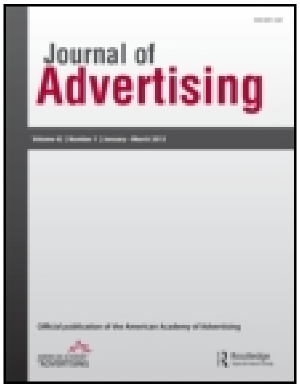


Journal of Advertising
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ujoa20

Exploring Ad-Elicited Emotional Arousal and Memory for the Ad Using fMRI

Tomer Bakalash [a] & Hila Riemer [a]
[a] Ben-Gurion University of the Negev , Beer-Sheva , Israel
Published online: 30 Oct 2013.

To cite this article: Tomer Bakalash & Hila Riemer (2013) Exploring Ad-Elicited Emotional Arousal and Memory for the Ad Using fMRI, Journal of Advertising, 42:4, 275-291, DOI: 10.1080/00913367.2013.768065

To link to this article: http://dx.doi.org/10.1080/00913367.2013.768065

Journal of Advertising, 42(4), 275–291

ISSN: 0091-3367 print / 1557-7805 online
DOI: 10.1080/00913367.2013.768065

Routledge
Taylor & Francis Group

Exploring Ad-Elicited Emotional Arousal and Memory for the Ad Using fMRI

Tomer Bakalash and Hila Riemer
Ben-Gurion University of the Negev, Beer-Sheva, Israel

Using fMRI and self-reports, we explore the relationship between ad-elicited emotional arousal and memory for the ad, as well as the mechanisms involved in this relationship. A broad conceptual framework proposes three routes for emotional memory: attention, elaboration, and social cognition. Our exploratory study examines the association between ad-elicited emotional arousal and predetermined ad memorability, as a proxy for memory for the ad. Results reveal greater amygdala activation in memorable (versus unmemorable) ads, reinforcing the association between ad-elicited emotional arousal and memory for the ad. Amygdala activation was accompanied by activation in the brain region termed the superior temporal sulcus (STS), which is involved in social cognition. These results are indicative of a sociocognitive emotional memory process, which has been neglected in past research. Future research directions are discussed.

Consumers are exposed daily to a considerable number of ads. Often there is a significant time delay between exposure to an ad and the purchase decision. Thus, for an ad to be effective, memory for the ad is critical. Recognizing the importance of memory for the ad, many researchers have attempted to determine the factors that enhance it (e.g., Baack, Wilson, and Till 2008; MacInnis and Jaworski 1989; Putrevu 2008). One such factor that has received increasing attention is the affective response to the ad.

Our study aims to expand knowledge of the underlying process by which affective response to an ad influences memory for the ad. Affect, defined as "valenced feelings state" (Cohen and Areni 1991), is a general term referring to both mood and emotions (Bagozzi, Gopinath, and Nyer 1999). Mood is a general, low intensity, and enduring feeling state and is unrelated to a specific object; emotions are more intense, specific, and short-lived (Forgas 1995). For our purposes, affective response to an ad refers to emotions evoked during exposure to that ad. The two-dimensional view of affect (Russell 1980) distinguishes between the valence and arousal dimensions. Valence refers to the direction of affect (i.e., positive versus negative) and arousal refers to its intensity (e.g., calm versus excited or sad versus stressed). When dealing with the affect evoked during exposure to ads, we focus on the emotional arousal elicited by the ad. Our research does not classify the specific emotions evoked by the ad; rather, it deals with the intensity of the emotional response.

Based on the current knowledge of the relationship between emotional arousal and memory, we develop a general framework for understanding the mechanisms by which ad-elicited emotional arousal may influence memory for the ad. Our framework suggests that the effect of ad-elicited emotional arousal on memory for the ad may be mediated through three routes: an attention-related route, an elaboration-related route, and a social cognition-related route. The first two routes have received relatively more attention in the literature, while the third one has had less investigation in the context of emotional memory. Our study demonstrates the occurrence of this less-investigated route involving social cognition and suggests directions for future investigation.

The exploratory empirical study presented in this article is guided by the proposed broad conceptual framework. In this study we use a neural activation measure (fMRI) to assess the processes that take place during exposure to various ads. Instead of manipulating ad-elicited emotional arousal and then measuring memory for the ad, we chose ads that differ in level of memorability, based on an external measure, and measured the emotional and neural responses to the ads. Thus, in our study ad memorability is predetermined and is viewed as an ad characteristic. The ad memorability is assessed based on a

This research is part of a doctoral dissertation of the first author, supervised by the second author. The article is dedicated to the memory of Ayala Malach-Pines, who served as a co-chair of the doctoral committee. The authors thank Rafi Malach and Yulia Golland for their neuroscientific guidance and the Brandman Market Research Agency for providing the stimuli for this study. The authors also thank the *Journal of Advertising* reviewers, assistant editor, and editor for their insightful comments and suggestions throughout the review process.

Address correspondence to Hila Riemer, Ben-Gurion University of the Negev, POB 653, Beer-Sheva 84105, Israel. E-mail: hriemer@bgu.ac.il

Tomer Bakalash (MA, Ben-Gurion University of the Negev) is a PhD candidate in the Guilford Glazer Faculty of Business and Management, Ben-Gurion University of the Negev.

Hila Riemer (PhD, University of Illinois at Urbana–Champaign) is an assistant professor in the Guilford Glazer Faculty of Business and Management, Ben-Gurion University of the Negev.

national survey conducted on an independent sample. This external measure serves as a proxy for memory for the ad. As such, the empirical study presented in this article focuses on the relationship between ad memorability and ad-elicited emotional arousal. It is exploratory in the sense that it does not assess causal relationships, but rather provides evidence for an association between them. Thus, the study can be considered an initial examination of the broad conceptual framework we propose.

In dealing with memory, our investigation concerns memory of the *ad* itself, rather than of the brand or the claim. Memory for the ad may be assessed using either recognition or recall—each has its advantages and limitations (Krishnan and Chakravarti 1999). In our study, the operationalization of the predetermined ad memorability relies on a measure of recognition, which has the advantage of relatively higher sensitivity (discriminating power) compared to recall (Singh, Rothschild, and Churchill 1988). Other measures will be left for future research.

One of the main challenges in studying emotional memory processes relates to the measures that are indicative of their mechanisms. Researchers have used a variety of measures to assess emotional arousal, including self-reports and autonomic measures (Poels and Dewitte 2006). Using solely self-report measures is limited in providing insight into the underlying mechanism. Neuroscientific methods can shed additional light on these conscious and unconscious psychophysiological processes. One such method is functional magnetic resonance imaging (fMRI), which detects changes in neural activity of brain regions. These changes can be indicative of the processes affiliated with the various brain regions.

The application of neuroscientific approaches in general, and particularly fMRI, has gained attention among consumer researchers in the past several years (e.g., Kenning et al. 2007; Plassmann et al. 2007; Schaefer et al. 2006; Yoon et al. 2006; for a review, see Egidi, Nusbaum, and Cacioppo 2008). Studies have investigated a wide range of topics, including pricing and branding. Investigation of neural processes in advertising has been limited (but see Ambler and Burne 1999; Ioannides et al. 2000; Rothschild and Hyun 1990; Rothschild et al. 1988). Our study combines fMRI with self-reports to explore the underlying process for the relationship between ad-elicited emotional arousal and memory for the ad.

The rest of this article is organized as follows: We first review the current knowledge on the mechanisms by which emotional arousal may influence memory. Based on this review, we develop a general framework that integrates the various underlying processes for emotional memory. We then discuss insights from neuroscientific research on emotion and memory that provide a basis for our empirical study. The empirical study, presented after the theoretical sections, explores the association between ad memorability and ad-elicited emotional arousal. Insights from this study, combined with our proposed broad framework, may channel additional research on the topic, as discussed in the conclusion of the article.

THE EFFECT OF EMOTIONAL AROUSAL ON MEMORY

The role of emotional arousal in memory has been studied from both the psychological and biological perspective (for a review, see Reisberg and Heuer 2004). There is abundant evidence that memory of emotionally arousing events tends to be better than memory of neutral events (e.g., Bradley et al. 1992; Cahill and McGaugh 1995; Hamann 2001; Ochsner and Schacter 2003; Phelps 2004). Emotional arousal can influence not only the likelihood of remembering an event but also the vividness of the memory (Kensinger and Corkin 2003; Ochsner 2000). Some research suggests that emotional arousal has an inverted-U effect on memory (Yerkes and Dodson 1908). Yet Kroeber-Riel (1979) posits that marketing stimuli may not be capable of creating levels of arousal high enough to exhibit inverted-U relationships, such as those observed in psychology research. Thus, in an advertising context, it is reasonable to assume a positive effect of emotional arousal on memory (Singh and Churchill 1987).

Indeed, advertising research has suggested that emotionally arousing ads have a memory advantage (see Aaker, Stayman, and Hagerty 1986; Bolls, Lang, and Porter 2001; Friestad and Thorson 1993; Thorson and Friestad 1989). Several studies have dealt with emotion and memory for advertising, applying various neuroscientific methods. Ambler and Burne (1999) treated participants with either placebo or β-blockers (chemical substances that inhibit the experience of emotions). Their results show a link between ad-elicited emotional arousal and memory. In addition, memory was less sharp for participants treated with β-blockers compared to those given placebos. Rothschild and colleagues (Rothschild and Hyun 1990; Rothschild et al. 1988) used electroencephalograms (EEGs; the brain's spontaneous electrical activity, related to factors such as arousal, attention, and information processing). Their studies showed it is the EEG of a specific component of the ad, rather than the aggregated activity during exposure to the whole ad, that predicts memory. Altogether, it can be said that there is general agreement that emotional arousal enhances memory for the ad. Yet there is little agreement among researchers regarding the psychological process by which ad-elicited emotional arousal influences ad memory (Mehta and Purvis 2006), as discussed next.

The Mechanism By Which Emotional Arousal Influences Memory

Various theoretical explanations have been proposed to account for the effect of emotional arousal on memory. These theories can be classified into three categories of mechanisms: those involving attention, elaboration, or social cognition. In this section we describe the mechanisms suggested in the literature and combine them into one comprehensive framework.

Emotional arousal-memory mechanisms suggested in the literature. Attention-related mechanisms rely on the assumption that arousal leads individuals to focus on certain stimuli more than on others. Different theories suggest different reasons for arousal effects on attention allocation. Some suggest that higher arousal decreases processing capacity, which leads individuals to focus on certain information (e.g., Kahneman 1973). According to the cue utilization theory (Easterbrook 1959), for example, high arousal leads people to neglect secondary cues and to focus on primary cues. Sanbonmatsu and Kardes (1988) suggest that high arousal leads people to focus more on peripheral (versus central) cues, because peripheral cues can be more easily processed. Pham (1996) suggests that it is not only the processing demand of a stimulus that determines how much attention is devoted to it but also the diagnosticity (i.e., how relevant it is for the judgment task). Other research suggests emotionally arousing stimuli attract attention because they are novel (for a review, see Schooler and Eich 2000). Berlyne (1960) suggests that the level of arousal associated with a stimulus will interact with the individual's preferred level of stimulation to influence attention allocation (see also Steenkamp, Baumgartner, and van der Wulp 1996).

Elaboration-related mechanisms rely on the assumption that arousal increases the individual's processing capacity, which in turn increases the level of information processing. Craik and Lockhart's (1972) level of processing explanation posits that memory depends on the degree of stimulus elaboration. This predicts that high-arousal stimuli will be more memorable than low-arousal stimuli. Advertising research in which emotional arousal is manipulated through the context of the ad presentation (e.g., a television program) supports this prediction. For example, Pavelchak, Antil, and Munch (1988) measured recall for ads presented during Super Bowl games; they demonstrated better recall for viewers who were affiliated with the playing teams (i.e., cities) compared to those not affiliated with the teams. No effect was demonstrated for losing versus winning teams. These findings can be attributed to the level of processing created by the emotional arousal involved within this context. In Kroeber-Riel's (1979) studies, arousal was related to the stimulus and not the context. Here too the higher the level of arousal, the better the memory. Kroeber-Riel argues this effect is due to the increased processing capacity produced by stimulus arousal, which is consistent with the elaboration explanation.

Social cognition-related mechanisms have received less attention in the literature in the context of the emotion-memory relationship. Social cognition refers to processes by which individuals try to make sense of their social environment. It includes assessment of other people, oneself, and interactions between the self and others (Adolphs 1999, 2001, 2009). As such, social cognition consists of perceiving, recognizing, and evaluating social information. These processes result in a representation of the social environment (Adolphs 2001).

Social cognitive processes differ from attention and elaboration. Attention- and elaboration-related processing refers to the quantity of information processing. Attention processes have to do with the selection of the information on which the individual will focus, and with the allocation of processing resources to the various informational pieces (e.g., the viewer noticed the smiling person in the ad but did not notice what was written about the brand's attribute). Elaboration processes have to do with the amount of thought devoted to information processing in general (e.g., the emotional arousal elicited by the ad increased the viewer's processing capacity, which led him or her to devote a great deal of thought to the ad's claim). In contrast, social cognition refers to the quality of information processing, including devoting thought to the meaning of the information (e.g., the person in the ad is smiling when he or she is using the product; the viewer infers the person is happy, which in turn leads the viewer to think that the product must be good).

Research points to the involvement of social cognitive processes in emotional processing. According to Lazarus (1991), exposure to any emotionally arousing event or stimulus leads individuals to engage in an evaluation process whose aim is to appraise and to generate meaning. This involves, for example, assessment of the significance of the event or stimulus to oneself and one's well-being. In the same vein, emotional appraisal theories postulate that evaluation of the situation is what leads to the elicitation of emotions (e.g., Frijda 1986; Smith and Ellsworth 1985). In other words, to experience emotional arousal one should undergo a social cognitive process that includes perception, recognition, and evaluation. Specifically to the context of advertising, exposure to an emotionally arousing scene may elicit emotional arousal in the viewer as a result of appraisal processing. That is, when an individual views other people experiencing emotional arousal, the individual undergoes a social appraisal process, which in turn elicits emotional arousal in the viewer (Parkinson and Simons 2009).

The occurrence of these social cognitive processes may contribute to the memory of the emotional information. Indeed, according to LeDoux (1996) it is the meaning of the information that may enhance its memorability. Remembering an emotionally arousing experience may often be relevant to survival or well-being. Encoding information of such an emotional experience and remembering it may assist the individual in planning for (or avoiding) its future reoccurrence. This implies that social cognitive processes may result in enhanced memory for emotional (versus nonemotional) information.

Integrating the various mechanisms into a comprehensive framework. The review of the existing theoretical approaches to emotional memory suggests that the relationships between emotional arousal and memory are complex and require the consideration of many issues. Taken together, the three alternative mechanisms—attention, elaboration, and social cognition—may account for the effect of ad-elicited emotional arousal on memory. Yet it seems that the various theories may be considered complementary rather than contradictory, and that integration of the theories into a comprehensive framework might better describe the relationships. Combining the three main mechanisms would suggest that emotional arousal can act through three routes, based on attention, elaboration, or social cognition (see Figure 1).

Specific evidence for the occurrence of these processes is lacking, particularly in advertising research, presumably due to

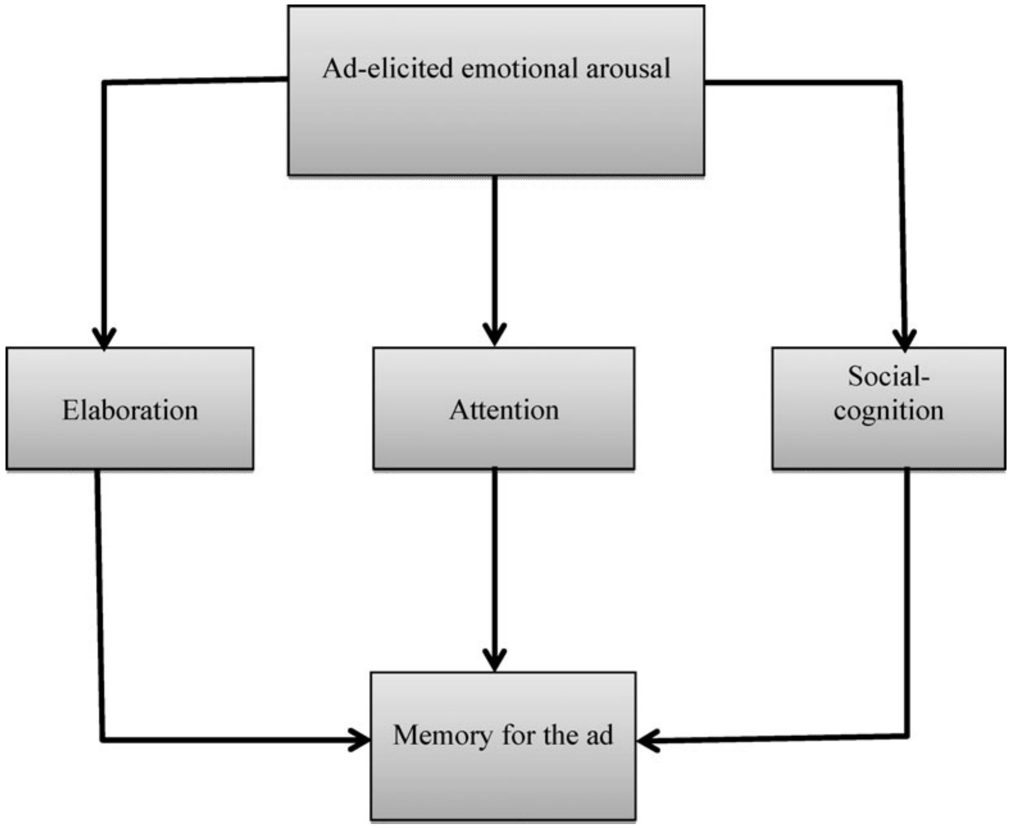


FIG. 1. The proposed broad conceptual framework for the effect of ad-elicited emotional arousal on memory.

the limited ability of self-reports to provide such data. Brain imaging enables a direct view into the consumer's "black box" (Bagozzi, Gopinath, and Nyer 1999; Egidi, Nusbaum, and Cacioppo 2008), allowing the exploration of the neural reactions that follow ad exposure, as well as their psychophysiological meanings. Studies that have used neuroscientific methods to study emotional arousal-memory effects are discussed next.

Neuroscientific Research on Emotion and Memory

Neuroscientific research indicates emotionally arousing stimuli engage specific neural mechanisms that enhance memory. Studies have established the key role of the amygdala—an almond-shaped region of the medial temporal lobe—in enhancing memory for emotional stimuli (e.g., Canli et al. 2000; Dolcos, LaBar, and Cabeza 2004; Hamann 2001; Kensinger and Corkin 2004; Kilpatrick and Cahill 2003). This was initially shown based on various neuroimaging studies (e.g., Cahill et al. 1996; Canli et al. 2000). Lesion studies have reinforced these results. Patients with damage to the amygdala do not show memory enhancement for emotional information (Kensinger and Schacter 2008). Amygdala activation is therefore necessary for emotional memory enhancement.

Amygdala activation is interconnected with other brain regions (Young 1993). Furthermore, coactivation of the amygdala with other regions is essential for emotional memory formation. A meta-analysis of fMRI studies by Murty and colleagues (2010) characterizes the neural systems that are consistently associated with emotional memory formation. Based on past studies, the authors list brain regions that support emotional memory encoding. Murty and colleagues emphasize the central role of the medial temporal lobe (MTL) in emotional encoding (see also Dolcos, LaBar, and Cabeza 2004; Hamann 2001; Kensinger and Corkin 2004). The MTL is known for its role in declarative (explicit) memory formation (Scoville and Milner 1957). The interaction between the amygdala and MTL reinforces the positive effect of emotional arousal on memory. Murty and colleagues (2010) further specify additional brain regions that are associated with memory formation and can be indicative of the process by which emotional arousal enhances memory. Interestingly, the functions of the brain regions listed in this meta-analysis overlap the routes proposed in our general conceptual framework, namely, attention, elaboration, and social cognition. Figure 2 describes the brain regions involved in the various emotional memory processes that are mentioned in Murty and colleagues' (2010) review. As described, attention-related processing involves the parietal cortex (dorsal parietal and ventral parietal) and the ventral stream (the medial occipital and medial temporal gyri); elaboration-related processing involves the prefrontal cortex (specifically the inferior frontal gyrus); social cognition-related

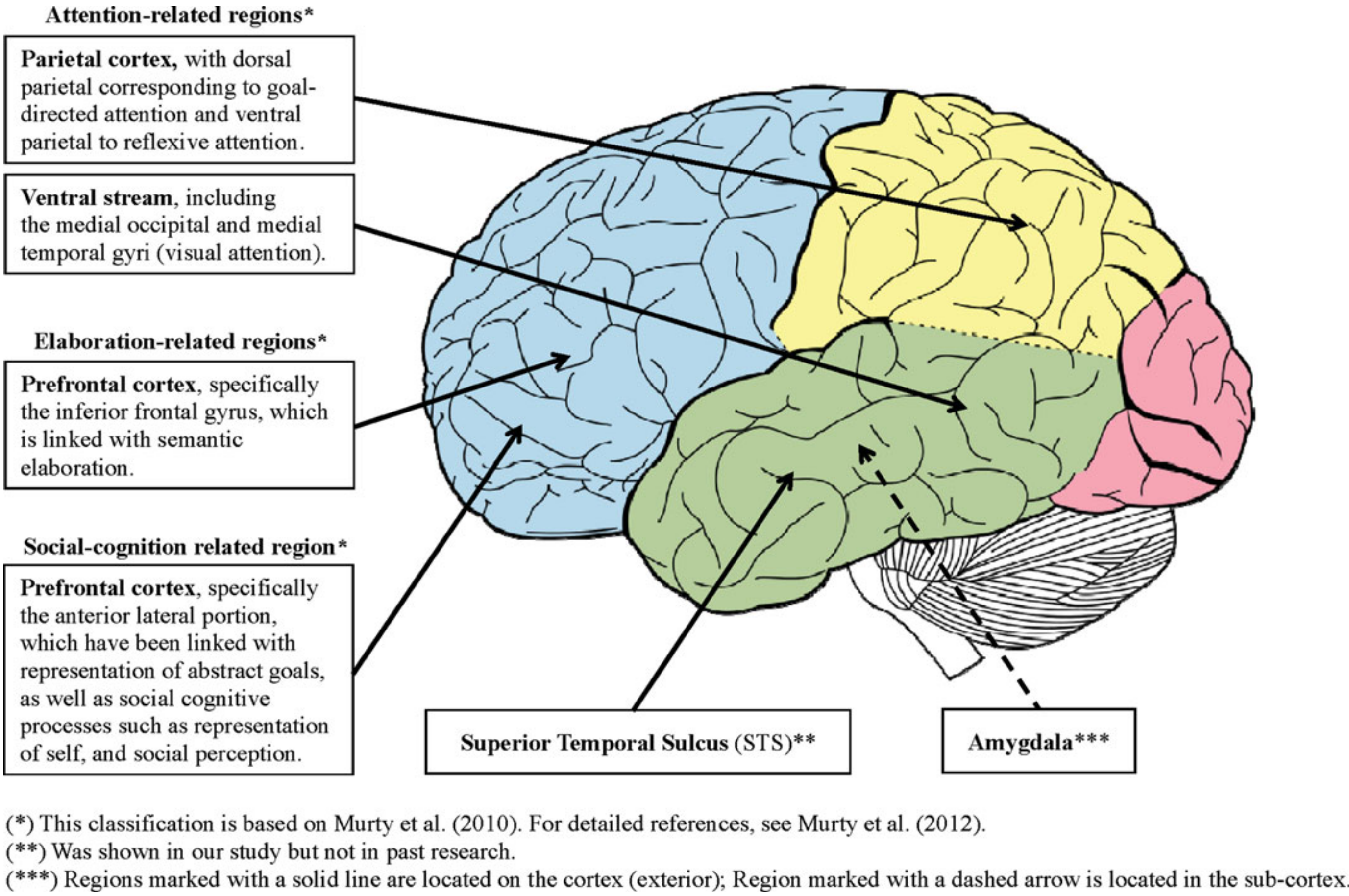


FIG. 2. Brain regions associated with emotional memory. (Color figure available online).

processing involves the prefrontal cortex (specifically the anterior lateral portion). Thus, neuroscientific research provides a further foundation for our integrative frameworks. Yet as Murty and colleagues (2010) stated, "More research is warranted that breaks down these gross constructs into more detailed analysis of cognitive sub-processes and corresponding neural mechanisms" (p. 3467).

EXPLORING AD PROCESSING USING fMRI

Our exploratory investigation will attempt to demonstrate the occurrence of the underlying processes that differentiate between memorable and unmemorable ads. This empirical study will examine the association between predetermined ad memorability and ad-elicited emotional arousal. Level of ad memorability, based on a survey conducted on an independent sample, will serve as a proxy to memory for the ad. The study is exploratory in the sense that (1) it can assess only the association between ad-elicited emotional arousal and ad memory and not the causal relationship, and (2) it relies on an external, independent measure of ad memorability as a proxy for memory for the ad. This exploratory investigation is an initial step in exploring the proposed integrative framework and has the potential to offer important insights for future in-depth investigation of the matter.

The literature reviewed here suggests that emotionally arousing ads are better remembered than non-emotionally arousing ads. Thus we predict that memorable ads will be associated with enhanced activation in the amygdala, which is indicative of emotional processing. Furthermore, based on the three routes suggested in our conceptual framework, we expect that amygdala activation in exposure to memorable ads will be accompanied by activation of regions that are indicative of either attention-based, elaboration-based, or social perception-based processes.

> **H1:** Neural activity associated with memorable (versus unmemorable) ads will differ such that:
> **H1a:** Greater amygdala activation, indicating emotional arousal, will be observed under exposure to memorable (versus unmemorable) ads.

H1b: Neural activation in brain regions associated with either attention-related, elaboration-related, or social cognition-related processes will be greater for memorable compared to unmemorable ads.[1]

METHOD

Study Overview

Participants were exposed to two types of commercials: "memorable" and "unmemorable." Level of ad memorability was predetermined using a national representative sample and served as a proxy for memory for the ad in our study (details on the memorability measure appear later in this section).

Using fMRI, we compared neural activity during exposure to the two types of commercials (memorable versus unmemorable). These data were integrated with self-report measures assessing the participant's attitude toward the ad, involvement with the advertised product, intensity of emotional reaction evoked by the ad, level of cognitive processing evoked by the ad, and purchase intentions. The purpose of these measures was to assist in uncovering the meaning of the neural activity. Next we provide details on fMRI and how it has been used and then move on to a more detailed description of our method.

Using fMRI to Uncover the Underlying Mechanism for Ad Memorability

fMRI enables rapid whole-brain scans. It is noninvasive, which allows for repeated measurements (as opposed to CT and PET, which require the injection of radioactive materials; Egidi, Nusbaum, and Cacioppo 2008). fMRI methods rely on the fact that increased neural activity of a brain region is followed by changes in the regional cerebral blood flow. This is the basis for a technique known as blood-oxygenation-level-dependent (BOLD; Kwong et al. 1992) contrast imaging. In normal people, at each given moment, almost the entire brain is active. Thus fMRI measures differences in the blood oxygenation levels between conditions and conducts statistical comparisons. These comparisons produce activity maps specifying brain regions that are more active in one condition compared to another. These differences in neural activity in various brain regions could thus be attributed to differences between conditions. Incorporating knowledge about the functions of various brain regions enables the interpretation of differences in neural activity for variations in psychological processes.

In our study, fMRI was used to compare neural activity during exposure to memorable versus unmemorable ads in a within-subjects setup. Because brain activity is involuntary, it is unlikely that demand characteristics (due to hypothesis guessing) will influence the results. The fMRI statistical software produced an average of the neural activity across all participants in each condition (the memorable ad condition and the unmemorable ad condition). It then contrasted the neural activity during exposure to memorable versus unmemorable ads to produce the neural activity map.

Participants and Stimuli

Fifteen healthy students (seven females and eight males, 22 to 34 years old) participated in the study; all participants had normal or corrected-to-normal vision. Each provided written informed consent and received $40 for his or her participation.

Real commercials were selected based on a predetermined level of memorability, measured by an external memory test administered by a national market research agency, as part of advertising effectiveness research. This test was derived from a national phone survey conducted every two weeks on independent random national representative samples ($n = 500$, 14 to 69 years old). The test includes all television ad campaigns broadcast on national TV. It measures memory for the ad using a uniform method of a verbal recognition test, in which participants are provided with a detailed verbal description of a particular ad and are asked to indicate whether they have seen this ad. The method controls for the number of words used to describe each ad, the content and elements in the descriptions, the timing of running the survey in relation to the time of the broadcast, and the randomized order of the tested commercials in each survey. Each month more than 100 commercials are regularly tested using this method, creating a database of more than 1,000 ads per year. The level of investment in broadcasting and the actual spending of the advertisers are both monitored. In developing this measure, the market research agency has assessed measurement reliability by testing the correspondence between the results of repeat measurements of the same ads to verify that there are insignificant differences between the results of the different measurements. Indeed, according to the market research agency, the development process of the measure has assured its reliability. Based on this measure, we identified the nine most memorable and the ten least memorable commercials (for the years 2005 and 2006). The ads portrayed a variety of products and services (e.g., a convenience store, insurance, soft drinks, beer, coffee, cars, perfume, cosmetics, chewing gum, baby food, media and Internet services, fashion, health services, snacks, detergents, and tourism). To control for the probability of participants' previous exposure to the various ads, we kept media expenditure in the range of $750,000 to $1 million.

Self-Report Measure

In addition to the fMRI measure, we included self-report measures of participants' responses to the ads, with five questions. The five questions assessed the following: attitude toward the ad (the extent to which they liked the ad); involvement with the advertised product (the extent to which the advertised product/service was relevant to the participants); intensity of the emotional reaction evoked by the ad (the extent to which the ad induced any kind of emotional arousal); the level of cognitive processing evoked by the ad (the extent to which the ad made them engage in thinking about the product, the claim, or the ad); and purchase intentions (the extent to which the next time they needed a similar product/service they would consider buying the one in the ad).[2] All items used 7-point scales (1 = *Not at all*;

7 = *Very much*). These assisted in determining the subjective meaning of the neural patterns and other potential confounds.

Procedure

The ads were projected via a liquid crystal display (LCD) projector onto a tangent screen positioned over the subject's forehead and were viewed through a tilted mirror. Auditory signals were controlled for volume and were delivered via earphones, which minimized the participant's exposure to the scanner noise. The ads were presented with a 10-second blank gray screen between them and a 30-second blank gray screen (for activation baseline) at the beginning and end of the series. Participants were asked to view the ads but did not receive any specific instructions. After scanning, participants were asked to view all the ads again (outside the scanner). After viewing each ad, they completed the self-report measures.

We used a high-field MRI scanner (3T) equipped with a standard head coil. Participants underwent a detailed, high-resolution anatomical scan, followed by the functional scan.[3] Functional imaging using BOLD (Kwong et al. 1992) contrast was obtained with Gradient Echo Planar Imaging (EPI) sequence (TR = 2,500, TE = 35, flip angle = 90°, field of view 20 × 20 cm^2, matrix size 64 × 64). The scanned volume included 38 nearly axial slices of 3 mm thickness and 0 mm gap.[4] A whole brain spoiled gradient (SPGR) sequence was acquired for each participant to allow accurate cortical segmentation, reconstruction, and volume-based statistical analysis. T1-weighted high-resolution (1 × 1 × 1 mm) anatomical images and a three-dimensional (3D) spoiled gradient-echo sequence were acquired for each subject.[5] This procedure is consistent with past neuroscientific studies (e.g., Grill-Spector and Malach 2001).

Due to technical issues pertaining to the availability of the scanner, data were collected in two sessions, which took place 18 months apart. The sessions were identical in terms of research setup and protocol. Although incidental, this split data collection eventually assisted us in ruling out an alternative explanation related to the familiarity effect, as will be discussed later.

Data Analysis

Data were analyzed using BrainVoyager software. Due to the hemodynamic nature of brain response (i.e., delay between stimulation and blood oxidation), the first three volumes of each scan (i.e., the first 7.5 seconds) were discarded. Images were superimposed on two-dimensional (2D) anatomical images and incorporated into the 3D data sets through trilinear interpolation. The complete data set was transformed into Talairach space (a normalized brain). Transforming all the data into the Talairach space allowed us to make cross-condition comparisons across all subjects. Preprocessing included 3D motion correction, linear trend removal, slice scan time correction, and spatial smoothing using a Gaussian filter of 6 mm full width at half maximum value (FWHM).[6] The cortical (exterior) surface was reconstructed into a 2D map from the 3D-SPGR scan. The reconstruction procedure included segmentation of the white matter using a grow-region function, the smooth covering of a sphere around the segmented region, and the expansion of the reconstructed white matter into the gray matter. The surface was then unfolded, cut along the calcarine sulcus, and flattened.[7] To assess the selective activations and deactivations across all participants, we applied a standard general linear model (GLM) analysis. A box-car predictor with a hemodynamic delay of three seconds was constructed, and the model was independently fitted to the time course of each voxel. A regression coefficient was calculated for each predictor using the least-squares algorithm. After computing the coefficients for all regressors, we performed a two-tailed contrast test of the two conditions. This statistical analysis compares the neural activation between the two conditions (memorable versus unmemorable ad) to determine the neural pattern and processes that characterize processing of memorable ads. Results were corrected for multiple comparisons using false discovery rate (FDR) control (a common procedure for multiple comparisons in brain imaging, replacing methods such as the Bonferroni; see Benjamini and Yekutieli 2001).

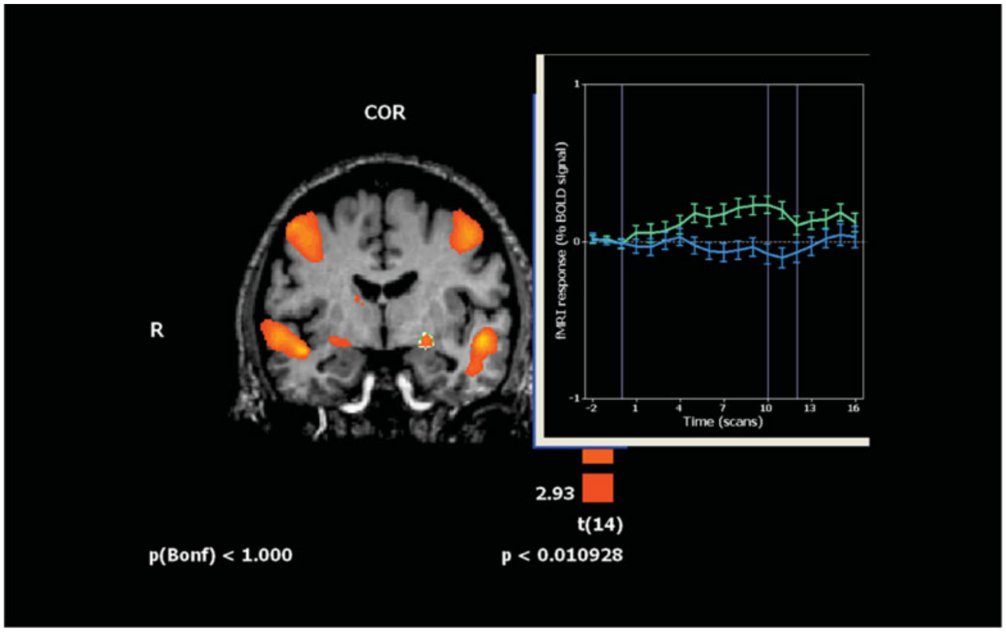
RESULTS AND DISCUSSION

The Relationship Between Ad Memorability and Brain Activity

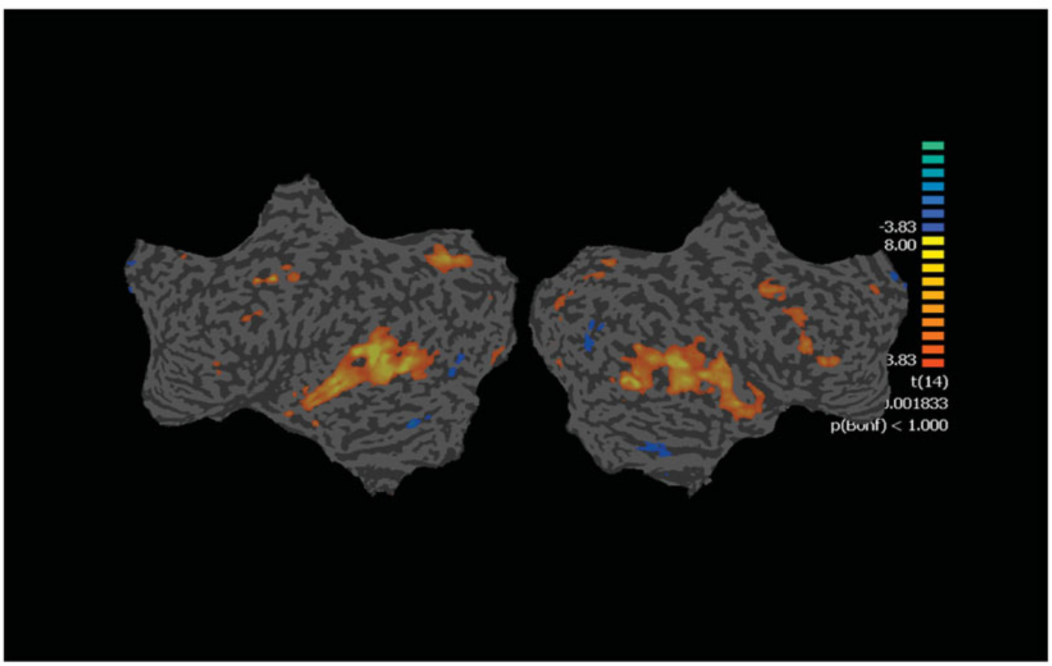
Memorable ads should be associated with higher emotional arousal compared to unmemorable ads. We expected, therefore, that memorable ads would be associated with higher amygdala activation than would unmemorable ads. We also expected to view activation differences between memorable and unmemorable ads in those brain regions involved in attention, elaboration, or sociocognitive processes.

To examine the neural activity patterns that distinguish between the different ads, we used a random effect multi-GLM by applying memorability predictor (0 = *Nonmemorable*, 1 = *Memorable*) as a regressor. This analysis was performed both on the subcortical (interior) and the cortical (exterior) structure of the brain to uncover the brain regions indicative of the different possible processes.

Activation differences in the subcortical (interior) structures (amygdala). Figure 3(A) shows the results in the subcortical structures, where the amygdala is located. In this figure the highlighted areas indicate brain regions in which there were significant differences in activation between memorable and unmemorable ads. The highlighted areas in the interior part of the brain (marked with arrows) indicate that memorable and unmemorable ads significantly differ in the activation of the amygdala. The graph attached to this figure presents the activation level as a function of time for unmemorable and memorable ads, and generally indicates a higher activation level for memorable than for unmemorable ads ($q[\text{FDR}] < .05$).[8] This is consistent with our expectation for a positive association between ad memorability and ad-elicited emotional arousal.



(A) Sub-Cortical (interior) Results GLM Results for 15 Participants, Revealing Significant Difference in the Amygdala (Left and Right). Top/green line: memorable ads; bottom/blue line: unmemorable ads.



(B) Cortical (exterior) Results GLM Results Revealing Significant Difference in the STS (Left and Right).

FIG. 3. Differences in neural activation between memorable and unmemorable ads.

Activation differences in the cortical (exterior) structures. Figure 3(B) shows the results in the cortical structures, presented on unfolded hemispheres. Here again, the highlighted areas indicate brain regions in which there are significant differences in activation between memorable and unmemorable ads. Results revealed significant differences in the overall cortical neural activations between memorable and unmemorable ads (q[FDR] $< .05$). Furthermore, this was not distributed randomly across the cortex but rather in two areas: (1) the precuneus and (2) the superior temporal sulcus (STS). The precuneus is

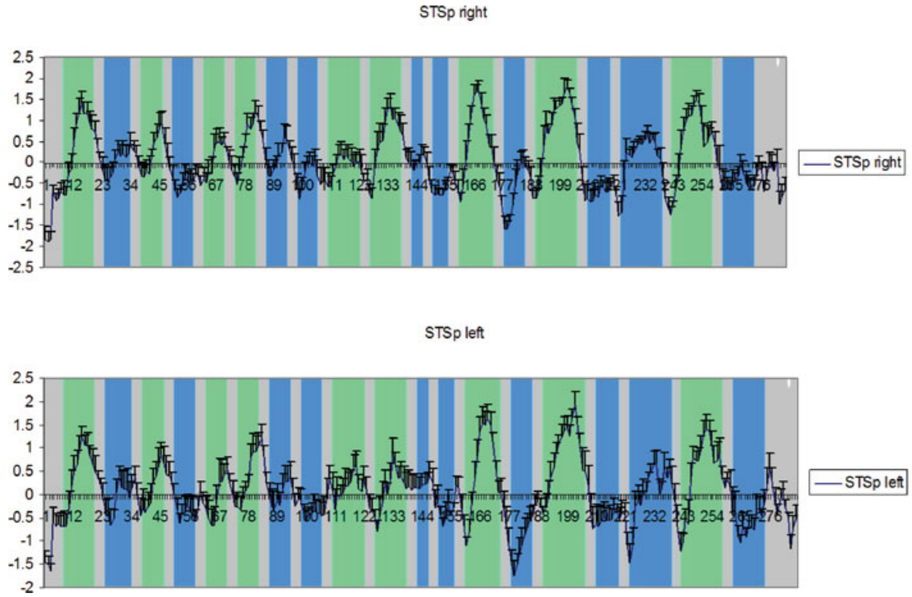


FIG. 4. Change in neural activation at the STS across all ads. Average time course in STS activity (right and left), revealing consistent differences between memorable and unmemorable conditions across all ads viewed (light/green = *memorable* ads; dark/blue = *unmemorable* ads). (Color figure available online).

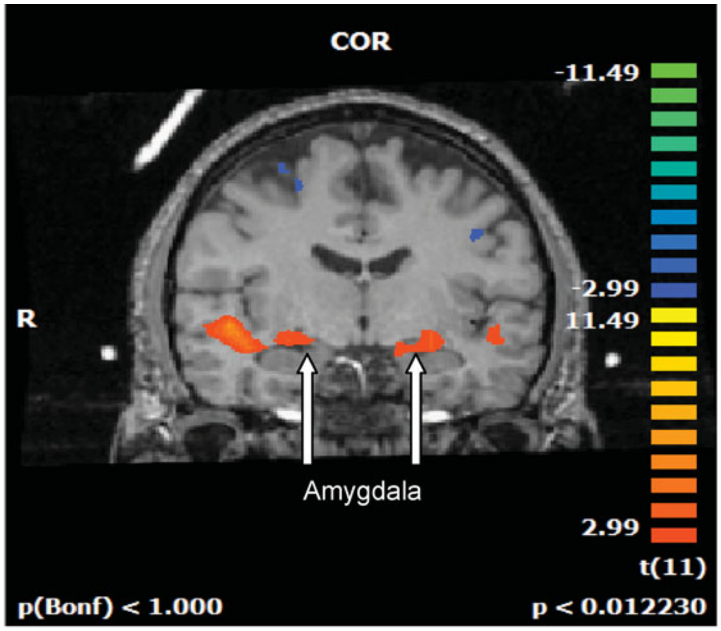
the medial area of the superior parietal cortex; see Figure 3(B), regions marked with arrows. It is involved in episodic memory (Cavanna and Trimble 2006). It is not surprising, therefore, that the memorable and unmemorable ads differed in activation in this area. In fact, differences in activation in the precuneus seem to support the memorability difference between the two conditions (which was based on an external index) and thus can serve as an additional manipulation check.

The second area with activation differences between memorable and unmemorable ads indicated in Figure 3(B) was the STS. To assess whether differences in STS activation were consistent across each ad in the memorable and unmemorable groups, we examined STS activity variations across exposure time. Results reveal a consistent difference. That is, STS activation was higher not only on average but also during exposure to every memorable ad, as compared to every unmemorable ad. (See Figure 4, which represents the average level of STS activation across all participants as a function of time. The different colors of the strips indicate the time interval of exposure to various ads: dark/blue strips mark unmemorable ads, light/green strips mark memorable ads.)

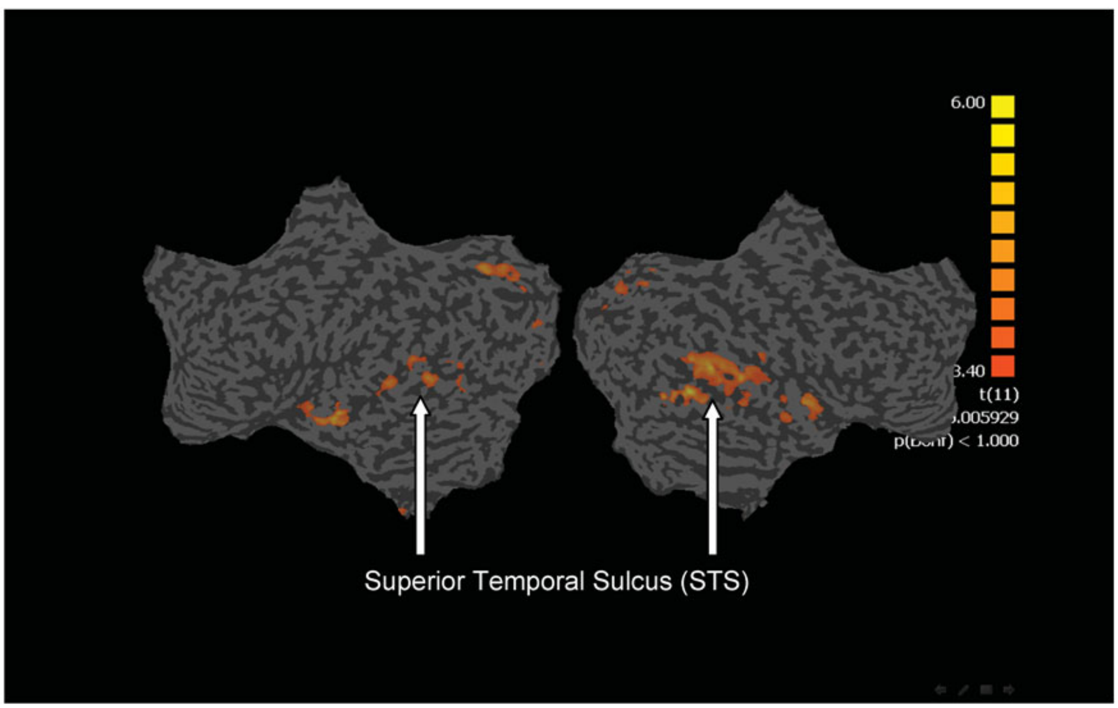
The meaning of STS activation. Distinct activation in STS is interesting for two main reasons. First, past research did not identify this area as involved in emotional memory (see Murty et al. 2010 and Figure 2). Second, insights about the STS from past research may shed light on the process involved in emotional memory in our case. The STS is a cortical structure located in the temporal lobe of the brain. Activation of the STS has been associated with a variety of functions, including (but not limited to) biological motion (e.g., Grossman et al. 2000), processing of speech (e.g., Binder et al. 2000; Rimol et al. 2005; Uppenkamp et al. 2006), eye gazing (e.g., Hoffman and Haxby 2000), and facial perception (e.g., Ishai, Schmidt, and Boesiger 2005). More recently, Hein and Knight (2008) suggested that the function of the STS is determined by the coactivation with other brain regions. Consistent with research suggesting that the STS is associated with social cognitive processes (Allison, Puce, and McCarthy 2000; Vander Wyk et al. 2009), coactivation of the STS with the amygdala was shown to be associated with the integration of emotional information (Park et al. 2010), such as facial features that convey socially relevant information (e.g., eyes, mouth) (Puce et al. 1998; see Adolphs 1999). Integration of such information assists in the identification of another person's emotional state (Park et al. 2010).This is in line with the previously discussed research suggesting that emotional processing involves social cognitive processes whereby individuals identify others' emotions and appraise these emotions to affect one's own emotional state (Parkinson and Simons 2009).

The indication of higher STS activation in memorable ads suggests a positive association between social cognitive processing in exposure to ads and ad memorability. Furthermore, evidence of heightened emotional reaction in exposure to the memorable ads, as indicated in the amygdala activation, suggests links among ad-elicited emotional arousal, sociocognitive processing, and ad memorability. The self-report data, discussed next, assisted us in further exploring these associations.

Self-reports analysis. To further explore the specific factors that underlie the differences in amygdala and STS activation, we used the participants' self-report measures of attitude toward the ad, involvement in the advertised product, intensity of emotional response, level of cognitive processing, and purchase intentions.



(A) Subcortical (interior) results for psychophysics analysis based on self-reported emotional response as a predictor for neural activations, revealing significant difference in amygdala activation (left and right).



(B) Cortical (exterior) results for psychophysics analysis based on self-reported emotional response as a predictor for neural activations, revealing significant difference in STS activation.

FIG. 5. Neural activation map using self-reported emotional response as a predictor.

Data from three participants who failed to complete the self-report questionnaires were excluded, with data retained from 12 participants. Comparing each of these self-reported factors across the two groups of ads revealed that the only significant measure associated with ad memorability was the intensity of the emotional response to the ad ($M_{\text{unmemorable}} = 3.708$, $M_{\text{memorable}} = 5.093$, $t\,(11) = 9.302$, $p < .05$). None of the other factors was significantly associated with memorability, indicating that none of them can explain memorability differences.

To reinforce the premise that differences in amygdala and STS activation are indeed due to differences in emotional responses between conditions, we conducted another analysis that combined the self-reported emotional responses. We ran a psychophysical multi-GLM analysis by median splitting the self-reported emotional arousal and using it as a regressor. Median splitting, rather than a continuous regression analysis, was used to maintain consistency with the fMRI analysis, which compares across two conditions. Thus, we examined differences in the neural activation between ads of high versus low emotional response. Figure 5 represents the neural activation differences during exposure to ads that were self-reported as eliciting high versus low emotional arousal. Here again, ads that elicited a high emotional response were associated with greater neural activation in both the amygdala and the STS; see Figures 5(A) and 5(B), respectively. Figure 6 presents the neural activation patterns of the memorable versus unmemorable ad comparison, as shown in Figure 3(B), overlaid onto the high versus low emotional reaction comparison, as shown in Figure 5(B), and indicates a considerable similarity in the two (that is, considerable overlapping regions). This reinforces the premise that STS activation variations are associated with emotional responses and strengthens the link between ad-elicited emotional arousal, sociocognitive processing, and ad memorability.

Assessing Alternative Explanations

Physical characteristics of the ads. Because we used real ads, it was impossible to fully control for all of their characteristics. Thus, activation differences may have been due to the low-level physical features of the ads (e.g., simple visual characteristics such as movement, color, or editing techniques) rather than the ad-elicited emotional arousal. Yet the activations maps (contrasting memorable versus unmemorable) show no differences in the primary sensory cortices (the occipital lobe, indicating low-level visual and auditory processing). This explanation may therefore be ruled out.

Ad length. An examination of the ads reveals length differences between the memorable and unmemorable ads, with a longer average time span of the memorable compared to the unmemorable ads ($M_{\text{memorable}} = 28.2$ sec, $M_{\text{unmemorable}} = 20.9$ sec groups). This may suggest another alternative explanation relating the observed activation variations to ad length. To assess this explanation, we analyzed the results while controlling for stimulus length. We first divided the stimuli into two random conditions (each contained both memorable and unmemorable ads). The comparison of the neural activation between these random

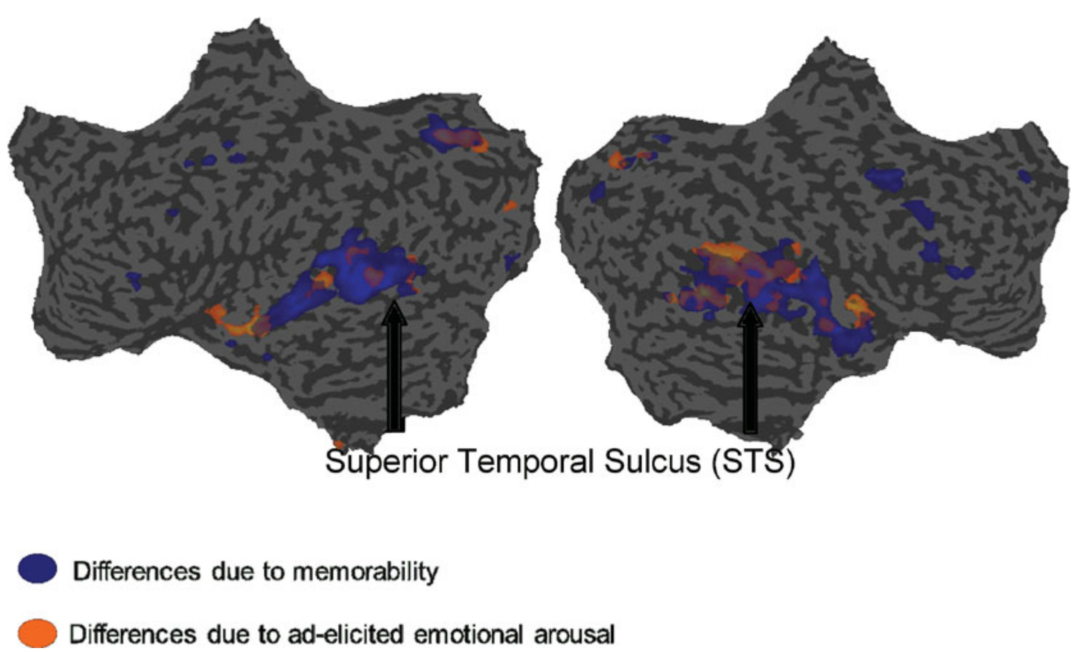


FIG. 6. Two neural activation maps overlaid (memorability and emotional response). The two GLM analysis results maps (memorability and emotional response) overlaid, revealing similarity between them.

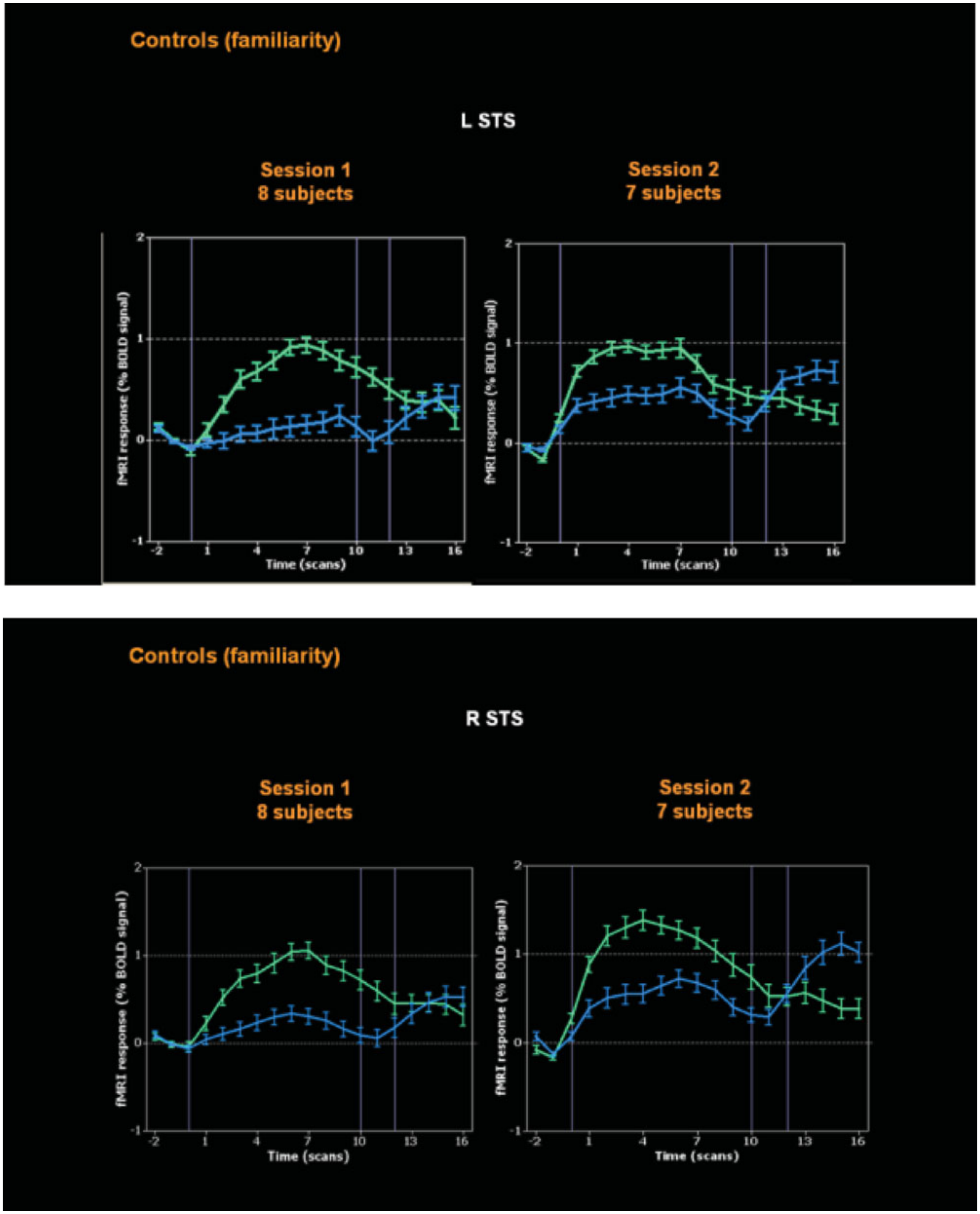


FIG. 7. Change in neural activation at the STS across memorable and unmemorable ads for the two MRI sessions. Time course results for left and right STS for the two sessions that took place 18 months apart, revealing no difference between them (light/green = *memorable* ads; dark/blue = *unmemorable* ads). (Color figure available online).

groups revealed no significant activation difference (q[FDR] > .05). We then divided all stimuli into two groups: long and short, based on median splitting (median = 20 sec: short ads ranged between 9 and 20 seconds; long ads ranged between 24 and 39 seconds). A multi-GLM analysis revealed insignificant differences between the two length conditions (q[FDR] > .05). Further, we ran two separate multi-GLM analyses on the two research conditions (memorable and unmemorable), splitting each group based on ad length (i.e., memorable long versus short, and unmemorable long versus short; $median_{memorable}$ = 29 sec; $median_{unmemorable}$ = 19 sec). Here again, we found no significant differences between the two length groups (q[FDR] > .05). Finally, we took only those ads balanced in length from the memorable and unmemorable ads groups (five memorable and five unmemorable ads) and ran an additional multi-GLM. Here we did find a significant difference (q[FDR] < .05), indicating that the neural activation effect is not contingent upon ad length.

Variations in familiarity with the ads. The ads in our study were broadcast nationally prior to the execution of the study. Consequently, familiarity variations may have led to differences in neural activation. In other words, it could be argued that memorable ads elicit higher levels of activation due to better familiarity or recognition. To examine this alternative explanation, we relied on the premise that ad familiarity may decline over time. Recall that, due to technical issues, our data collection was conducted in two sessions, 18 months apart. This may be used to examine the familiarity issue. It is reasonable to assume that participants in the first session were more familiar with the ads compared to participants in the second session. We thus compared patterns of neural differences between the memorable and unmemorable ads in the two separate sessions. Figure 7 presents the left and right STS neural activation during exposure to memorable versus unmemorable ads across time for the two data collections sessions. The comparison revealed substantial similarities in the pattern of results between the first and second sessions, suggesting that the observed findings are probably not due to familiarity.

Altogether, analyses of alternative explanations may rule out the potential effects of low-level physical characteristics, ad length, and familiarity. Further, the self-report data showed no association between memorability and attitude toward the ad, involvement in the product, level of cognitive processing, or purchase intentions. In conclusion, our analysis can provide evidence for an association between memorability and ad-elicited emotional arousal, and can eliminate alternative explanations. Although the order of events (memorability and emotional arousal) was reversed in our experimental design, a discussion of the familiarity alternative explanation suggests that memorability level does not lead to variations in emotional response. That is, memorability may have not led to emotional arousal. Although preliminary and in need of further empirical support, it turns out, therefore, that the ad-elicited emotional arousal evident in both amygdala neural activation and the self-reports may account for the variations in memorability. Thus, the coactivation of STS and amygdala in memorable ads may provide evidence for the social perception route in the relationship between emotional response to ads and memorability. Implications of these findings and future directions are discussed next.

CONCLUSION

Ad memorability is positively associated with ad-elicited emotional arousal. Ad-elicited emotional arousal, evident in both amygdala activation and the self-reports, was accompanied by STS activation, indicating a sociocognitive process. This study thus provides evidence for the occurrence of a social cognition process in the relationship between ad-elicited emotional arousal and ad memorability. Such evidence can contribute to the advertising and psychology literature, and suggests future research directions, as discussed here.

The Relationships Between Ad-Elicited Emotional Arousal and Memory for the Ad

Our general framework suggested three routes by which emotional arousal may influence memory: attention, elaboration, and social cognition. Yet past studies on the effect of emotional arousal on memory have provided evidence mostly for attention and elaboration effects; the social cognition explanation has received less theoretical and empirical attention. In demonstrating the occurrence of the social cognitive mechanism, this study suggests that emotional arousal may be related not only to attention allocation and the level of processing on the ad; emotional arousal may also lead to processing that involves attempts to understand the social environment by engaging in a combination of such processes as perception, recognition, integration, interpretation, and prediction.

Interestingly, our self-report results did not demonstrate differences between memorable and unmemorable ads in terms of the level of cognitive processing. As such, our study provides no evidence for the elaboration-related route. In addition, neural analysis data did not indicate attentional distinctions between the memorable and unmemorable ads, as no neural activation variations were observed in attention-related brain regions, that is, the medial occipital and medial temporal gyri (Ungerleider and Haxby 1994) or the parietal cortex (Corbetta and Shulman 2002).

The absence of evidence on attention and elaboration processes does not mean that these routes should be abandoned. Instead, two options should be considered. First, it may be that there are boundary conditions for the occurrence of each of these mechanisms. Alternatively, it is possible that attentional and elaboration processes, at least in the context of advertising, may involve social cognition. In attentional processes, for example, these social cognitive processes may be in terms of diagnosticity of the information or of importance to oneself (Pham 1996). As a result, it may be that these sociocognitive processes are more dominant, which decreases any evidence of attentional and low-level processing. These two options should be further explored in future studies.

The Involvement of Sociocognitive Processes in Emotional Memory

From a neural perspective, the involvement of the STS in emotional memory is new to the literature. In their meta-analysis of emotional memory, Murty and colleagues (2010) do relate evidence of various types of processes, but none of the studies reviewed specifies distinct activation in STS. Other brain regions that may also be related to sociocognitive processes, such as the middle frontal gyrus, have been identified (see Figure 2). Our study thus extends previous research not only in that it provides evidence for a sociocognitive mechanism in emotional memory but also in that it specifies the involvement of the STS.

Is STS activation specific to ads? Our results are insufficient for providing an answer to this question. Yet evidence given for a sociocognitive neural process using relatively passive exposure to stimuli is interesting, as fMRI studies on social cognitive neural networks have used more complex and interactive stimuli (e.g., Redcay et al. 2010). Future research should examine what exactly leads to the specific sociocognitive response under passive exposure to ads. It may be that there is something related to ads (as compared to other stimuli) that has led to such processing. Investigating the exact type of sociocognitive processes involved may shed light on these issues.

Will other types of emotionally arousing information (beyond ads) lead to similar neural patterns? Past studies may have provided two alternative speculations. One approach relies on the notion that semantic judgments about brands and about persons are processed similarly (Aaker 1997). In line with this, neural processing of ads would be similar to the processing of information on people. Another approach can be based on Yoon and colleagues (2006), who argue that information about brands involves different neural processes than does information about people. This may suggest the neural patterns in our study may be unique to ads. Illuminating this issue may contribute to both neuroscience and marketing.

Expanding the Understanding of Unconscious Processing

Past research has shown that unconscious processes have an effect on conscious information processing. Janiszewski (1988, 1990a, 1990b), for example, demonstrated how subconscious operations such as mere exposure, conditioning, and hemispheric lateralization influence conscious cognitive processes (see also Bargh 1989; Marcel 1983). Our results are consistent with these findings, showing that unconscious processing, such as social cognitive emotional processing, is involved in conscious cognitive factors, such as ad memory. Moreover, Janiszewski (1988) suggested that emotional responses can be formed independently of conscious thoughts, although the mechanism by which this effect takes place is somewhat unclear. Our study adds to this view by shedding additional light on the underlying mechanism that drives this effect.

Further, our research demonstrates the advantage of using a neuroscientific approach that goes beyond traditional advertising measures (i.e., self-reports). Thus far, researchers have used mostly self-report measures to assess emotional reactions, including verbal self-report, visual self-report, and moment-to-moment ratings (Poels and Dewitte 2006). These methods, however, are limited in their ability to differentiate between conscious and unconscious psychological processing and to provide insights regarding the underlying mechanisms of such processes. Neuroscientific methods make it possible to investigate the physiological processes accompanying both the conscious and the unconscious mental processes that take place during and after exposure to ads.

The Role of Valence and Specific Emotions

Our investigation was limited to dealing with the emotional arousal elicited by ads, and neglected the role of valence. Research on the role of valence in ad memory has provided mixed findings. Some show no effect of valence on memory (e.g., Bolls, Lang, and Porter 2001), but others suggest that valence is involved in information processing (for a review, see Cohen, Pham, and Andrade 2008). Neuroscientific research suggests that similar brain systems seem to engage across positive and negative valences (LaBar and Cabeza 2006). These contradictory views require further investigation on the role of valence. In addition, other studies have related not only to the different dimensions of affect but also to specific emotions (e.g., Levine and Burgess 1997; for a review, see Levine and Pizarro 2004). There is insufficient knowledge at this stage about the role of specific emotions in memory. Future research should expand on this topic, specifically in the context of advertising.

Beyond Memory for the Ad

This research focused on ad memorability, which was operationalized using recognition measures. Assessing ad memorability using other measures (e.g., recall) may yield different findings, as retrieval in those different cases may undergo distinct mechanisms (Wyer and Srull 1989). Relating to other types of memory in advertising, such as memory for the brand or for the claim, may also uncover important insights. It may be, for example, that it is the effect on memory for the claims of the ad—but not for the ad itself—that will be mediated though attentional mechanisms. This issue should be further investigated. Finally, not only memory but also judgment may be related to ad-elicited emotional arousal. The effect of emotional arousal on judgment may involve various processes—some may be related to memory (e.g., the affect-congruent memory and judgment; Bower 1991; Isen 1987), and some may not necessarily be related to memory (e.g., attribution mechanisms; Schachter and Singer 1962; Zillmann 1978). In fact, ad memory may influence judgment and other behavioral responses (e.g., brand equity and purchase intention; Plassmann et al. 2007). As such, advances in understanding ad processing should eventually lead to additional insights on this matter as well.

Limitations

This research has a few limitations that merit attention and should be dealt with in future research. First, the use of real ads that were previously broadcast did not allow us to confidently draw conclusions about whether brain activity influenced memorability or ad familiarity produced the neural activity. To resolve this issue, future studies need to use unfamiliar ads. Second, the study design, which manipulated ad memorability and measured the emotional response and the co-occurring processing, allowed us to refer only to the association between ad-elicited emotional arousal, social cognitive processing, and ad memorability. Future research should manipulate ad-elicited emotional arousal and measure memory for the ad along with the underlying process, to allow for drawing conclusions about a mediated effect.

NOTES

1. For a detailed list of possible brain regions associated with each type of process, please see Figure 2.
2. For a justification of the use of a single-item measures, please see Bergkvist and Rossiter (2007), who suggest that single item measures are valid when dealing with concrete objects (e.g., a brand or an ad) or a concrete construct (e.g., attitude, involvement).
3. Anatomical scans produce a brain structural map for each participant. The functional scan detects neural activity in the various brain regions. Overlaying the structural and the functional maps assists in determining the exact location of the neural activity.
4. This means that every 2.5 seconds the scanner produces 38 images across the entire brain. Each image refers to a brain "slice." Each slice has a thickness of 3 mm, and the distance between the slices is 0 mm. Note that this assumes brains of equal sizes. This assumption is valid due to a normalization process between subjects termed Talairach.
5. This means that a combination of all slices produces a three-dimensional image of the whole brain.
6. This procedure corrects for natural movement that may occur during the scanning (e.g., due to breathing). The corrections take place through smoothing the images and may be done for movements up to 6 mm. Beyond this limit, data are discarded.
7. To ease viewing, the three-dimensional image was transformed into a two-dimensional map.
8. The q-value is the FDR analogue of the p-value.

REFERENCES

Aaker, David A., Douglas M. Stayman, and Michael R. Hagerty (1986), "Warmth in Advertising: Measurement, Impact, and Sequence Effects," *Journal of Consumer Research*, 12 (March), 365–81.

Aaker, Jennifer L. (1997), "Dimensions of Brand Personality," *Journal of Marketing Research*, 34 (August), 347–56.

Adolphs, Ralph (1999), "Social Cognition and the Human Brain," *Trends in Cognitive Science*, 3, 469–79.

Adolphs, Ralph (2001), "The Neurobiology of Social Cognition," *Current Opinion in Neurobiology*, 11, 231–39.

Adolphs, Ralph (2009), "The Social Brain: Neural Basis of Social Knowledge," *Annual Review of Psychology*, 60, 693–716.

Allison, Truett, Aina Puce, and Gregory McCarthy (2000), "Social Perception from Visual Cues: Role of the STS Region," *Trends in Cognitive Sciences*, 1 (July), 267–78.

Ambler, Tim, and Tom Burne (1999), "The Impact of Affect on Memory of Advertising," *Journal of Advertising Research*, 39 (March–April), 25–34.

Baack, Daniel W., Rick T. Wilson, and Brian D. Till (2008), "Creativity and Memory Effects," *Journal of Advertising*, 37 (4), 85–94.

Bagozzi, Richard P., Mahesh Gopinath, and Prashanth U. Nyer (1999), "The Role of Emotions in Marketing," *Journal of the Academy of Marketing Science*, 27 (March), 184–206.

Bargh, John A. (1989), "Conditional Automaticity: Varieties of Automatic Influence in Social Perception and Cognition," in *Unintended Thought*, James S. Uleman and John A. Bargh, eds., New York: Guilford, 3–51.

Benjamini, Yoav, and Daniel Yekutieli (2001), "The Control of the False Discovery Rate in Multiple Testing under Dependency," *Annals of Statistics*, 29 (4), 1165–88.

Bergkvist, Lars, and John R. Rossiter (2007), "The Predictive Validity of Multiple-Item Versus Single-Item Measures of the Same Constructs," *Journal of Marketing Research*, 44 (May), 175–84.

Berlyne, Daniel E. (1960), *Conflict Arousal and Curiosity*, New York, NY: McGraw-Hill.

Binder, Jeffrey R., Julie A. Frost, Thomas A. Hammeke, Patrick S. F. Bellgowan, Jane A. Springer, Jacqueline N. Kaufman, and Edward T. Possing (2000), "Human Temporal Lobe Activation by Speech and Nonspeech Sounds," *Cerebral Cortex* 10 (5), 512–28.

Bolls, Paul D., Annie Lang, and Robert F. Porter (2001), "The Effect of Massage Valence and Listener Arousal on Attention, Memory, and Facial Muscular Responses to Radio Advertisements," *Communication Research*, 28 (October), 627–51.

Bower, Gordon H. (1991), "Mood Congruity and Social Judgment," in *Emotions and Social Judgments*, Joseph P. Forgas, ed., Oxford: Pergamon, 31–54.

Bradley, Margaret M., Mark K. Greenwald, Margaret C. Petry, and Peter J. Lang (1992), "Remembering Pictures: Pleasure and Arousal in Memory," *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18 (March), 379–90.

Cahill, Larry, Richard J. Haier, James Fallon, Michael T. Alkire, Cheuk Tang, David Keator, Joseph Wu, and James McGaugh (1996), "Amygdala Activity at Encoding Correlated with Long-Term, Free Recall of Emotional Information," *Proceedings of the National Academy of Sciences*, 93 (April), 8016–21.

———, and James L. McGaugh (1995), "A Novel Demonstration of Enhanced Memory Associated with Emotional Arousal," *Consciousness and Cognition*, 4 (December), 410–21.

Canli, Turhan, Zuo Zhao, James Brewer, John Gabrieli, and Larry Cahill (2000), "Event-Related Activation in the Human Amygdala Associates with Later Memory for Individual Emotional Experience," *Journal of Neuroscience*, 20 (October), RC99.

Cavanna, Andrea E., and Michael R. Trimble (2006), "The Precuneus: A Review of Its Functional Anatomy and Behavioural Correlates," *Brain*, 129, 564–83.

Cohen, Joel B., and Charles Areni (1991), "Affect," in *Handbook of Consumer Behavior*, Thomas S. Robertson and Harold H. Kassarjian, eds., Englewood Cliffs, NJ: Prentice-Hall, 188–240.

———, Michel Tuan Pham, and Eduardo B. Andrade (2008), "The Nature and Role of Affect in Consumer Behavior," in Curtis P. Haugtvedt, Paul M. Herr, and Frank R. Kardes, eds., *Handbook of Consumer Psychology*, New York, NY: Erlbaum, 297–348.

Corbetta, Maurizio, and Gordon L. Shulman (2002), "Control of Goal-Directed and Stimulus-Driven Attention in the Brain," *Nature Reviews Neuroscience*, 3 (3), 201–15.

Craik, Fergus I. M., and Robert S. Lockhart (1972), "Level of Processing: A Framework for Memory Research," *Journal of Verbal Learning and Verbal Behavior*, 11, 671–84.

Dolcos, Florin, Kevin S. LaBar, and Roberto Cabeza (2004), "Interaction Between the Amygdala and the Medial Temporal Lobe Memory System Predicts Better Memory for Emotional Events," *Neuron*, 42 (June), 855–63.

Easterbrook, James A. (1959), "The Effect of Emotion on Cue Utilization and the Organization of Behavior," *Psychological Review*, 66 (May), 183–201.

Egidi, Giovanna, Howard C. Nusbaum, and John T. Cacioppo (2008), "Neuroeconomics: Foundational Issues and Consumer Relevance," in Curtis P. Haugtvedt, Paul M. Herr, and Frank R. Kardes, eds., *Handbook of Consumer Psychology*, New York, NY: Psychology Press, 1177–214.

Forgas, Joseph P. (1995), "Mood and Judgment: The Affect Infusion Model (AIM)," *Psychological Bulletin*, 117, 39–66.

Friestad, Marian, and Esther Thorson (1993), "Remembering Ads: The Effects of Encoding Strategies, Retrieval Cues and Emotional Response," *Journal of Consumer Psychology*, 2 (1), 1–23.

Frijda, N. H. (1986), *The Emotions*, Cambridge, UK: Cambridge University Press.

Grill-Spector, Kalanit, and Rafael Malach (2001), "fMR-Adaptation: A Tool for Studying the Functional Properties of Human Cortical Neurons," *Acta Psychologica*, 107, 293–321.

Grossman, E., M. Donnelly, R. Price, D. Pickens, V. Morgan, G. Neighbor, and R. Blake (2000), "Brain Areas Involved in Perception of Biological Motion," *Journal of Cognitive Neuroscience*, 12 (5), 711–20.

Hamann, Stephan (2001), "Cognitive and Neural Mechanisms of Emotional Memory," *Trends in Cognitive Science*, 5 (9), 394–400.

Hein, Grit, and Robert T. Knight (2008), "Superior Temporal Sulcus—It's My Area: Or Is It?" *Journal of Cognitive Neuroscience*, 20 (12), 2125–36.

Hoffman, Elizabeth A., and James V. Haxby (2000), "Distinct Representations of Eye Gaze and Identity in the Distributed Human Neural System for Face Perception," *Nature Neuroscience*, 3, 80–84.

Ioannides, Andreas A., Lichan Liu, Dionyssios Theofilou, Jürgen Dammers, Tom Burne, Tim Ambler, and Steven Rose (2000), "Real Time Processing of Affective and Cognitive Stimuli in the Human Brain Extracted from MEG Signals," *Brain Topography*, 13 (September), 11–19.

Isen, Alice M. (1987), "Positive Affect, Cognitive Processes, and Social Behavior," in *Advances in Experimental Social Psychology*, Leonard Berkowitz, ed., vol. 20, New York, NY: Academic Press, 203–53.

Ishai, Alumit, Conny F. Schmidt, and Peter Boesiger (2005), "Face Perception Is Mediated by a Distributed Cortical Network," *Brain Research Bulletin*, 67 (1–2), 87–93.

Janiszewski, Chris (1988), "Preconscious Processing Effects: The Independence of Attitude Formation and Conscious Thought," *Journal of Consumer Research*, 15 (September), 199–209.

——— (1990a), "The Influence of Nonattended Material on the Processing of Advertising Claims," *Journal of Marketing Research*, 27 (August), 263–78.

——— (1990b), "The Influence of Print Advertisement Organization on Affect Toward a Brand Name," *Journal of Consumer Research*, 17 (June), 53–65.

Kahneman, Daniel (1973), *Attention and Effort*, Englewood Cliffs, NJ: Prentice Hall.

Kenning, Peter, Hilke Plassmann, H. Kugel, W. Schwindt, A. Pieper, and Michael Deppe (2007), "Neural Correlates of Attractive Ads," *FOCUS Magazin*, 287–98.

Kensinger, Elizabeth A., and Suzanne Corkin (2003), "Memory Enhancement for Emotional Words: Are Emotional Words More Vividly Remembered Than Neutral Words?" *Memory and Cognition*, 31 (July), 1169–80.

———, and ——— (2004), "Two Routes to Emotional Memory: Distinct Neural Processes for Valence and Arousal," *Proceedings of the National Academy of Sciences*, 101 (March), 3310–15.

———, and Daniel L. Schacter (2008), "Memory and Emotion," in *The Handbook of Emotion,* 3rd ed., Michael Lewis, Jeannette M. Haviland-Jones, and Lisa Feldman Barrett, eds., New York, NY: Guilford, 601–17.

Kilpatrick, Lisa, and Larry Cahill (2003), "Amygdala Modulation of Parahippocampal and Frontal Regions During Emotionally Influenced Memory Storage," *Neuroimage*, 20 (December), 2091–99.

Krishnan, H. Shankar, and Dipankar Chakravarti (1999), "Memory Measures for Pretesting Advertisements: An Integrative Conceptual Framework and a Diagnostic Template," *Journal of Consumer Psychology*, 8 (1) 1–37.

Kroeber-Riel, Werner (1979), "Activation Research: Psychobiological Approaches in Consumer Research," *Journal of Consumer Research*, 5 (March), 240–50.

Kwong, Kenneth K., John W. Belliveau, David A. Chester, Inna E. Goldberg, Robert M. Weisskoff, Brigitte P. Poncelet, David N. Kennedy, Bernice E. Hoppel, Mark S. Cohen, Robert Turner, Hong-Ming Cheng, Thomas J. Brady, and Bruce R. Rosen (1992), "Dynamic Magnetic Resonance Imaging of Human Brain Activity during Primary Sensory Stimulation," *Proceedings of the National Academy of Sciences of the United States of America*, 89 (12), 5675–79.

LaBar, Kevin S., and Roberto Cabeza (2006), "Cognitive Neuroscience of Emotional Memory," *National Review in Neuroscience*, 7 (January), 54–64.

Lazarus, S. Richard (1991), "Progress on a Cognitive-Motivational-Relational Theory of Emotion," *American Psychologist*, 46, 819–34.

LeDoux, Joseph E. (1996), *The Emotional Brain: The Mysterious Underpinnings of Emotional Life*, New York, NY: Simon and Schuster.

Levine, Linda J., and Stewart L. Burgess (1997), "Beyond General Arousal: Effect of Specific Emotions on Memory," *Social Cognition*, 15, 157–81.

———, and David A. Pizarro (2004), "Emotion and Memory Research: A Grumpy Overview," *Social Cognition*, 22, 530–54.

MacInnis, Deborah J., and Bernard J. Jaworski (1989), "Information Processing from Advertisements: Toward an Integrative Framework," *Journal of Marketing*, 53 (October), 1–23.

Marcel, Anthony J. (1983), "Conscious and Unconscious Perception: Experiments on Visual Masking and Word Recognition," *Cognitive Psychology*, 15 (2), 197–237.

Mehta, Abhilasha, and Scott C. Purvis (2006), "Reconsidering Recall and Emotion in Advertising," *Journal of Advertising Research*, 46 (March), 49–56.

Murty, Vishnu P., Maureen Ritchey, Alison R. Atcock, and Kevin S. LaBar (2010), "fMRI Studies of Successful Emotional Memory Encoding: A Quantitative Meta-Analysis," *Neuropsychologia*, 48, 3459–69.

Ochsner, Kevin N. (2000), "Are Affective Events Richly Recollected or Simply Familiar? The Experience and Process of Recognizing Feelings Past," *Journal of Experimental Psychology: General*, 129 (2), 242–61.

———, and Daniel L. Schacter (2003), "Remembering Emotional Events: A Social Cognitive Neuroscience Approach," in *Handbook of Affective Sciences*, Richard J. Davidson, Klaus R. Scherer, and Hill H. Goldsmith, eds., New York, NY: Oxford University Press, 343–60.

Park, Ji-Young, Bon-Mi Gu, Do-Hyung Kang, Yong-Wook Shin, Chi-Hoon Choi, Jong-Min Lee, and Jun Soo Kwon (2010), "Integration of Cross-modal Emotional Information in the Human Brain: An fMRI Study," *Cortex*, 46 (2), 161–69.

Parkinson, Brian, and Gwenda Simons (2009), "Affecting Others: Social Appraisal and Emotion Contagion in Everyday Decision Making," *Personality and Social Psychology Bulletin*, 35 (8), 1071–84.

Pavelchak, Mark A., John H. Antil, and James M. Munch (1988), "The Super Bowl: An Investigation into the Relationship Among Program Context, Emotional Experience, and Ad Recall," *Journal of Consumer Research*, 15 (December), 360–67.

Pham, Michel Tuan (1996), "Cue Representation and Selection Effects of Arousal on Persuasion," *Journal of Consumer Research*, 22 (March), 373–87.

Phelps, Elizabeth A. (2004), "Human Emotion and Memory: Interactions of the Amygdala and Hippocampal Complex," *Current Opinion in Neurobiology*, 14 (April), 198–202.

Plassmann, Hilke, Tim Ambler, Sven Braeutigam, and Peter Kenning (2007), "What Can Advertisers Learn from Neuro-Science?," *International Journal of Advertising*, 26 (2), 151–75.

Poels, Karolien, and Siegfried Dewitte (2006), "How to Capture the Heart? Reviewing 20 Years of Emotion Measurement in Advertising," *Journal of Advertising Research*, 46 (March), 18–37.

Puce, Aina, Truett Allison, Shlomo Bentin, John C. Gore, and Gregory McCarthy (1998), "Temporal Cortex Activation in Humans Viewing Eye and Mouth Movements," *Journal of Neuroscience*, 18 (6), 2188–99.

Putrevu, Sanjay (2008), "Consumer Responses Toward Sexual and Nonsexual Appeals," *Journal of Advertising*, 37 (2), 57–69.

Redcay, Elizabeth, David Dodell-Feder, Mark J. Pearrow, Penelope L. Mavros, Mario Kleiner, John D. Gabrieli, and Rebecca Saxe (2010), "Live Face-to-Face Interaction during fMRI: A New Tool for Social Cognitive Neuroscience," *NeuroImage*, 50 (4), 1639–47.

Reisberg, Daniel, and F. Heuer (2004), "Memory for Emotional Events," in *Memory and Emotion*, Daniel Reisberg and Paula Hertel, eds., New York, NY: Oxford University Press, 3–41.

Rimol, Lars M., Karsten Specht, Susanne Weis, Robert Savoy, and Kenneth Hugdahl (2005), "Processing of Sub-Syllabic Speech Units in the Posterior Temporal Lobe: An fMRI Study," *NeuroImage*, 26 (4), 1059–67.

Rothschild, Michael L., and Yong J. Hyun (1990), "Predicting Memory for Components of TV Commercials From EEG," *Journal of Consumer Research: An Interdisciplinary Quarterly*, 16 (4), 472–78.

———, ———, Byron Reeves, Esther Thorson, and Robert Goldstein (1988), "Hemispherically Lateralized EEG as a Response to Television Commercials," *Journal of Consumer Research*, 15 (September), 185–98.

Russell, James A. (1980), "A Circumplex Model of Affect," *Journal of Personality on Social Psychology*, 39 (December), 1161–78.

Sanbonmatsu, David M., and Frank R. Kardes (1988), "The Effect of Physiological Arousal on Information Processing and Persuasion," *Journal of Consumer Research*, 15 (December), 379–85.

Schachter, Stanley, and Jerome E. Singer (1962), "Cognitive, Social, and Psychological Determinants of Emotional State," *Psychological Review*, 69, 379–99.

Schaefer, Michael, Harald Berens, Hans-Jochen Heinze, and Michael Rotte (2006), "Neural Correlates of Culturally Familiar Brands of Car Manufactures," *NeuroImage*, 31 (June), 861–65.

Schooler, Jonathan W., and Eric Eich (2000), "Memory for Emotional Events," in *The Oxford Handbook of Memory*, Endel Tulving and Ferqus I. M. Craik, eds., New York, NY: Oxford University Press, 379–92.

Scoville, William B., and Brenda Milner (1957), "Loss of Recent Memory After Bilateral Hippocampal Lesions," *Journal of Neurology, Neurosurgery, and Psychiatry*, 20 (1), 11–21.

Singh, Surendra N., and Gilbert A. Churchill, Jr. (1987), "Arousal and Advertising Effectiveness," *Journal of Advertising*, 16 (1), 4–40.

———, Michael L. Rothschild, and Gilbert A. Churchill, Jr. (1988), "Recognition Versus Recall as Measures of Television Commercial Forgetting," *Journal of Marketing Research*, 22 (February), 72–80.

Smith, Craig A., and Phoebe C. Ellsworth (1985), "Patterns of Cognitive Appraisal in Emotion," *Journal of Personality and Social Psychology*, 48, 813–38.

Steenkamp, Jan-Benedict E. M., Hans Baumgartner, Elise van der Wulp (1996), "The Relationships Among Arousal Potential, Arousal and Stimulus Evaluation, and the Moderating Role of Need for Stimulation," *International Journal of Research in Marketing*, 13, 319–29.

Thorson, Esther, and Marian Friestad (1989), "The Effects of Emotion on Episodic Memory for Television Commercials," in *Cognitive and Affective Responses to Advertising*, Patricia Cafferata and Alice M. Tybout, eds., Lexington, MA: Lexington Books, 305–26.

Ungerleider, Leslie G., and James V. Haxby (1994), "'What' and 'Where' in the Human Brain," *Current Opinion in Neurobiology*, 4 (2), 157–65.

Uppenkamp, Stefan, Ingrid S. Johnsrude, Dennis Norris, William Marslen-Wilson, and Roy D. Patterson (2006), "Locating the Initial Stages of Speech? Sound Processing in Human Temporal Cortex," *NeuroImage*, 31 (3), 1284–96.

Vander Wyk, Brent C., Caitlin M. Hudac, Elizabeth J. Carter, David M. Sobel, and Kevin A. Pelphrey (2009), "Action Understanding in the Superior Temporal Sulcus Region," *Psychological Science*, 20 (6), 771–77.

Wyer, Robert S. Jr., and Thomas K. Srull (1989), *Memory and Cognition in Its Social Context*, Hillsdale, NJ: Erlbaum.

Yerkes, Robert M., and John D. Dodson (1908), "The Relation of Strength of Stimulus to Rapidity of Habit-Formation," *Journal of Comparative Neurological Psychology*, 18, 459–82.

Yoon, Carolyn, Angela H. Gutchess, Fred Feinberg, and Thad A. Polk (2006), "A Functional Magnetic Resonance Imaging Study of Neural Dissociations between Brand and Person Judgments," *Journal of Consumer Research*, 33 (June), 31–40.

Young, P. Malcolm (1993), "The Organization of Neural Systems in the Primate Cerebral Cortex," *Proceedings Biological Sciences*, 252 (1333), 13–18.

Zillmann, Dolf (1978), "Attribution and Misattribution of Excitatory Reactions," in *New Directions in Attribution Research*, John H. Harvey, William John Ickes, and Robert F. Kidd, eds., vol. 2, Hillsdale, NJ: Erlbaum, 335–68.