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Evaluating the neural mechanisms of exposure and retrieval of hedonic and utilitarian banners: A fMRI study

Luis-Alberto Casado-Aranda [a,*], Juan Sánchez-Fernández [a], Nathalie García [b]

[a] Department of Marketing and Market Research, University of Granada, Campus Universitario Cartuja, 18011, Granada, Spain
[b] Department of Tourism and Marketing, Madrid Open University, Vía de Servicio A-6, 15, 28400 Collado Villalba, Madrid, Spain

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ABSTRACT

Traditional psychological theories of message persuasion typically conclude that messages that are able to facilitate an optimal allocation of cognitive resources in the audience will increase memory encoding, will be better retrieved and recalled, and will likely be more persuasive. The growing competition in online advertising has led to a need to evaluate which type of banners are able to allocate cognitive resources more efficiently, as this has a positive impact on the ability to remember the banner and potentially increase the purchase frequency of the advertised product. By means of functional Magnetic Resonance Imaging (fMRI), this study provides the first evidence of neural differences during the exposure and reimagination of two widely used banner appeals; namely, hedonic (i.e., banners that vividly emphasize the social, personal, and experiential benefits of buying the product) and utilitarian (i.e., banners focused on informative, convenient, and functional arguments). Our findings reveal that, when compared to utilitarian banners, hedonic static advertisements engage stronger neurocognitive processes, which translate into higher brain activations related to memory encoding and retrieval, ultimately correlating to higher recall. These findings advise the design of static and hedonic banners to improve the ad recall.

1. Introduction

Online advertising involves using the Internet to inform consumers about the characteristics of a given product or service, in an attempt to persuade them to click and purchase it. Despite the COVID-19 crisis, online advertising revenues increased by 29.6% in 2021, compared to 2020 (IAB, 2022). Indeed, the total budget in this growing advertisement (ad) channel is expected to increase by 13.6% in 2022 and 12.9% in 2023 (eMarketer, 2022). For example, UK companies increased their online advertising in 2021 around 11.8%, when compared to 2020 (IPA Bellwether Report, 2022). These figures correspond to the increased societal use of digital platforms and devices, coupled with the boom of active Internet users worldwide (more than half of the global population; Statista, 2021). Among all the new forms of online advertising (e.g., social media videos, advertorials, interstitials, or publicity), display ads and, particularly, static banners stand out, as they achieve 18.4% higher click-through rates than other display ads (Bannerflow, 2022). Banners constitute a type of digital paid ad which is typically an image and allows viewers to click on it to be directed to the firm's website (Campbell, Cohen, & Ma, 2014). The high competition in online advertising has forced companies to invest great efforts in endowing messages with effective content and attributes, such that they favor the learning, attention, and memory capacity of their banners and advertised goods, thus increasing the likelihood of consumers purchasing of their products (Ghosh, S, & Dwivedi, 2021).

Identifying the banner content that is most likely to draw greater attention, recall and, more broadly, number of clicks is difficult. This is because not all content to which a viewer is exposed is equally likely to be remembered, ad researchers have largely studied the effects of messages after exposure to different banner attributes, such as animation (Diao, 2004; Hamborg, Bruns, Ollermann, & Kaspar, 2012), size (Namin, Hamilton, & Rohm, 2020), orientation (Simola, Kuisma, Oörni, Uusitalo, & Hyönä, 2011), or complexity (Lee & Cho, 2010). One of the research lines that has recently received close attention is the comparison between utilitarian and hedonic banner appeals or arguments. While utilitarian banners present a message through a combination of attributes focused on factual information (e.g., product information, text, attributes, uses, and performance) and functional benefits, the value of hedonic banners reside in the emotional, symbolic, and experiential attributes associated with products and their use (Couwenberg

* Corresponding author.
E-mail addresses: lcasado@ugr.es (L.-A. Casado-Aranda), sanchezf@ugr.es (J. Sánchez-Fernández), nathalie.garcia@e-retailadvertising.com (N. García).

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et al., 2017).

Studies in the field of communication have explored, without consensus, which of these two typologies of ads trigger greater attention, relevance, memory and, more broadly, purchases. For example, some investigations confirmed that utilitarian and highly informative (vs. hedonic) environments facilitate more rational and deliberate decision making, especially during the purchase of high-involvement or typically utilitarian products (e.g., calculator) (Motoki, Suzuki, Kawashima, & Sugiura, 2020). Furthermore, according to Bilgihan and Bujisic (2015), utilitarian banners are also crucial in developing a calculative commitment—that is, the intention to continue the relationship with the company, considering the costs and lack of alternatives.

The main stream in advertising research, however, concludes that the affective, self-relevant, and richer media attributes of hedonic messages more strongly increase intentions, attitudes, trust and anticipated emotions toward the advertised product (Amatulli, De Angelis, & Donato, 2020; Hausman & Siekpe, 2009; Moore & Lee, 2012). Cancela, Briñol, and Petty (2021) even found that individuals processing hedonic or funny (vs. utilitarian) communications increase their personal involvement leading to more elaboration, attention, memory and persuasion. Lining up with this latter mainstream, and building upon psychological theories of information processing and message persuasion (such as the limited capacity model of motivated mediated message processing — LC4MP, Lang, 2006; or the dual-coding theory —Sadoski & Paivio, 2012—), most communication literature has also confirmed the superiority of using experiential pictures (closer to hedonic appeals) instead of facts and information (closer to utilitarian appeals) in advertising. For example, Huskey, Wilcox, Clayton, and Keene (2020) or Tal and Wansink (2016) found that inserting experiential pictures (vs. text) in advertising not only increases attention to and recall/memory of advertised information, but also improves comprehension of the given product/service. Yet, the specific psychological mechanisms leading to such better memory toward hedonic over utilitarian messages (such as memory encoding, storage, or retrieval) have not been determined. This would indeed constitute a step forward considering the close association between short- and long-term memory and modifications in targeted message outcomes (Clayton, Lang, Leshner, & Quick, 2019).

A great deal of online advertising research has used self-reporting techniques (e.g., surveys or focus groups) to evaluate attention and memory induced by both hedonic and utilitarian banner ads, without consensus (Bilgihan & Bujisic, 2015; Hausman & Siekpe, 2009; Klein & Melnyk, 2016; Lin, Murshed, & Zhang, 2020). Yet, no study so far has made use of neuroimaging or psychophysiology tools (such as functional magnetic resonance imaging or eye-tracking), which could facilitate a deeper understanding of the inner, introspective, and implicit mechanisms that more likely determine consumer memory toward these online ads (Guo, Zhang, Ding, & Wang, 2016), trust in the online retailer's offers (Casado-Aranda, Liébana-Cabanillas, & Sánchez-Fernández, 2018), and even online consumer behavior (Couwenberg et al., 2017). The inclusion of this new so-called consumer neuroscience approach not only may help to overcome some subjectivity-related limitations of traditional methods in advertising research (e.g., social desirability bias or delayed measurement of ad reactions), but is expected to particularly enable **clarification of the neural mechanisms by which the two typologies of banner appeals—namely, hedonic and utilitarian—differently influence the main mechanisms of memory formation of the ad** (i.e., memory encoding, storage, and retrieval) and, more broadly, its persuasion (Kranzler, Schmälzle, Pei, Hornik, & Falk, 2018). These intervening processes are key, as greater memory for content is related to modifications in targeted message outcomes (Brennan et al., 2012).

The current research constitutes a first, in using both neuroimaging and surprise memory test measures to evaluate memory formation for hedonic and utilitarian banner ads. More particularly, we (i) use fMRI to assess the neural mechanisms underlying the exposure and retrieval of hedonic and utilitarian banner ads; (ii) implement a self-reported surprise memory task aiming to assess the levels of conscious recall of hedonic and utilitarian ads; and (iii) explore the relationships between brain regions involved in the exposure and retrieval of banners and the levels of recognition of hedonic and utilitarian banners. Overall, our goal is to shed light on the neural processes leading to potential differences in the memory derived from exposure and retrieval of factual and information-related (i.e., utilitarian) banners vs. experiential and symbolic (i.e., hedonic) banners.

2. Theoretical background and hypothesis development

2.1. Processing messages: memory encoding, storage, and retrieval

How do companies build effective banners? The communication literature has traditionally developed several psychological theories of information processing and message persuasion to answer such question. The traditional heuristic-systematic model of information processing (HSM) constitutes a commonly used dual-process theory according to which individuals can make use of two modes of information-processing when making judgements about messages: a systematic, analytically oriented processing, or a heuristic, simplified processing of message contents (Davis & Tuttle, 2013). Another dual-process approach, the elaboration likelihood model (ELM), aims to explain how communication campaigns can change attitudes and behaviors. To that aim, the ELM proposes that there is a central route of persuasion that involves a high level of cognitive resources to carefully process and elaborate the message when it is highly relevant for the individual; in turn, the peripheral route is used when the audience has little interest in the subject and/or has not ability to process the message (Petty & Cacioppo, 1986). Despite these two approaches are useful for assessing decision-making processes in online contexts (Cameron, 2009), they require individuals to make a judgement (which is not the case for just assessing hedonic or utilitarian layouts) and are highly appropriate for more complex contexts in which the task, user, and social factors affect the decision-making process. Furthermore, although the ELM could shed light on the motivation, elaboration and self-relevance elicited by hedonic and utilitarian banners, it does not provide a deep understanding of the psychological mechanisms by which both types of banners may be more or less memorable.

The social judgement theory (Sherif & Hovland, 1961, p. 218) and the inoculation model (Compton, 2013) constitute psychological approaches of message persuasion traditionally employed to explore how prior public attitudes and beliefs can affect message processing and be more resistant to future challenges. These approaches have been largely used to evaluate alternatives to change attitudes and actions of public interest, such as health or political behaviors (Compton & Pfau, 2005), which do not align with the aims of the current research. Closer to the goal of the current investigation, the dual-coding theory (Sadoski & Paivio, 2012) suggests that both verbal and pictorial information are used to evaluate messages, and that these two types of information are differently processed along distinct psychological channels. Studies in the field of advertising persuasion have largely evidenced a picture superiority effect by confirming the beneficial effects of including images in individuals' interest, attention, memory and behavior (Tal and Wansink (2016). However, again this theory is insufficient to elucidate the cognitive and affective mechanisms leading to an increased memory towards more experiential or image-related environments, and is not able to explain the effects of more complex combinations of pictures and text (such as hedonic and utilitarian layouts).

To our knowledge, the limited capacity model of motivated mediated message processing (LC4MP) is, perhaps, the theory that best allows to unveil the mechanisms by which individuals select, encode and retrieve information in the context of online advertising (Lang, 2006). According to this theory, processing messages requires three pivotal sub-processes: encoding, storage, and retrieval. Encoding refers to the process of selecting relevant information and aspects from the message for further

processing, while storage involves the linking of recently encoded information to previously stored information. According to this model, only messages and/or content that are motivationally relevant and novel elicit more cognitive resource allocation in message encoding and storage processes, leading to greater recognition and recall (Fisher, Keene, Huskey, & Weber, 2018). The third sub-process is retrieval, which is related to retrieving or reimaging previously stored information. Lang (2006) concluded that "memory is conceived of as bits of information that are associated with one another. When a bit is active, this activation is thought to spread through the links to activate closely related information". Therefore, once information is encoded from banner content, for instance, its activation spreads to linked information, priming to the ongoing retrieval of information related to the message. Again, resource allocation is required in order for retrieval to occur, such that the pattern of allocation can be conclusive in showing whether messages are encoded and stored well and can, consequently, be retrieved in the future.

According to LC4MP, factors such as the viewer's goals and, above all, the content of the message are responsible for the greater or lesser allocation of resources to encoding, storage, and retrieval of the message. Particularly, "content differs in the amount and quality of processing it engenders, which in turn influences motivation, memory encoding, storage" (Kranzler et al., 2018). When the requirements of advertisement contents produce more resource calls than there are, what is known as cognitive overload occurs. As a result, one, two, or all three sub-processes will deteriorate, such that the message could be encoded and stored (good selection of relevant information and recognition memory, respectively), but may be poorly retrieved and reimagined. Building upon the ad processing literature, ad attributes confer a suitable, insufficient, or excessive allocation of resources, in order to cause (or not) optimal memory encoding and retrieval.

For example, the structural pacing of TV messages increases the resources allocated to encoding and, therefore, the attention to and memory for the messages up to a point; however, when the transitions become too fast, the encoding step is overloaded and memory deteriorates (Fox et al., 2004). Studies have shown that low-arousal negative messages (Lang, Park, Sanders-Jackson, Wilson, & Wang, 2007) and complex structures (Fisher et al., 2018), respectively, elicit insufficient and excessive resource allocation. Radio and TV messages are created to be entirely listened to and watched, respectively, without breaks or pace, such that such temporally demanding activities may cause too much allocation resources and, in turn, a lot of information may not be encoded and, consequently, become lost (Lang, Sanders-Jackson, Wang, & Rubenking, 2013). In this line, the works by Langleben et al. (2009) and Seelig et al. (2014) have analyzed the cognitive resources needed to evaluate video public service announcements varying in sensation value, which refers to the audiovisual intensity of the ads to elicit affective, sensory, and arousal reactions. Their findings confirmed that the "attention-grabbing" and excessive resource allocation of high message sensation value video ads impeded the learning and retention of their content and reduced their overall recall and effectiveness.

Other research, in turn, has stated that elements such as camera changes, sudden movements, loud noises, or videos in TV ads constitute orienting stimuli, which can be used to call optimal encoding resources (Lang, 2000). Scholars have also suggested that motivationally relevant and emotional images and words inserted into audio and video messages trigger orienting responses and are remembered better than non-motivationally relevant or neutral/factual features (Lee & Potter, 2005). In line with this reasoning, ad researchers have found that personalized vs. non-personalized (Dijkstra & Ballast, 2012), arousing vs. non-arousing (Yegiyan & Lang, 2010), and affective vs. instrumental messages (Couwenberg et al., 2017; Samson, Nanne, & Buijzen, 2020) elicit proper resource allocation to encoding, which enables them to gain and maintain attention and memory towards the ad. Furthermore, scholars have stated that optimal retrieval is only possible if we build meaningful and distinctive contents, which are not associated with other memories and serve to remind of only the original experience (Nairne, 2002).

2.2. Brain responses during advertising exposure and retrieval

2.2.1. Consumer neuroscience and advertising processing

The brain is the place in which message reception, motivation, and memory take place (Huang, Kuo, Luu, Tucker, & Hsieh, 2015; Kranzler et al., 2018; Rosenthal-von der Pütten et al., 2014). Neuroimaging techniques, such as functional magnetic Resonance Imaging (fMRI) or Electroencephalography (EEG), allow for monitoring of the neurocognitive processes engaged by different message contents occurring in our brain regions. More importantly, unlike traditional self-reporting techniques (e.g., questionnaires, focus groups, or surveys), the application of neuroimaging to communication and marketing fields (so-called consumer neuroscience) enables the measurement of brain activity during (and not after) message exposure and retrieval, without interrupting these processes. Recent consumer neuroscience studies have confirmed that brain regions, during message exposure, can even predict message-related recall, intentions, or behaviors of high interest for the advertiser (Manippa, Padulo, van der Laan, & Brancucci, 2017; Sánchez-Fernández, Casado-Aranda, & Bastidas-Manzano, 2021). For example, the activation of brain regions involved with value, reward, and mentalizing during message exposure have recently been shown to forecast smoking cessation (Cooper, Tompson, Brook O'Donnell, & Emily, 2015; Falk, Berkman, Mann, Harrison, & Lieberman, 2010; Schmaelzle et al., 2020), consumer purchase intentions (Casado-Aranda, Liébana-Cabanillas, & Sánchez-Fernández, 2018; Casado-Aranda, Sánchez-Fernández, & Luque-Martínez, 2020; Casado-Aranda, Van der Laan, & Sánchez-Fernández, 2018), or social media viral marketing success (Motoki et al., 2020).

Few investigations, nevertheless, have utilized theories relating to persuasion and message retrieval (e.g., LC4MP) in the analysis of neural processes involved with message exposure (Couwenberg et al., 2017; Langleben et al., 2009; Scholz, Baek, O'Donnell, & Falk, 2019; Seelig et al., 2014). All of them coincide in that message attributes (e.g., hedonic vs. utilitarian appeals) influence the allocation of cognitive resources to process the message content, thus affecting consumer beliefs and intentions. Therefore, ads in general, and banners in particular, vary with respect to the extent to which they elicit different neurocognitive processes of interest, which are relevant for ad recall during and after the scanner task. However, to date, no research has evaluated the neurocognitive processes triggered by exposure and, above all, the retrieval of static banners which vary in terms of the degree of experiential vs. functional benefits explained in the advertised product.

2.2.2. Brain networks during memory encoding and retrieval

Neuroscientific research has largely corroborated, across disciplines, that memory encoding and storage during stimuli exposure are initially associated with hippocampal and medial/inferior temporal lobe activation (Hannula & Ranganath, 2008). Studies have also shown that properly encoded message content requires stronger cognitive processing and top-down attention, which is reflected in the activation of areas in the medial prefrontal cortex (Knudsen, 2007; Murray & Ranganath, 2007). In line with these findings, Kranzler et al. (2018) have recently found that brain areas related to memory encoding—namely the hippocampus and medial temporal lobe—moderate the relationship between opportunities for exposure to anti-smoking messages and message recall. Indeed, neuroimaging scholars have confirmed that hippocampal activity, as well as attentional visual activations (e.g., the occipital and fusiform gyri) during message exposure and encoding, predict subsequent memory (Tsukiura & Cabeza, 2011).

Traditional neuroscientific studies have also investigated the neural underpinnings of short-delay information retrieval, by asking participants to make discriminative choices of scenes after exposure to the

original stimulus of interest (Kwok & Macaluso, 2015), or by inviting them to reimagine previously exposed messages (Kranzler et al., 2018). The results of both paradigms are quite similar: middle areas of the superior parietal cortex, such as the precuneus, are particularly involved in the retrieval of stored information. This was the case in the study of Freton et al. (2014), who corroborated the role of the precuneus in egocentric spatial processing in the context of autobiographical retrieval. Scholars evaluating brain activity during episodic and semantic retrieval, such as Cabeza, Dolcos, Graham, and Nyberg (2002) and Prince, Tsukiura, and Cabeza (2007), found that activation in the superior part of the parietal cortex (precuneus) and ventrolateral and superior/inferior frontal areas were strongly activated during episodic retrieval.

2.3. The current study

2.3.1. Hedonic vs. utilitarian banners

As advanced above, this research focuses particularly on the neurocognitive processes derived from the exposure and retrieval of two specific types of online advertising: hedonic and utilitarian banners. Ad researchers have defined online **hedonic banners** as those that use a combination of attributes to vividly describe the feelings and pleasure of product consumption, while **utilitarian** online ads offer functional benefits about the product in an appeal to rational-based processing and decision making (Scarpi, 2012). More particularly, Chiu, Wang, Fang, and Huang (2014) defined the characteristics and dimensions of hedonic and utilitarian arguments in the context of online banners. According to these authors, utilitarian banners are those that include (i) detailed information about the functional benefits and use of the product (e.g., battery, instructions for use, or refund policy), (ii) different perspectives (images or descriptions) of a company's product portfolio, (iii) information about the time and effort to use the product (convenience), and (iv) the possibility to obtain offers and bargains. In turn, hedonic banners emphasize benefits such as (i) vivid photos or images to express the experience and adventure related to the purchase of the product, (ii) links with social networks that allow sharing with the social environment, (iii) personal and customized benefits of purchasing the product (e.g., relaxation images or images that emphasize personal value), (iv) degree of product innovation and novelty (e.g., latest technology), and (v) eliciting the audience's experience, and emotions. In other words, while utilitarian banners focus on highlighting the functional benefits of using the product, hedonic banners focus on the symbolic and experiential character of the advertised good.

The advertising literature has recently attempted to clarify, without consensus, the effects on consumers of these two types of banner appeals. Some scholars have confirmed that the affective, self-relevant, and richer media attributes of hedonic (vs. utilitarian) messages increase memory, attitudes, trust, anticipated emotions, and loyalty to the ad and product (Hausman & Siekpe, 2009; Moore & Lee, 2012; Rosen & Purinton, 2004). Along the same line, Li and Mao (2015) concluded that intelligent virtual advisers using a hedonic communication style enhanced the feeling of social presence and increased reuse intentions in individuals. Further, Amatulli et al. (2020) corroborated that hedonic message appeals increase perceived luxuriousness and consumers' willingness to buy and recommend the product. Other investigations, such as Cancela et al. (2021), Huskey et al. (2020) or Tal and Wansink (2016), confirmed that hedonic environments also trigger a more elaborated and valuable processing, leading to greater attention and memory toward hedonic layouts. On the other hand, other studies have found no differences and stated that utilitarian environments are equally useful in increasing the customer's qualitative commitment (Bilgihan & Bujisic, 2015). Other research has even stated that the effectiveness of a hedonic or utilitarian ad depends on the type of product being advertised. Ads for typically hedonic products (e.g., chocolate or hotel reservations) are more effective when presented in a hedonic environment, while utilitarian products (e.g., a calculator or a microwave) increase purchase intent when accompanied by a utilitarian environment (Motoki et al., 2020).

Although there have been some attempts that explored the attention, effort, and cognitive resources triggered by tailored vs. untailored messages (Cancela et al., 2021; Huskey et al., 2020; Moore & Lee, 2012), to the best of our knowledge, no online communication research to date has cleared up the three primary cognitive processes involved in memory formation, namely, encoding, storage and retrieval, during the processing of combinations of banner attributes (not just a single item, a single picture, but a higher-level mixture of elements) that together form reality-based hedonic and utilitarian ad appeals.

2.3.2. Hypothesis development

Building upon the persuasion and motivated mediated message processing literature, we contend that the extent to which a given message/banner is motivationally relevant, personalized, and appeals to the affective experience through rich media affects its engagement and the optimality of memory encoding processes, as indexed by neural activation in key encoding-related brain regions during ad exposure (Lee & Potter, 2005; Yegiyan & Lang, 2010). Consequently, more intense experiences, emotions, personal value, adventurousness, and enjoyment, as conveyed by hedonic banners, may deeply elicit resource allocation processes and provoke greater brain activations associated with memory encoding, when compared to utilitarian banners. Therefore, we propose the following hypothesis:

H1. Hedonic (vs. utilitarian) banners elicit stronger neural responses associated with memory encoding (hippocampus, superior medial gyrus, inferior/medial temporal lobe, occipital and fusiform gyri) during ad exposure.

According to the LC4MP (Lang, 2006), messages that are better encoded and stored will likely be better retrieved in future tasks. In addition, the distinctive and relevant nature of hedonic banners (i.e, those which are more personalized and emphasize the personal and unique value associated with purchasing the product) can assist in retrieval processing (Nairne, 2002), thus making this type of ad more successful, compared to utilitarian ones. Consequently, we expect that:

H2. Hedonic (vs. utilitarian) banners elicit stronger neural responses associated with memory retrieval (precuneus and inferior/superior frontal areas) during ad reimagination.

As previous research has found relationships between stronger encoding and retrieval processing and ad recall (Pillai, Katsikeas, & Presi, 2012; Tsukiura & Cabeza, 2011), we expect that the type of banner that more strongly elicits encoding and retrieval processing (i.e., hedonic ads, in our case) will more likely provoke higher recall, when compared to utilitarian ads. Despite the fact that some studies have found that highly sensory, audiovisual, and arousing ads reduce consumer recall, due to their cognitive overload (Langleben et al., 2009), research closer to our experimental design found that affective vs. rational ads provoke better memory and recall (Drolet, Williams, & Lau-Gesk, 2007). Therefore, we formally propose that:

H3. Hedonic banners increase consumer recall when compared to utilitarian banners.

Given the importance, from the consumer neuroscience perspective, to understand the role of specific brain areas elicited by ads in forecasting consumer effects, we additionally explored whether brain regions involved with memory encoding and retrieval during ad exposure and reimagination, respectively, are associated with the self-reported recall of banner ads. As shown in previous studies (Tsukiura & Cabeza, 2011), we expect that hippocampal or/and precuneus activity during message exposure and encoding, respectively, will be related to subsequent self-reported memory.

3. Methods and materials

3.1. Participants

Despite that fact that we initially recruited 30 participants, in the end, only 27 were able to take part in the fMRI experiment, due to excessive movement and claustrophobia problems during the session. In affective and cognitive neuroscience research, samples sizes from 20 to 40 participants are quite common, given the objective nature and high spatial resolution of fMRI (Casado-Aranda & Sanchez-Fernandez, 2022; Solnais, Andreu-Perez, Sánchez-Fernández, & Andréu-Abela, 2013), which, together with the a priori Region of Interest approach and the use of multiple trials in the current study (i.e., repetitions of conditions within participant), it would explain our sample of 29 individuals and give solid significance of the activations along the whole sample. Particularly, 12 right-handed men and 15 right-handed women ranging in age from 18 to 29 years old (average age = 24.30, SD = 5.40) were selected. In social neuroscience, it is usual to recruit right-handed subjects as differences in the handedness could constitute a cofounding factor. As right hemisphere focuses on creativity and right hemisphere on logic (Pool, Rehme, Eickhoff, Fink, & Grefkes, 2015), participants with right- or left-handedness could undesirably and differently evaluate marketing stimuli, such as hedonic and utilitarian banners. Furthermore, consumer neuroscience studies have commonly used a gender-equivalent sample of males and females in investigations whose main interest is different from evaluating gender differences. Among other reasons, one of the most crucial is due to the cost and accessibility difficulties that would be involved in testing, in addition to the main effects of interest (for example, differences between hedonic vs. utilitarian), differences in gender. In other words, the inclusion of one more covariate, or even the performance of a between-subjects analysis, would need to increase the sample size to obtain high statistical power (Weber, Huskey, Mangus, Westcott-Baker, & Turner, 2015). The study protocol and consent form were approved by the Ethics Committee of the University of Granada. We only selected participants with a high frequency of online shopping: all of them had purchased a product online in the last year, and 88% of them had within the last six months.

3.2. Stimuli design

The experimental task simulated an online environment in which participants viewed utilitarian and hedonic banners advertising headphones. Following similar research in consumer neuroscience (Motoki et al., 2020 or; Guerrero Medina, Martínez-Fiestas, Casado Aranda, & Sánchez-Fernández, 2021), we made use of a within-subject design, in which each participant was exposed to 30 hedonic and 30 utilitarian banners. We restricted the task to headphones not only as previous studies in the field of consumer neuroscience have used this product category (Casado-Aranda, Liébana-Cabanillas, & Sánchez-Fernández, 2018; Hubert et al., 2018), but also because technological products constitute one of the most-purchased categories online in Spain, the country of the current study (IAB, 2022). We ensured that the majority of participants had purchased technological products in the last year (73.1%), and reported a moderate interest in purchasing headphones (average: 5.74, SD = 1.29; where 1 = lowest interest and 7 = highest interest).

As the literature has confirmed that the type of product can affect the processing of the environment (hedonic or utilitarian) in which it is presented, we tested whether headphones were classified as predominantly hedonic or utilitarian products. Specifically, we asked participants to report their opinions on a 7-point Likert scale, ranging from 1 (not at all) to 7 (very much), for the following hedonic and utilitarian items: "hedonic: fun/not fun, exciting/dull, delightful/not delightful, thrilling/not thrilling, enjoyable/unenjoyable; utilitarian: effective/ineffective, helpful/unhelpful, functional/not functional, necessary/unnecessary, practical/impractical" (Motoki et al., 2020). The findings showed that headphones cannot be classified as a predominantly hedonic or utilitarian product, as no significant differences were found between the hedonic (mean hedonic = 5.45, SD = 0.93) and utilitarian (mean utilitarian 5.79, SD = 0.53) scales (p = 0.123). Therefore, following Baltas, Kokkinaki, and Loukopoulou (2017), in our experimental design, the product category did not trigger any confounding effect on the banner evaluation and retrieval.

Then, we designed an initial set of 100 hedonic and utilitarian banner ads, strictly following the dimensions and characteristics specified by Chiu et al. (2014). Particularly, utilitarian banners contained: (i) Different views of the advertised headphone, (ii) product features (e.g., battery, microphone, or speaker information), (iii) convenience (e.g., images and text on delivery time or after-sales service), and (iv) savings. In turn, hedonic banners included aspects of: (i) Adventure (images of athletes in isolation, thanks to the headphones), (ii) gratification (e.g., images reflecting calm or text emphasizing the personal benefit "Headphones 100% adapted to you"), (iii) social aspect (links to Youtube, Twitter, or Instagram), (iv) technological dimensions and pictures of headphone innovation, and (v) invitation to the audience's experience (e.g., "Feel the music" or "Enjoy by listening"). Apart from these differences between hedonic and utilitarian appeals, all banners followed identical attributes, as specified by Hussain, Sweeney, and Mort (2010): All were static, same spatial position on the screen, same font type, line spacing, and size, and all included both colorless and colorful images and text, a box with the bottom (saying "buy"), and the same fictitious brand name ("Tecnobuy"). The ad and headphone pictures resembled real-life examples taken from Amazon.com, except that they could not be clicked on during the fMRI task, which we designed to prevent confounding effects between the time of exposure and the independent variables.

Then, we carried out a test in an independent sample (n = 60), in order to select the banners most typically evaluated as hedonic or utilitarian (other examples of pretesting stimuli in consumer neuroscience are Chua et al., 2011 or Hubert et al., 2018). Particularly, the independent sample expressed their opinions on a 7-point Likert scale, ranging from 1 (informative, convenient and utilitarian banner; i.e., utilitarian ads) and 7 (visually attractive, joy-focused, interactive and hedonic banner; i.e., hedonic ads). We retained only those banners that received less than 3 points and were classified as utilitarian banners, while those higher than 5 points were categorized as hedonic banners. A paired-samples *t*-test showed significant differences ($p < 0.001$) between the 30 slides finally selected and qualified as hedonic banners (mean hedonic = 5.23, SD = 0.25) and the 30 selected to represent utilitarian ads (mean utilitarian = 2.08, SD = 0.36); see Fig. 1 for examples of hedonic and utilitarian banners.

3.3. Procedure

After checking that all participants met fMRI standards (no metals in the body, claustrophobia, or pregnancy), they were introduced into a fMRI scanner and instructed to look at 30 hedonic and 30 utilitarian ads during the banner exposure, and reimage them during the retrieval stage (similar approach to Cooper et al., 2018). Each series of banners began with a fixation period (1–3 s), followed by a randomly exposed utilitarian or hedonic banner (8 s). Subsequently, the participant had to reimagine the banner (i.e., free recall) just displayed during the retrieval phase (6 s). The scan duration was around 24 min, including the anatomical imaging time. We used the E-Prime Professional 2.0 software to present the fMRI stimuli.

Outside the scanner, participants were required to undertake a surprise memory task (following Chua et al., 2011), aimed at assessing their level of self-reported recall and episodic memory of utilitarian and hedonic scenes during the scanning. The test consisted of viewing a total of 40 scenes, broken down into 20 hedonic and 20 utilitarian banners. Each of the 20 scenes were further broken down into 10 viewed during the fMRI scan and 10 new images. Participants had to mark below each

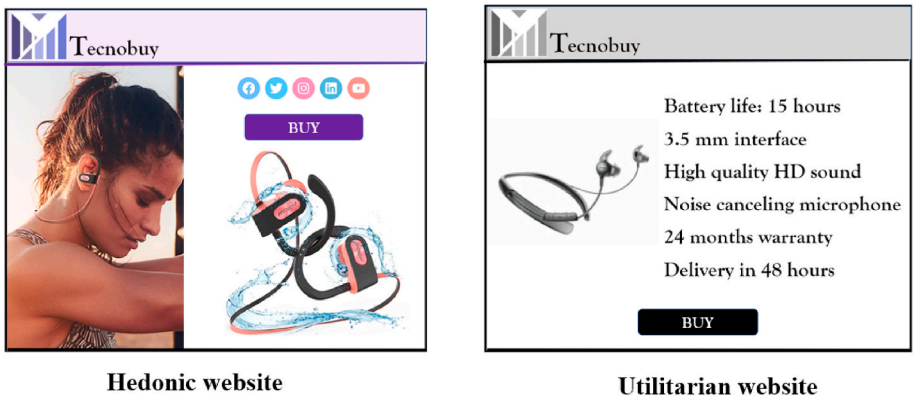

Fig. 1. Depiction of hedonic and utilitarian banner layouts included in the experimental design.

banner whether they had seen it during the scan or not. After the completion of the session, the participants were thanked and reimbursed. See Fig. 2 for a visual diagram of each of the tasks in the experimental design.

3.4. fMRI analysis

3.4.1. Image acquisition, pre-processing, and statistical analysis

A 3 T Trio Siemens Scanner equipped with a 64-channel head coil was used to obtain the MRI images. Anatomical images were acquired using a sagittal orientation with 1 mm^3 voxel size. Functional scans were acquired by a T2*-weighted echoplanar imaging (EPI) sequence (TR = 2000 ms, TE = 25 ms, FA = 90°, thickness = 3.5 mm; slices = 35, slice order = descending). A distance factor of 20% resulted in a total of 790 slices with a FoV of 238 mm.

We analyzed the neuroimaging data using standard software (SPM12, Wellcome Department of Cognitive Neurology, London, UK, https://www.fl.ion.ucl.ac.uk/spm/software/spm12/) run on MATLAB R2012a. Default settings were applied in SPM. We first visually inspected the mean functional images for artifacts. Then, these images were realigned to correct for motion, coregistered, segmented, normalized into standard stereotactic space, and smoothed (7 × 7 × 7 mm Gaussian kernel FWHM). Afterwards, we generated statistical maps for each participant by fitting a boxcar function to the time-series convolved with a canonical hemodynamic response function. We then built a general linear model (GLM) for each subject, considering the following regressors of interest: (i) Exposure to hedonic banner, (ii) exposure to utilitarian banner, (iii) reimagining hedonic banner, and (iv) reimagining utilitarian banner. Furthermore, six covariates associated with movement-related noise, a constant session term, and fixation crosses were treated as regressors of no interest.

To explore which brain regions showed significant activations during exposure to hedonic and utilitarian banners, two contrasts were calculated on the first level: exposure to hedonic vs. utilitarian banners (i vs. ii) and vice versa, applying a T-contrast to the first and second regressors of the model, respectively. To evaluate brain regions differently activated when reimaging hedonic and utilitarian banners, two new contrasts were generated on the first level: reimagining hedonic vs. utilitarian banners (iii vs. iv), and vice versa. On the second level, the above-mentioned resulting contrasts were subjected to one-sample *t*-test analysis, in order to identify brain activation networks common to all participants.

3.4.2. Regions of interest approach

Following the methodology of previous consumer neuroscience studies (Guerrero Medina et al., 2021; Scholz et al., 2019), for the Region of Interest (ROI) analysis, we first selected constructs that were theoretically expected to be involved in the exposure to and retrieval of utilitarian and hedonic ads, as explained in Section 2.2.2. Particularly, memory-encoding and -retrieval regions were identified using the Neurosynth database (http://neurosynth.org), which contains neural activation coordinates for a large volume of fMRI studies, "based on the occurrence of words or phrases in the text of articles, producing mappings between brain activity and a range of cognitive states" (Kranzler et al., 2018; Yarkoni, Poldrack, Nichols, Van Essen, & Wager, 2011). We identified these regions using association test brain FDR-corrected maps

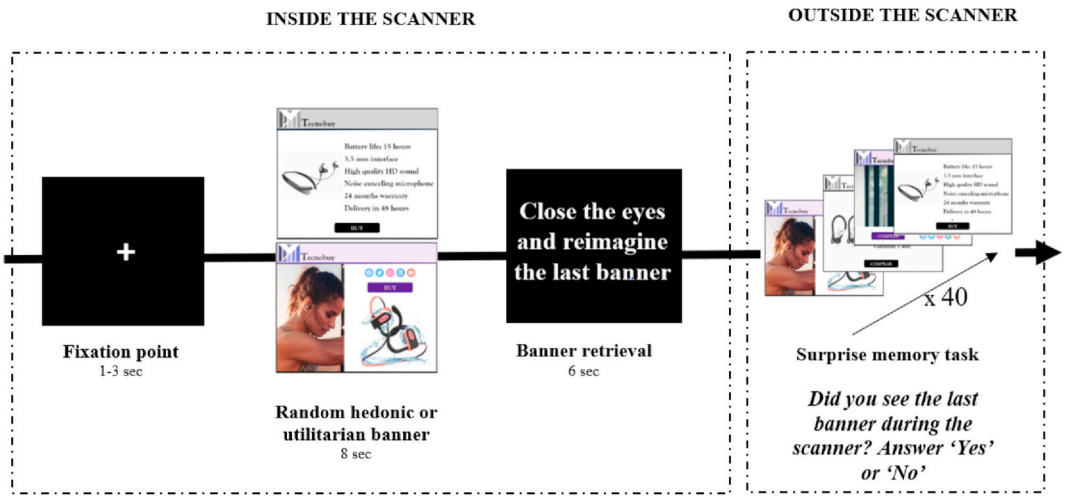

Fig. 2. Visual diagram of each of the tasks in the experimental design.

which correspond with the occurrence of the phrases "memory encoding" (for memory encoding during banner exposure, 5073 studies) and "memory retrieval" (for reimaging the banners, 9305 studies). Once we extracted the maps, we applied them to the contrasts of interest (i.e., exposure to hedonic vs. utilitarian banners and vice versa, and reimagining hedonic vs. utilitarian banners and vice versa), as masks within SPM and used the Family-wise error rate (FWE) at $p = 0.05$, and $k = 10$ to control multiplicity. Fig. 3 includes the resulting masks for the memory-encoding (banner exposure) and memory-retrieval (banner reimagining) extracted ROIs.

To evaluate the extent to which significant neural ROIs for hedonic and utilitarian banner exposure and retrieval are associated with self-reported banner recall (as indexed by the percentage of hedonic or utilitarian banners correctly identified as new or old), we ran a correlation analysis. Particularly, we used Marsbar to extract parameter estimates (10 mm radius spheres) from the significant set of ROIs, as derived from the contrasts of interest that survived the masks, and then correlated them to the percentage of recognition accuracy of hedonic or utilitarian banners.

4. Results

4.1. Memory encoding and retrieval of hedonic and utilitarian banner ads

When compared to utilitarian banners, exposure to hedonic ads triggered stronger significant activations in the expected ROIs related to memory encoding; namely, the bilateral hippocampus, bilateral medial superior frontal gyrus, inferior temporal gyrus, and occipital areas, such as the cuneus and bilateral fusiform gyri (see Table 1 for a detailed list of significant ROIs). The reverse contrast, in turn, did not elicit any significant activation in memory-encoding related brain regions.

When participants were asked to reimagine the banners they had previously seen during the fMRI task, they also experienced different activations when retrieving hedonic and utilitarian ads. More specifically, the expected ROI precuneus, a brain area involved with memory retrieval, was strongly and significantly activated when reimagining hedonic vs. utilitarian banners. Utilitarian banners did not provoke any ROI activation involved with memory retrieval (see Table 2 for a detailed list of significant ROIs).

Table 1
ROIs extracted from the neurosynth database (www.neurosynth.org) which showed significant activation during exposure to hedonic vs. utilitarian banners.

Brain regions	Coordinates MNI (mm) x y z			k	T
Exposure to hedonic vs. utilitarian banners					
Peaks coordinates that are located within the memory encoding ROI mask					
Fusiform	40	−56	−14	3	7.76
Fusiform	−24	−35	−18	2	4.73
Cuneus	15	−98	11	2	7.48
Hippocampus	29	−14	−18	19	5.52
Hippocampus	−17	−7	−18	9	5.42
Superior frontal medial	−6	−67	21	1	4.54
Superior frontal medial	−6	49	39	4	4.26
Inferior temporal gyrus	−34	−35	−14	1	4.19
Precuneus	15	−39	4	1	3.93
Exposure to utilitarian vs. hedonic banners					
Peaks coordinates that are located within the memory encoding ROI mask					
-	–	–	–	–	–

Note: *k*, cluster size defined as the number of voxels; *t*, t-value derived from the *t*-test analysis contrasting the exposure of utilitarian vs. hedonic banners.

Table 2
ROIs extracted from the neurosynth database (www.neurosynth.org) which showed significant activation during the retrieval of hedonic vs. utilitarian banners.

Brain regions	Coordinates MNI (mm) x y z			k	T
Reimagining hedonic vs. utilitarian banners					
Peaks coordinates that are located within the memory retrieval ROI mask					
Precuneus	1	−63	39	5	4.25
Precuneus	1	−60	32	2	3.80
Reimagining utilitarian vs. hedonic banners					
Peaks coordinates that are located within the memory retrieval ROI mask					
-	–	–	–	–	–

Note: *k*, cluster size defined as the number of voxels; *t*, t-value derived from the *t*-test analysis contrasting the exposure of utilitarian vs. hedonic banners.

4.2. Surprise memory task and its association with brain responses

The levels of performance in the surprise memory test demonstrated overall higher levels of recall of hedonic banners. In particular, the mean recognition accuracy for ads viewed during the scan were moderately higher for hedonic (average correct proportion = 0.93, SD = 0.11) than for utilitarian (average correct proportion = 0.85, SD = 0.17; $p = 0.07$) banners. Participants also revealed a significantly higher accuracy when identifying a new ad when it was hedonic (average correct proportion = 0.96, SD = 0.1), rather than utilitarian (average correct proportion = 0.85, SD = 0.14). Overall, the participants recalled hedonic (average correct proportion = 0.94, SD = 0.07) significantly better, compared to utilitarian banners (average correct proportion = 0.85, SD = 0.10; $p = 0.002$).

Activation in the significant ROI precuneus during reimagining of hedonic banners covaried significantly (positive) with the reported average correct proportion of hedonic banners during the surprise memory task ($r_{precuneus} = 0.41$; $p = 0.03$). Thus, participants that reported a higher accuracy in correctly recognizing hedonic banners showed significantly stronger activation in this area while reimaging

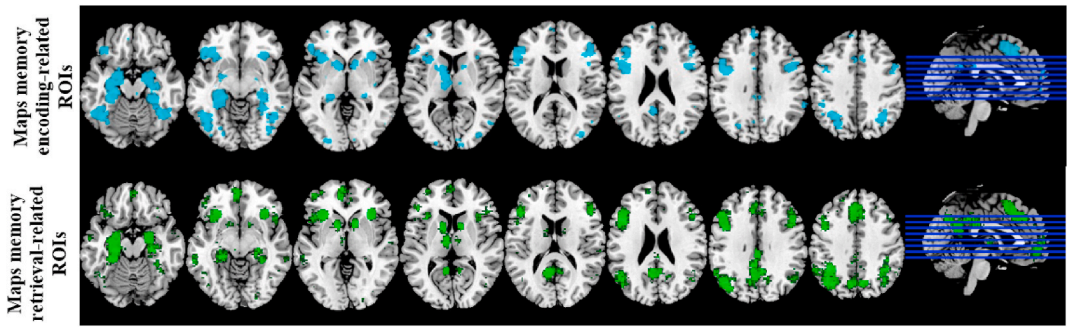

Fig. 3. Multi-slice brain images based on the meta-analysis reverse inference maps extracted from www.neurosynth.org related to the exposure (memory-encoding) and reimagining (memory-retrieval) of utilitarian and hedonic banners.

hedonic banners. No significant ROI related to memory encoding, however, was able to predict the highest recall of hedonic banners.

5. Discussion

According to traditional psychological theories of message processing and persuasion (e.g., LC4MP; Lang, 2000), messages that are able to facilitate an optimal allocation of cognitive resources in the audience will increase memory encoding, be better retrieved and recalled, and will likely be more persuasive (Kranzler et al., 2018). The increasing competition in online advertising has led to a need to evaluate which type of banners are able to allocate cognitive resources more efficiently, as this will have a positive impact on the ability to remember the banner and potentially increase the number of purchases of the advertised product. Our study provides the first evidence for differences in brain regions involved with memory encoding and retrieval between two widely used banner appeal modes: hedonic and utilitarian. Specifically, we showed that static banners that emphasize the social, personal, innovative, and experiential benefits of buying the product (i.e., hedonic banners), compared to those focused on convenience, instrumental, and factual arguments (i.e., utilitarian banners), engage the cognitive processes of memory encoding and retrieval, which ultimately correlate to higher recall, to a greater extent.

On one hand, in line with Hypothesis 1, exposure to hedonic banners provoked stronger brain activations in memory-encoding regions, such as the medial temporal lobe (including the hippocampus and inferior temporal gyrus), superior frontal gyrus, and occipital brain areas (e.g., the fusiform gyri and cuneus). Utilitarian banners, however, did provoke relatively less activation in those memory-encoding regions. Unlike utilitarian banners, which were more focused on the functional benefits related to the product, hedonic banners appeal to the feelings, adventure, enjoyment, and social environment derived from the purchase of the product. Therefore, that greater emotional engagement and personal value conveyed to the audience by hedonic banners may have been responsible for the higher cognitive and attentional processes and memory encoding. These findings support traditional communication theories, which contend that motivationally relevant, personalized, affective, and arousing messages (i.e., closer to hedonic) elicit a high resource allocation, which enables their gain and maintenance of attention and memory (Couwenberg et al., 2017; Samson et al., 2020; Yegiyan & Lang, 2010). Indeed, past studies have shown that including sensory features in messages may increase cognitive processing and, even, reduce the viewer's ability to argue against an advertisement's arguments, thus making it more persuasive (Harrington et al., 2003).

These findings, nevertheless, do not entirely align with the conclusions of Langleben et al. (2009) and Seelig et al. (2014), who confirmed that audiovisual ads with high intensity and sensory features "actually compete with ad's content for limited cognitive resources, thus reducing the processing of an ad's message". These authors found that video ads which are low in sensory features (i.e., close to utilitarian banners) trigger activations in the middle temporal gyrus and the dorsal prefrontal cortex, brain areas involved with working memory and attention; in turn, highly sensorial video ads elicited occipital activations which, according to the authors, reallocated processing resources away from encoding of the ad message. We contend that the results of our research are compatible with those of Langleben et al. (2009), due to the differences in the experimental stimuli. The messages used by those authors were audiovisual, without breaks between scenes, and using a large number of uncontrolled features (i.e., colors, music, characters). Instead, we used static banners, with previously tested hedonic or utilitarian manipulations, and controlled words, size, position, brand, and type of product. Building upon the LC4MP, it seems reasonable that the number of cognitive resources consumed in our hedonic banners was lower, to the point that it did not prevent the encoding of the message but, instead, favored it to an optimal level. Consequently, our findings provide insight, for the first time, that the involvement not only of temporal and medial frontal brain areas in the encoding of messages with moderate emotional and sensory features (i.e., static hedonic banners), but also visual occipital regions, may facilitate resource allocation.

On the other hand, when participants were asked to close their eyes and reimagine the banners, they showed significant differences in the retrieval of both typologies of ads. Particularly, and consistent with Hypothesis 2, reimagining hedonic (vs. utilitarian) banners elicited stronger activations in the ROI bilateral precuneus, a brain area present during episodic and semantic retrieval (Freton et al., 2014; Kwok & Macaluso, 2015). These results provide strong support for classical message processing theories, which claim that messages engaging initially ample cognitive resources (i.e., facilitate memory encoding) easily enable the storage and retrieval of their content (Lang, 2000; (Frankland, Josselyn, & Köhler, 2019). According to Nairne (2002), in order to maximize retrieval, it is advisable to build *meaningful* and valuable cues which remind us of the original experience. Our interpretation is that the higher personalization, social value, and experience conferred by hedonic banners became meaningful and not only strengthened memory encoding, but also encouraged the retrieval of the stored features of hedonic ads to a greater extent. Hence, it is crucial to endow advertising messages with affection, experience, and elements of personal value, in order to facilitate memory retrieval. These findings are also in line with traditional psychological models, which state that the deeper processing of stimuli leads to more durable memory traces (Craik & Lockhart, 1972).

This article's final goal was to identify whether the brain ROIs involved in the exposure and/or retrieval of banner ads vary with individual differences in the correct proportion of accurate banner recognition. In agreement with Hypothesis 3, hedonic banners gained higher levels of recall, compared to utilitarian banners. These findings are in line with previous advertising research, which stated that, when compared to utilitarian ads, hedonic appeals may be better recognized (Drolet et al., 2007), are more attention-grabbing (Rosen & Purinton, 2004) and, consequently, are more likely to facilitate consumer involvement with the ad and product (Hausman & Siekpe, 2009).

Interestingly, our correlation analysis showed that participants who experienced higher levels of activation in the precuneus when reimaging hedonic banners were more successful in correctly identifying old and new hedonic ads during the surprise memory task. None of the significant memory encoding-related brain areas, nevertheless, were associated with banner recall. First, these findings provide strong support to prior advertising research concluding that ad retrieval cues (e.g., the visual information in the ad) facilitate the access of elements from the ad memory trace and positively influence brand evaluations (Keller, 1987) and purchase intentions (Keller, 1993). Second, the results revealed a stronger role of memory retrieval over memory encoding brain areas in predicting prospective banner memory and recognition. These results are in alignment with the conclusions of previous studies stating that mere cognitive allocation and selection occurring during memory encoding does not necessarily automatize prospective memory recall in moderately cognitive demanding situations (e.g., the processing of banner ads) (McDaniel & Scullin, 2010). It is necessary, furthermore, that the information included in the stimuli is meaningful and chronologically understood, in order to facilitate the learning and reactivation of message cues (Karpicke & Roediger, 2008; Lang, 2000). Our interpretation is that the inclusion of more relevant attributes in hedonic (vs. utilitarian) banners enabled the better learning and reactivation of the message features, which is key to improving/predicting the prospective recall.

Theoretically, the results of this research represent a five-fold contribution. First, previous neuroscientific research has stated that the type of processing which occurs during message encoding critically affects memory formation (Henke, 2010). Our results represent a breakthrough in this regard, demonstrating that not only initial resource allocation to memory encoding during exposure to experiential and

symbolic banners is crucial for memory success. We showed that the extent to which the ad also includes affective, relevant, and vivid elements for the audience (e.g., hedonic banners) can facilitate learning, memory retrieval and, ultimately, recall. To our knowledge, this constitutes the first attempt in associating retrieval neural responses to advertising recall and recognition. Second, prior scholars have not been unanimous with respect to the effectiveness (indexed by memory encoding, retrieval, and recall processes) of highly vivid, intense, and sensory messages (Kranzler et al., 2018; Langleben et al., 2009; Seelig et al., 2014). Our findings confirmed that not all messages containing sensory, vivid, emotional, and relevant elements imply a cognitive overload and prevent optimal message processing. Instead, only those messages with a strong audiovisual component, which include fast scenes with a multitude of colors and different emotional intensity, may divert cognitive resources from processing the message content. Static banners, with sparce pictures and a controlled number of words and emotional states, could facilitate the optimal allocation of cognitive resources to encoding and retrieval, thus enabling high recognition accuracy.

Thirdly, previous studies have analyzed the exposure to audiovisual ads with high or low audiovisual intensity in the fields of anti-tobacco video ads and safe sex (Langleben et al., 2009). The current paper takes a step forward and analyzes both the exposure and retrieval of ads, thus extending the higher effectiveness of sensory and emotional ads to the field of online advertising and technological purchases. Fourth, our research constitutes an advance in incorporating theories relevant to persuasion and media effects into consumer neuroscience experiments. Prior studies have evaluated the neural predictors of anti-drug and anti-alcohol message effectiveness (Imhof, Schmälzle, Renner, & Schupp, 2017; Weber et al., 2015), the brain responses moderating the relationship between opportunities for exposure to anti-smoking campaigns and message recall (Kranzler et al., 2018), or the neural predictors of social media viral marketing success (Motoki et al., 2020). Studies closer to our research aim analyzed the neural processing of message features, such as gender voice (Casado-Aranda, Van der Laan, & Sánchez-Fernández, 2018) or message framing (Casado-Aranda, Venkatraman, Sánchez-Fernández, & Luque-Martínez, 2020). No research so far, however, has assessed brain processing during the exposure and retrieval of static online banners with varying levels of entertainment value, which represents an advance in the understanding of the psychophysiological origin of consumer decision making in online shopping environments. Fifth, our research serves as a step forward in identifying the psychological origins of the different effects on consumers of utilitarian and hedonic advertisements. In contrast to previous research that found that more pictorial and hedonic messages and contexts increased attention and memory (Cancela et al., 2021; Huskey et al., 2020; Moore & Lee, 2012), this research elucidates the implicit cognitive mechanisms of memory encoding and retrieval. It seems that the higher cognitive allocation triggered by experiential and vivid banners (hedonic) enable better encoding, retrieval, and subsequent recall, when compared to informative (utilitarian) ads.

6. Implications and future directions

Our findings may provide key implications for retailers who wish to design effective online advertising campaigns. On one hand, the optimal cognitive resource allocation of hedonic banners, which did not impede but, instead, facilitated message processing and recall, may imply that the use of static experience-, social- and emotional-based static attributes in the online presentation of goods will lead to optimal results. The inclusion of excessively vivid, audiovisual, and animated ads (e.g., pop-ups or interstitials) or highly convenient and factual information (such as utilitarian text or banners), respectively, may lead to overloaded or insufficient message cognitive processing, which could reduce ad effectiveness. These findings are of particular interest for retailers promoting products that are not clearly pigeon-holed as hedonic or utilitarian (e.g., sunglasses, electric scooters, or smartwatches). If static hedonic online ads are used, then their recall (and, potentially, their rate of purchase) may be increased. Furthermore, firms should use neural results to design new methodologies for analyzing ad effectiveness. If companies are able to create hedonic web environments that evoke brain activations related to memory encoding and retrieval, then they could be considered effective without resorting to biased and often inconclusive tools, such as self-reporting.

There were some limitations in the current study, which may provide a starting point for future research. Although we used a consumer neuroscience approach, which allowed us to identify brain areas involved during (and not after) message exposure and retrieval, and to correlate them with self-reported recognition rates, future research should go deeper into the association between areas involved with encoding and retrieval and actual online shopping behaviors. The results from our study warrant additional research, in order to corroborate the involvement of these message encoding and retrieval brain regions in the advertising of typically hedonic or utilitarian products. Despite we used an out-scanner surprise memory task for testing ad recall, prospective studies should investigate the unaddressed role of recalling emotions associated with the ads, for example, by including a self-evaluated level by the participant. This new approach would be crucial as precedent investigations highlight how self-assessments of emotions are strongly associated with behavioral intentions as well as with changes in attitudes (Brader, 2005; D'Errico & Poggi, 2016; Weber, 2013). Along the same line, given the key role of emotions in the processing of stimuli (Mak, Hu, Zhang, Xiao, & Lee, 2009), it could have been remarkable to measure and control (for example, with the traditional Self-Assessment Manikin Scale, Bradley & Lang, 1994) the emotional perceptions of each banner typology, with the aim to assess how the elicited emotions could modulate the neural processing of banner ads. This could constitute a fruitful research line for future development in the field of computers in human behavior. Furthermore, the characteristics of the sample in terms of age, gender or frequency of online shopping limit the replicability of our study and encourage future research to corroborate our results using more diverse participants. Future research is also in a good position to use complementary consumer neuroscience techniques (e.g., eye-tracking, skin conductance, or EEG) in the analysis of memory, recall, and effectiveness of hedonic and utilitarian ads.

7. Conclusions

Online advertising campaigns hold great promise to attract attention, increase engagement, and further the processing of the messages of firms, which can be considered useful, given the exponential increase of e-retailers, online ads and active Internet users worldwide. This is the first research to use a neuroscientific approach to identify neural differences in the exposure and retrieval of two appeals typically used by online companies at present: hedonic and utilitarian. Our results revealed, for the first time, that incorporating experiential, vivid, and value elements in static hedonic banners, as compared to using instrumental and utilitarian arguments, increased the requirement of cognitive sources and facilitated the retrieval of information regarding the advertisement which, ultimately, enabled higher recall.

Credit author statement

Luis-Alberto Casado-Aranda: Conceptualization; Methodology; Software; Formal analysis; Data curation; Writing – original draft; Funding acquisition; Juan Sánchez-Fernández: Resources; Visualization; Supervision; Writing – review & editing; Funding acquisition; Nathalie García: Conceptualization; Resources; Writing – review & editing.

Declaration of competing interest

None.

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References

eMarketer. (2022). *Digital ad spending outlook blows past previous forecasts*. Retrieved from https://www.emarketer.com/content/digital-ad-spending-outlook-blows-past-previous-forecasts.

Amatulli, C., De Angelis, M., & Donato, C. (2020). An investigation on the effectiveness of hedonic versus utilitarian message appeals in luxury product communication. *Psychology and Marketing, 37*(4), 523–534. https://doi.org/10.1002/mar.21320

Baltas, G., Kokkinaki, F., & Loukopoulou, A. (2017). Does variety seeking vary between hedonic and utilitarian products? The role of attribute type. *Journal of Consumer Behaviour, 16*(6), e1–e12. https://doi.org/10.1002/cb.1649

Bannerflow. (2022). *Is display advertising still effective?*. Retrieved from: https://www.bannerflow.com/blog/display-advertising-still-effective/.

Bilgihan, A., & Bujisic, M. (2015). The effect of website features in online relationship marketing: A case of online hotel booking. *Electronic Commerce Research and Applications, 14*(4), 222–232. https://doi.org/10.1016/j.elerap.2014.09.001

Brader, T. (2005). Striking a responsive chord: How political ads motivate and persuade voters by appealing to emotions. *American Journal of Political Science, 49*(2), 388–405. https://doi.org/10.2307/3647684

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry, 25*(1), 49–59.

Brennan, E., Momjian, A., Jeong, M., Naugle, D., Parvanta, S., & Hornik, R. C. (2012). *Mass media campaigns to reduce smoking among youth and young adults: Documenting potential campaign targets and reviewing the evidence from previous campaigns*. CECCR Working Paper Series.) Retrieved from https://repository.upenn.edu/cgi/viewcontent.cgi?article= 1384&context=asc_papers.

Cabeza, R., Dolcos, F., Graham, R., & Nyberg, L. (2002). Similarities and differences in the neural correlates of episodic memory retrieval and working memory. *NeuroImage, 16*(2), 317–330. https://doi.org/10.1006/nimg.2002.1063

Cameron, K. A. (2009). A practitioner's guide to persuasion: An overview of 15 selected persuasion theories, models and frameworks. *Patient Education and Counseling, 74*(3), 309–317. https://doi.org/10.1016/j.pec.2008.12.003

Campbell, C., Cohen, J., & Ma, J. (2014). Advertisements just aren't advertisements anymore: A new typology for evolving forms of online "advertising. *Journal of Advertising Research, 54*(1), 7–10. https://doi.org/10.2501/JAR-54-1-007-010

Cancela, A., Briñol, P., & Petty, R. E. (2021). Hedonic vs. epistemic goals in processing persuasive communications: Revisiting the role of personal involvement. *Motivation and Emotion, 45*(3), 280–298. https://doi.org/10.1007/s11031-021-09873-7

Casado-Aranda, L.-A., Liébana-Cabanillas, F., & Sánchez-Fernández, J. (2018). A neuropsychological study on how consumers process risky and secure E-payments. *Journal of Interactive Marketing, 43*, 151–164. https://doi.org/10.1016/j.intmar.2018.03.001

Casado-Aranda, L.-A., & Sanchez-Fernandez, J. (2022). Advances in neuroscience and marketing: Analyzing tool possibilities and research opportunities. *Spanish Journal of Marketing - ESIC*. https://doi.org/10.1108/SJME-10-2021-0196. *ahead-of-print* (ahead-of-print).

Casado-Aranda, L.-A., Sánchez-Fernández, J., & Luque-Martínez, T. (2020). Modulating the neural bases of political communications: Political involvement and perception of the economic situation. *Political Behavior*. https://doi.org/10.1007/s11109-020-09657-8

Casado-Aranda, L.-A., Van der Laan, L. N., & Sánchez-Fernández, J. (2018). Neural correlates of gender congruence in audiovisual commercials for gender-targeted products: An fMRI study. *Human Brain Mapping, 39*(11), 4360–4372. https://doi.org/10.1002/hbm.24276

Casado-Aranda, L.-A., Venkatraman, V., Sánchez-Fernández, J., & Luque-Martínez, T. (2020). Does partisan bias modulate neural processing of political information? An analysis of the neural correlates of corruption and positive messages. *Political Psychology, 41*(1), 145–164. https://doi.org/10.1111/pops.12581

Chiu, C.-M., Wang, E. T. G., Fang, Y.-H., & Huang, H.-Y. (2014). Understanding customers' repeat purchase intentions in B2C e-commerce: The roles of utilitarian value, hedonic value and perceived risk. *Information Systems Journal, 24*(1), 85–114. https://doi.org/10.1111/j.1365-2575.2012.00407.x

Chua, H. F., Ho, S. S., Jasinska, A. J., Polk, T. A., Welsh, R. C., Liberzon, I., & Strecher, V. J. (2011). Self-related neural response to tailored smoking-cessation messages predicts quitting. *Nature Neuroscience, 14*(4), 426–427. https://doi.org/10.1038/nn.2761

Clayton, R. B., Lang, A., Leshner, G., & Quick, B. L. (2019). Who fights, who flees? An integration of the LC4MP and psychological reactance theory. *Media Psychology, 22*(4), 545–571. https://doi.org/10.1080/15213269.2018.1476157

Compton, J. (2013). Inoculation theory. *The SAGE handbook of persuasion: Developments in theory and practice, 2*, 220–237.

Compton, J. A., & Pfau, M. (2005). Inoculation theory of resistance to influence at maturity: Recent progress in theory development and application and suggestions for future research. *Annals of the International Communication Association, 29*(1), 97–146. https://doi.org/10.1080/23808985.2005.11679045

Cooper, N., Tompson, S., Brook O'Donnell, M., & Emily, B. F. (2015). Brain activity in self- and value-related regions in response to online antismoking messages predicts behavior change. *Journal of Media Psychology, 27*(3), 93–109. https://doi.org/10.1027/1864-1105/a000146

Cooper, N., Tompson, S., O'Donnell, M. B., Vettel, J. M., Bassett, D. S., & Falk, E. B. (2018). Associations between coherent neural activity in the brain's value system during antismoking messages and reductions in smoking. *Health Psychology, 37*(4), 375–384. https://doi.org/10.1037/hea0000574

Couwenberg, L. E., Boksem, M. A. S., Dietvorst, R. C., Worm, L., Verbeke, W. J. M. I., & Smidts, A. (2017). Neural responses to functional and experiential ad appeals: Explaining ad effectiveness. *International Journal of Research in Marketing, 34*(2), 355–366. https://doi.org/10.1016/j.ijresmar.2016.10.005

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11*(6), 671–684. https://doi.org/10.1027/1864-1105/a000146

Davis, J. M., & Tuttle, B. M. (2013). A heuristic–systematic model of end-user information processing when encountering IS exceptions. *Information & Management, 50*(2), 125–133. https://doi.org/10.1016/j.im.2012.09.004

D'Errico, F., & Poggi, I. (2016). The bitter laughter". When parody is a moral and affective priming in political persuasion. *Frontiers in Psychology, 7*. https://www.frontiersin.org/article/10.3389/fpsyg.2016.01144.

Diao, F. (2004). Orienting response and memory for web advertisements: Exploring effects of pop-up window and animation. *Communication Research, 31*(5), 537–567. https://doi.org/10.1177/0093650204267932

Dijkstra, A., & Ballast, K. (2012). Personalization and perceived personal relevance in computer-tailored persuasion in smoking cessation. *British Journal of Health Psychology, 17*(1), 60–73. https://doi.org/10.1111/j.2044-8287.2011.02029.x

Drolet, A., Williams, P., & Lau-Gesk, L. (2007). Age-related differences in responses to affective vs. Rational ads for hedonic vs. Utilitarian products. *Marketing Letters, 18*(4), 211–221. https://doi.org/10.1007/s11002-007-9016-z

Falk, E. B., Berkman, E. T., Mann, T., Harrison, B., & Lieberman, M. D. (2010). Predicting persuasion-induced behavior change from the brain. *Journal of Neuroscience, 30*(25), 8421–8424. https://doi.org/10.1523/JNEUROSCI.0063-10.2010

Fisher, J. T., Keene, J. R., Huskey, R., & Weber, R. (2018). The limited capacity model of motivated mediated message processing: Taking stock of the past. *Annals of the International Communication Association, 42*(4), 270–290. https://doi.org/10.1080/23808985.2018.1534552

Fox, J. R., Lang, A., Chung, Y., Lee, S., Schwartz, N., & Potter, D. (2004). Picture this: Effects of graphics on the processing of television news. *Journal of Broadcasting & Electronic Media, 48*(4), 646–674. https://doi.org/10.1207/s15506878jobem4804_7

Frankland, P. W., Josselyn, S. A., & Köhler, S. (2019). The neurobiological foundation of memory retrieval. *Nature Neuroscience, 22*(10), 1576–1585. https://doi.org/10.1038/s41593-019-0493-1

Freton, M., Lemogne, C., Bergouignan, L., Delaveau, P., Lehéricy, S., & Fossati, P. (2014). The eye of the self: Precuneus volume and visual perspective during autobiographical memory retrieval. *Brain Structure and Function, 219*(3), 959–968. https://doi.org/10.1007/s00429-013-0546-2

Ghosh, T., S, S., & Dwivedi, Y. K. (2021). Examining the deferred effects of gaming platform and game speed of advergames on memory, attitude, and purchase intention. *Journal of Interactive Marketing, 55*, 52–66. https://doi.org/10.1016/j.intmar.2021.01.002

Guerrero Medina, C. A., Martínez-Fiestas, M., Casado Aranda, L. A., & Sánchez-Fernández, J. (2021). Is it an error to communicate CSR strategies? Neural differences among consumers when processing CSR messages. *Journal of Business Research, 126*, 99–112. https://doi.org/10.1016/j.jbusres.2020.12.044

Guo, F., Zhang, X., Ding, Y., & Wang, X. (2016). Recommendation influence: Differential neural responses of consumers during shopping online. *Journal of Neuroscience, Psychology, and Economics, 9*(1), 29–37. https://doi.org/10.1037/npe0000051

Hamborg, K.-C., Bruns, M., Ollermann, F., & Kaspar, K. (2012). The effect of banner animation on fixation behavior and recall performance in search tasks. *Computers in Human Behavior, 28*(2), 576–582. https://doi.org/10.1016/j.chb.2011.11.003

Hannula, D. E., & Ranganath, C. (2008). Medial temporal lobe activity predicts successful relational memory binding. *Journal of Neuroscience, 28*(1), 116–124.

Harrington, N. G., Lane, D. R., Donohew, L., Zimmerman, R. S., Norling, G. R., An, J.-H., Cheah, W. H., McClure, L., Buckingham, T., Garofalo, E., & Bevins, C. C. (2003). Persuasive strategies for effective anti-drug messages. *Communication Monographs, 70*(1), 16–38. https://doi.org/10.1080/03637750302478

Hausman, A. V., & Siekpe, J. S. (2009). The effect of web interface features on consumer online purchase intentions. *Journal of Business Research, 62*(1), 5–13. https://doi.org/10.1016/j.jbusres.2008.01.018

Henke, K. (2010). A model for memory systems based on processing modes rather than consciousness. *Nature Reviews Neuroscience, 11*(7), 523–532. https://doi.org/10.1038/nrn2850

Huang, Y.-F., Kuo, F.-Y., Luu, P., Tucker, D., & Hsieh, P.-J. (2015). Hedonic evaluation can be automatically performed: An electroencephalography study of website impression across two cultures. *Computers in Human Behavior, 49*, 138–146. https://doi.org/10.1016/j.chb.2015.02.016

Hubert, M., Hubert, M., Linzmajer, M., Riedl, R., Kenning, P., & Hubert, M. (2018). Trust me if you can – neurophysiological insights on the influence of consumer impulsiveness on trustworthiness evaluations in online settings. *European Journal of Marketing, 52*(1/2), 118–146. https://doi.org/10.1108/EJM-12-2016-0870

Huskey, R., Wilcox, S., Clayton, R. B., & Keene, J. R. (2020). The limited capacity model of motivated mediated message processing: Meta-analytically summarizing two decades of research. *Annals of the International Communication Association, 44*(4), 322–349. https://doi.org/10.1080/23808985.2020.1839939

Hussain, R., Sweeney, A., & Mort, G. S. (2010). Typologies of banner advertisements' attributes: A content analysis. *Journal of Promotion Management, 16*(1–2), 96–113. https://doi.org/10.1080/10496490903573114

IAB. (2022). *2020/2021 IAB Internet advertising revenue report*. Retrieved from https://www.iab.com/insights/internet-advertising-revenue-report/.

Imhof, M. A., Schmälzle, R., Renner, B., & Schupp, H. T. (2017). How real-life health messages engage our brains: Shared processing of effective anti-alcohol videos. *Social Cognitive and Affective Neuroscience, 12*(7), 1188–1196. https://doi.org/10.1093/scan/nsx044

IPA Bellwether Report. (2022). *UK companies revise marketing budgets up but Omicron slows down*. Retrieved from https://ipa.co.uk/news/bellwether-report-q4-2021/.

Karpicke, J. D., & Roediger, H. L. (2008). The critical importance of retrieval for learning. *Science, 319*(5865), 966–968. https://doi.org/10.1126/science.1152408

Keller, K. L. (1987). Memory factors in advertising: The effect of advertising retrieval cues on brand evaluations. *Journal of Consumer Research, 14*(3), 316–333. https://doi.org/10.1086/209116

Keller, K. L. (1993). Memory retrieval factors and advertising effectiveness. In *Advertising exposure, memory and choice*. Psychology Press.

Klein, K., & Melnyk, V. (2016). Speaking to the mind or the heart: Effects of matching hedonic versus utilitarian arguments and products. *Marketing Letters, 27*(1), 131–142. https://doi.org/10.1007/s11002-014-9320-3

Knudsen, E. I. (2007). Fundamental components of attention. *Annual Review of Neuroscience, 30*, 57–78. https://doi.org/10.1146/annurev.neuro.30.051606.094256

Kranzler, E. C., Schmälzle, R., Pei, R., Hornik, R. C., & Falk, E. B. (2018). Message-elicited brain response moderates the relationship between opportunities for exposure to anti-smoking messages and message recall. *Journal of Communication*. https://doi.org/10.1093/joc/jqz035

Kwok, S. C., & Macaluso, E. (2015). Immediate memory for "when, where and what": Short-delay retrieval using dynamic naturalistic material: Neural correlates of immediate episodic retrieval. *Human Brain Mapping*. https://doi.org/10.1002/hbm.22787. n/a-n/a.

Lang, A. (2000). The limited capacity model of mediated message processing. *Journal of Communication, 50*(1), 46–70. https://doi.org/10.1111/j.1460-2466.2000.tb02833.x

Lang, A. (2006). Using the limited capacity model of motivated mediated message processing to design effective cancer communication messages. *Journal of Communication, 56*(s1), S57–S80. https://doi.org/10.1111/j.1460-2466.2006.00283.x

Langleben, D. D., Loughead, J. W., Ruparel, K., Hakun, J. G., Busch-Winokur, S., Holloway, M. B., Strasser, A. A., Cappella, J. N., & Lerman, C. (2009). Reduced prefrontal and temporal processing and recall of high "sensation value" ads. *NeuroImage, 46*(1), 219–225. https://doi.org/10.1016/j.neuroimage.2008.12.062

Lang, A., Park, B., Sanders-Jackson, A. N., Wilson, B. D., & Wang, Z. (2007). Cognition and emotion in TV message processing: How valence, arousing content, structural complexity, and information density affect the availability of cognitive resources. *Media Psychology, 10*(3), 317–338. https://doi.org/10.1080/15213260701532880

Lang, A., Sanders-Jackson, A., Wang, Z., & Rubenking, B. (2013). Motivated message processing: How motivational activation influences resource allocation, encoding, and storage of TV messages. *Motivation and Emotion, 37*(3), 508–517. https://doi.org/10.1007/s11031-012-9329-y

Lee, S. Y., & Cho, Y.-S. (2010). Do web users care about banner ads anymore? The effects of frequency and clutter in web advertising. *Journal of Promotion Management, 16*(3), 288–302. https://doi.org/10.1080/10496490903582594

Lee, S., & Potter, R. F. (2005). In *Do words matter?: Effects of emotional words in radio messages on orienting, physiological arousal, and facial EMG response. Paper presented to the International Communications Association at their annual conference in New York*.

Li, M., & Mao, J. (2015). Hedonic or utilitarian? Exploring the impact of communication style alignment on user's perception of virtual health advisory services. *International Journal of Information Management, 35*(2), 229–243. https://doi.org/10.1016/j.ijinfomgt.2014.12.004

Lin, C.-W. J., Murshed, F., & Zhang, Y. (2020). Revisiting precipitation-induced smoking: The role of hedonic versus utilitarian advertising message on smoking-related intervention. *Social Marketing Quarterly, 26*(3), 204–217. https://doi.org/10.1177/1524500420942429

Mak, A. K. Y., Hu, Z.-G., Zhang, J. X., Xiao, Z.-W., & Lee, T. M. C. (2009). Neural correlates of regulation of positive and negative emotions: An fmri study. *Neuroscience Letters, 457*(2), 101–106. https://doi.org/10.1016/j.neulet.2009.03.094

Manippa, Valerio, Padulo, Caterina, van der Laan, Laura, & Brancucci, Alfredo (2017). Gender differences in food choice: Effects of superior temporal sulcus stimulation. *Frontiers in Human Neuroscience, 11*. https://doi.org/10.3389/fnhum.2017.00597

McDaniel, M. A., & Scullin, M. K. (2010). Implementation intention encoding does not automatize prospective memory responding. *Memory & Cognition, 38*(2), 221–232. https://doi.org/10.3758/MC.38.2.221

Moore, D. J., & Lee, S. P. (2012). HOW advertising influences consumption impulses: The role of visualization, anticipated emotions, taste anticipation, and hedonic rationalization. *Journal of Advertising, 41*(3), 107–120.

Motoki, K., Suzuki, S., Kawashima, R., & Sugiura, M. (2020). A combination of self-reported data and social-related neural measures forecasts viral marketing success on social media. *Journal of Interactive Marketing, 52*, 99–117. https://doi.org/10.1016/j.intmar.2020.06.003

Murray, L. J., & Ranganath, C. (2007). The dorsolateral prefrontal cortex contributes to successful relational memory encoding. *Journal of Neuroscience, 27*(20), 5515–5522.

Nairne, J. S. (2002). The myth of the encoding-retrieval match. *Memory, 10*, 389–395.

Namin, A., Hamilton, M. L., & Rohm, A. J. (2020). Impact of message design on banner advertising involvement and effectiveness: An empirical investigation. *Journal of Marketing Communications, 26*(2), 115–129. https://doi.org/10.1080/13527266.2017.1393767

Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In L. Berkowitz (Ed.), *Advances in experimental social Psychology* (Vol. 19, pp. 123–205). Academic Press. https://doi.org/10.1016/S0065-2601(08)60214-2.

Pillai, K. G., Katsikeas, C. S., & Presi, C. (2012). Print advertising: Type size effects. *Journal of Business Research, 65*(6), 865–868. https://doi.org/10.1016/j.jbusres.2010.04.010

Pool, E.-M., Rehme, A. K., Eickhoff, S. B., Fink, G. R., & Grefkes, C. (2015). Functional resting-state connectivity of the human motor network: Differences between right- and left-handers. *NeuroImage, 109*, 298–306. https://doi.org/10.1016/j.neuroimage.2015.01.034

Prince, S. E., Tsukiura, T., & Cabeza, R. (2007). Distinguishing the neural correlates of episodic memory encoding and semantic memory retrieval. *Psychological Science, 18*(2), 144–151. https://doi.org/10.1111/j.1467-9280.2007.01864.x

Rosen, D. E., & Purinton, E. (2004). Website design: Viewing the web as a cognitive landscape. *Journal of Business Research, 57*(7), 787–794. https://doi.org/10.1016/S0148-2963(02)00353-3

Rosenthal-von der Pütten, A. M., Schulte, F. P., Eimler, S. C., Sobieraj, S., Hoffmann, L., Maderwald, S., Brand, M., & Krämer, N. C. (2014). Investigations on empathy towards humans and robots using fMRI. *Computers in Human Behavior, 33*, 201–212. https://doi.org/10.1016/j.chb.2014.01.004

Sadoski, M., & Paivio, A. (2012). *Imagery and text: A dual coding theory of reading and writing* (2nd ed.). Routledge. https://doi.org/10.4324/9780203801932

Samson, L., Nanne, A. J., & Buijzen, M. (2020). Remember the motivationally-relevant appeals? The influence of social and sensory appeals on memory for pronutritional messages promoting healthy foods. *International Journal of Advertising*, 1–20. https://doi.org/10.1080/02650487.2020.1833675, 0(0.

Sánchez-Fernández, J., Casado-Aranda, L.-A., & Bastidas-Manzano, A.-B. (2021). Consumer neuroscience techniques in advertising research: A bibliometric citation analysis. *Sustainability, 13*(3), 1589. https://doi.org/10.3390/su13031589

Scarpi, D. (2012). Work and fun on the Internet: The effects of utilitarianism and hedonism online. *Journal of Interactive Marketing, 26*(1), 53–67. https://doi.org/10.1016/j.intmar.2011.08.001

Schmaelzle, R., Senecal Cooper, N., O'Donnell, M., Tompson, S., Lee, S., Cantrell, J., Vettel, J., & Falk, E. (2020). The effectiveness of online messages for promoting smoking cessation resources: Predicting nationwide campaign effects from neural responses in the EX campaign. *Frontiers in Human Neuroscience, 14*, Article 565772. https://doi.org/10.3389/fnhum.2020.565772

Scholz, C., Baek, E. C., O'Donnell, M. B., & Falk, E. B. (2019). Decision-making about broad- and narrowcasting: A neuroscientific perspective. *Media Psychology*, 1–25. https://doi.org/10.1080/15213269.2019.1572522, 0(0.

Seelig, D., Wang, A.-L., Jaganathan, K., Loughead, J. W., Blady, S. J., Childress, A. R., Romer, D., & Langleben, D. D. (2014). Low message sensation health promotion videos are better remembered and activate areas of the brain associated with memory encoding. *PLoS One, 9*(11), Article e113256. https://doi.org/10.1371/journal.pone.0113256

Sherif, M., & Hovland, C. I. (1961). *Social judgment: Assimilation and contrast effects in communication and attitude change*. Yale Univer. Press (pp. xii, 218).

Simola, J., Kuisma, J., Oörni, A., Uusitalo, L., & Hyönä, J. (2011). The impact of salient advertisements on reading and attention on web pages. *Journal of Experimental Psychology: Applied*. https://doi.org/10.1037/a0024042

Solnais, C., Andreu-Perez, J., Sánchez-Fernández, J., & Andréu-Abela, J. (2013). The contribution of neuroscience to consumer research: A conceptual framework and empirical review. *Journal of Economic Psychology, 36*, 68–81. https://doi.org/10.1016/j.joep.2013.02.011

Statista. (2021). *Redes sociales con mayor número de usuarios activos*. Retrieved from https://es.statista.com/estadisticas/600712/ranking-mundial-de-redes-sociales-por-numero-de-usuarios/.

Tal, A., & Wansink, B. (2016). Blinded with science: Trivial graphs and formulas increase ad persuasiveness and belief in product efficacy. *Public Understanding of Science, 25*(1), 117–125. https://doi.org/10.1177/0963662514549688

Tsukiura, T., & Cabeza, R. (2011). Remembering beauty: Roles of orbitofrontal and hippocampal regions in successful memory encoding of attractive faces. *NeuroImage, 54*(1), 653–660. https://doi.org/10.1016/j.neuroimage.2010.07.046

Weber, C. (2013). Emotions, campaigns, and political participation. *Political Research Quarterly, 66*(2), 414–428. https://doi.org/10.1177/1065912912449697

Weber, R., Huskey, R., Mangus, J. M., Westcott-Baker, A., & Turner, B. O. (2015). Neural predictors of message effectiveness during counterarguing in antidrug campaigns. *Communication Monographs, 82*(1), 4–30. https://doi.org/10.1080/03637751.2014.971414

Yarkoni, T., Poldrack, R. A., Nichols, T. E., Van Essen, D. C., & Wager, T. D. (2011). Large-scale automated synthesis of human functional neuroimaging data. *Nature Methods, 8*(8), 665–670. https://doi.org/10.1038/nmeth.1635

Yegiyan, N. S., & Lang, A. (2010). Processing central and peripheral detail: How content arousal and emotional tone influence encoding. *Media Psychology, 13*(1), 77–99. https://doi.org/10.1080/15213260903563014