognitive biases (or an unexpected attitude toward the ADV) in the experimental subjects. In fact, in tasks 1 and 2, they were shown an Instagram post on sunscreen. The company

assumed the ad would be effective because they believed people were already thinking about going to the beach. However, the unusual cold during that period could have affected how the participants perceived the sunscreen. They may not have felt the same level of excitement or emotion that the company was hoping for in potential consumers. Further research should elaborate on this, by taking into account also contextual variables when conducting similar experiments.

7. Future research

In conclusion, neuromarketing has a big potential for research in the digital field, both for public and private institutions that want to gain insights into consumer behaviour and preferences that would be less easy to obtain through traditional marketing research methods.

Here are a few suggestions on the topics that future research could explore with neuromarketing:

- Comparative analysis: researchers could compare the effectiveness of different types of digital marketing campaigns, such as email marketing, social media marketing, and pay-per-click advertising, using neuromarketing techniques. This could help to identify the most effective approaches for engaging consumers/users and generating sales or leads.

- Personalization: this is a key trend in digital marketing, and neuromarketing could be used to identify the most effective ways to personalize marketing messages for different audiences. This could include testing different types of content, imagery, and messaging to determine which resonates best with specific consumers'/users' segments.

- User experience: neuromarketing could be used to evaluate the user experience of websites, apps, and other digital platforms like this research has done, but also analyzing the impact of different design elements, user interfaces, on the whole integrated marketing communication strategy.

- Brand perception: neuromarketing could be used to assess the impact of digital marketing on brand perception and loyalty. This could include evaluating the emotional response of consumers to different types of branding and advertising messages, as well as assessing the impact of digital marketing on brand awareness and recognition.

-Cross-cultural differences: as mentioned earlier, testing people of different nationalities could be an interesting avenue for future research. Comparing the effectiveness of digital marketing campaigns across different cultures and regions could help to identify the most effective strategies for global brands.

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APPENDIX

To achieve the aims of the research, three neuromarketing techniques have been used to assess participants' responses during website navigation.

A) To test visual attention, eye-tracker instrumentation was used to determine the areas of greatest intensity of gaze and the level of exploratory movement in relation to banner position. Eye movements were recorded with Asus Tobii 2 and screen-based Eye Tracker Tobii X2-30, which can capture gaze data at 30 Hz.

B) Secondly, electroencephalography (EEG) was used to measure cognitive responses (Approach-Withdrawal and Cognitive Effort). Cerebral activity was recorded by means of a small portable EEG system (BEmicro and Galileo software, EBneuro, Italy), which is able to produce high signal quality (low noise, high sensitivity for a large dynamic, high CMRR). Electrodes were arranged according to an extension of the 10-20 international system. Since the frontal areas have previously been shown to be involved in the investigated phenomena (Erk et al., 2002; Braeutigam, 2005; Vecchiato et al., 2011; Knutson et al. 2007), we used the following channels: AF7, Fp2, Fpz, Fp1, AF8, F3, AF3, AFz, AF4, and F4. EEG activity was sampled at 256 Hz, while the impedances were kept below 10 kΩ. Each EEG trace was then converted into the Brain Vision format (BrainAmp, Brain Products GmbH, Germany) in order to perform signal pre-processing such as artefact detection, filtering, and segmentation. The EEG signals were band-pass filtered at 1–45 Hz and blink activity was identified and removed by employing independent component analysis (ICA). Individual alpha frequency (IAF) was calculated according to Klimesch (1999), for each subject, over an open-eyes segment that lasted 60 seconds, recorded before the experimental task. Therefore, the EEG frequency bands of interest, theta [IAF −6, IAF −3] and alpha [IAF −4, IAF +2], were defined in accordance with the IAF value, for every subject. The IAF was calculated on the basis of one minute when the participant had closed eyes, with the dominant alpha activity: this calculation was made with the purpose of relying on the personal alpha frequency, instead of the commonly adopted frequency range.

This allows for interpersonal variability, which can otherwise lead to inaccurate measures. To evaluate the activity of the cortical areas of interest in a specific frequency band, Global Field Power (GFP) was computed. This measure summarises the synchronisation level of the brain activity over the scalp surface (Lehmann & Michel, 1990). GFP is computed from a specific set of electrodes by

calculating the sum of the squared values of the EEG potential at each electrode, averaged for the number of electrodes involved, which results in a time-varying waveform related to the increase or decrease of the global power in the analysed EEG. The GFP formula is as follows:

$$GFP = \frac{1}{N}\sum_{i=1}^{N} X_{\theta_i}\,(t)\text{^}2$$

where θ is the EEG band on the frontal cortical area, N is the number of electrodes included in the area of interest, and *i* is the electrodes' index.

EEG indices were calculated and normalised for each second using the mean and the standard deviation of the same neuro-metrics.

C) Finally, for emotion, the Blood Volume Pulse (BVP) and Galvanic Skin Response (GSR) were recorded with the Shimmer System (Shimmer Sensing, Ireland) at a sampling rate of 64 Hz. For the recording of these signals (see Figure 3), two electrodes have been placed on the palmar side of the middle phalanges of the second and third fingers on the participant's non-dominant hand in order to acquire the GSR signal according to published procedures (Boucsein, 2012) and a photoplethysmography sensor (PPG) was placed on the thumb of the same hand for the BVP recording. In order to obtain the heart rate (HR) signal from the BVP, the Pan-Tompkins algorithm was used (Pan & Tompkins, 1985). The constant-voltage method (0.5 V) was employed for the acquisition of the GSR.

Then, by using the LEDAlab software (Benedek & Kaernbach, 2010), the tonic component of the skin conductance (Skin Conductance Level, SCL) was estimated. In order to combine GSR and HR signals, to produce a unidimensional variable to reflect the participant's emotional state, the emotional index is defined by considering the GSR and HR signals (Vecchiato et al., 2014b).

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