Decoding Neural Responses to Emotion in Television Commercials

An Integrative Study of Self-Reporting and fMRI Measures

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Although current practice either regards physiological measures as superior to self-reporting or uses just one type of measure, this study proposes an integrative procedure combining a visual self-reporting scale with functional magnetic resonance imaging (fMRI) to measure emotional response to television commercials. Advertising messages are used to locate brain regions responsible for emotional responses. This study pinpoints brain responses to emotions in advertising at the gyrus level, which refers to folds and ridges that create a larger surface area for the brain and allow greater information-processing function of the brain, thus, enriching the knowledge base of neuromarketing: It indicates to researchers and practitioners the importance of the three key dimensions of emotion, appeal, engagement, and empowerment in measuring feelings about advertising and marketing communications.

Management Slant

- Emotions are important for creating positive and involving messages. These feelings, generated by advertising, can be transferred to brands. Therefore, one area that requires substantial improvement is how emotional response to advertising is measured in the brain.
- Advertising practitioners interested in neuromarketing should measure emotional response to their advertising and marketing communication by adopting a three-dimensional integrative approach. This approach should combine proven self-reporting methods with the currently popular neuroimaging technologies.
- We identify brain regions at the gyrus level for the emotional dimensions of *appeal* and *engagement*, which have been shown in previous research to predict purchase intentions and brand interest.
- Cost and participant availability are not necessarily deterring factors to neuroimaging research, but continuous effort to improve the precision of neurophysiological analyses is key to the successful implementation of neuromarketing.

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INTRODUCTION

Brands are anchored in emotion, and emotion is essential to "learning, problem-solving, and decision-making" (Gordon, 2006). Therefore, advertising without an emotional impact is largely useless. Researchers have reported that emotional advertisements with no distinct message are more effective than factual advertisements with clear messages (Wood, 2012). The power of emotion in advertisement derives from people's limited motivation or ability to deeply process each piece of information they encounter every day (Petty and Wegener, 1998). Emotional response to advertising can also function as what Daniel Kahneman (2011) called the Affect Heuristic—a mental shortcut that allows people to make decisions and solve problems quickly and efficiently—in which current emotion—fear, pleasure, surprise, etc.—influences behavior.

Analyses of industrial data, as reported in the *JAR*, show that emotion-based campaigns are more profitable than fact-based campaigns (Wood, 2012); emotion-based advertisements generate stronger brand associations and more relevant brand metaphor in consumers than fact-based advertisements (Micu and Plummer, 2010); and emotional response is more predictive of behavioral intention than cognitive measures (Morris, Woo, Geason, and Kim, 2002). Morris *et al.* (2002) used a visual self-reporting scale that was incorporated in the current study and in many other studies.

For many years, however, researchers have sought to move beyond self-reporting to physiological measures such as galvanic skin response and electromyography (Poels and Dewitte, 2006). Given that the research reported in the *JAR* article (Morris *et al.*, 2002) demonstrated the strong link of emotion to purchase intention and brand interest, we concluded that this study should use the same self-reporting methodology in conjunction with a physiological measure. Functional magnetic resonance imaging (fMRI) was chosen as the physiological measure of emotion as it presents the most detailed map of the brain while simultaneously superimposing the brain activity in any given situation (Kenning, Plassmann, and Ahlert, 2007).

Note that marketing researchers typically view the relationship between self-reporting and physiological instruments as competitive and contrast the two types of instruments to determine which one is superior to and can therefore replace the other (Hazlett and Hazlett, 1999; Peacock, Purvis, and Hazlett, 2011). For example, some researchers argue that physiological instruments are better than self-reporting techniques because the former continuously records naturally occurring emotional response during the viewing of an advertisement, whereas the latter requires respondents to recall their emotional experience after exposure to the advertisement (Peacock *et al.*, 2011). Nevertheless, one major issue associated with physiological measures is that the area under observation is so broad and interconnected that physiological change may be induced by emotional response without definitive methods for determining the precise location (Poels and Dewitte, 2006).

It is more important to note that emotional response cannot be exclusively equated with physiological changes. To know what is the emotional response, one must ask how it feels (Barrett, Mesquita, Ochsner, and Gross, 2007). The job of science is to work out the "bridging laws" that link analyses at different levels (Nagel, 1961). This complementary view is well adopted by neuropsychologists in their research on emotion and is the very foundation of this study. Instead of adopting the competitive view of emotional measurements and contrasting self-reporting with fMRI to analyze which one would be better, this study proposes to integrate fMRI and a visual self-reporting scale to measure emotional response to advertising. This integrative approach provides researchers and practitioners with a viable alternative to the current practice, which either uses one type of measure or regards physiological measures as superior to self-reporting measures. By reporting neural responses to emotions in television commercials, this study enriches the knowledge base of neuromarketing and indicates to researchers and practitioners the key brain areas to investigate when neuroscience is applied to advertising research.

In the remainder of the article, we first provide a review of emotion theories and measures. Next, we describe an experiment that identified neural systems that isolated two emotional dimensions: appeal and engagement. Finally, the implications of the study are discussed.

One major issue associated with physiological measures is that the area under observation is so broad and interconnected that physiological change may be induced by emotional response without definitive methods for determining the precise location

LITERATURE REVIEW

The many effects that emotion may produce, as well as the many theories of emotion, create a significant challenge for scholars and practitioners interested in the measurement of emotion and emotional response (Micu and Plummer, 2010). Although the variety of measures of emotional response is truly staggering, most measures can be categorized as self-reporting, physiological, or symbolic (Micu and Plummer, 2010). Self-reporting measures can be further divided into verbal or visual methods (*e.g.*, Wood, 2012), and symbolic measures, self-reporting at face value, are based on picture-sorting techniques for emotion assessment (Micu and Plummer, 2010; Young, 2004). In addition, one important initiative for physiological measures is to apply neuroscience to investigate emotional response to advertising (Gordon, 2006). As explained in the introductory section, this article is not intended to follow the prevailing tradition of comparing different types of measures but to advocate for an integrative approach that uses a self-reporting visual method in conjunction with a physiological measure.

Measuring Emotion in Advertising

Emotional response to advertising can be measured through a list of discrete feelings or as a multidimensional space (Poels and Dewitte, 2006). Previous research has investigated multiple categories of emotional response to advertising such as anger, sadness, joy, and surprise (Kim and Niederdeppe, 2014; Teixeira, Wedel, and Pieters, 2012), but this wide range of feelings can be more efficiently organized along a limited number of dimensions such as pleasure, arousal, and dominance (PAD; Bellman, 2007; Mehrabian and Russell, 1974).

Measuring emotional response along these dimensions can be accomplished by two methods: verbal or visual. The verbal method requires participants to respond to a list of emotion adjectives (*e.g.*, Edell and Burke, 1987; Mehrabian and Russell, 1974), and the scores are then combined into the dimensions through factor analysis. Alternatively, the visual method instructs participants to respond to a set of figures representing different dimensions of emotion. The Self-Assessment Manikin (SAM) scale (Lang, 1980) is the most frequently used visual measure in advertising research (Poels and Dewitte, 2006). SAM (see Figure 1) features a set of five figures for each of the PAD dimensions (Mehrabian and Russell, 1974): For pleasure, SAM ranges from happy to unhappy; for arousal, SAM ranges from excited to sleepy; and for dominance, SAM ranges from a very small figure representing a feeling of submissive to a very large figure representing a powerful feeling. Participants are required to indicate which figure in each of the dimensions best represents their feeling state. Compared with verbal scales that are typically composed of 18 to 69 items (*e.g.*, Edell and Burke, 1987; Mehrabian and Russell, 1974), SAM is much less cumbersome (Lang, 1985). Another advantage of SAM is that its graphic nature helps eliminate the cognitive processing for semantic judgment, an inherent problem in all verbal measures of emotion (Morris, 1995). In addition, SAM is highly correlated with the PAD verbal scale ($r_{\text{pleasure}} = 0.94$; $r_{\text{arousal}} = 0.94$; $r_{\text{dominance}} = 0.66$; Lang, 1980).

The PAD dimensions have recently been redefined as AEE (appeal–engagement–empowerment) because the new descriptors are better able to explain the purposes and needs of communications and therefore are better suited to industry objectives (Jang, Chun, Ko, and Morris, 2014). SAM is an integral component of physiological research on emotion, particularly in the investigation of physiological responses of appeal and engagement.

Physiological Responses to Emotion

The dominant physiological theories of emotion are arousal theory and the theory of facial expressions. Arousal theory focuses on physiological responses of the autonomic nervous system. Galvanic skin

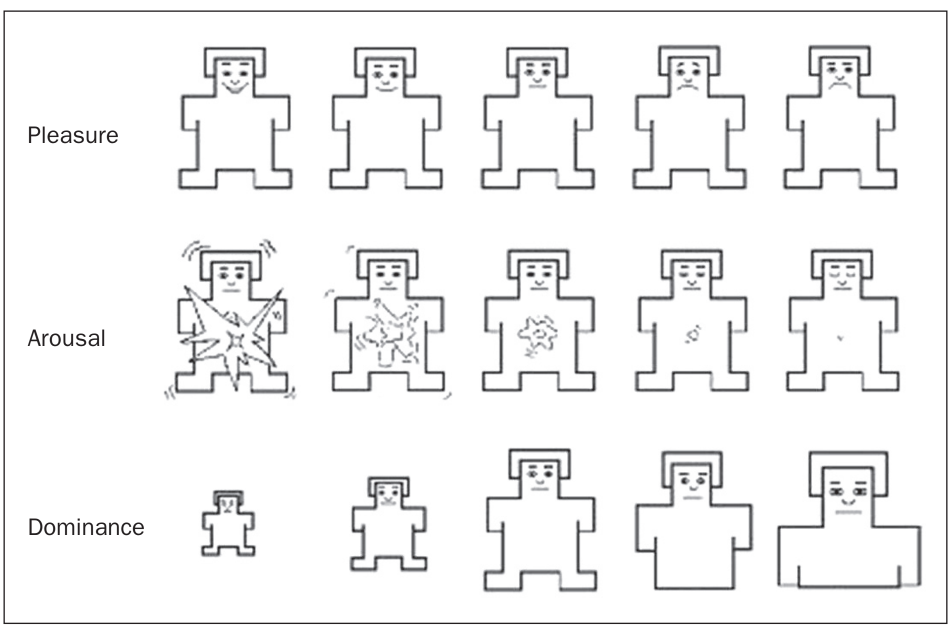


Figure 1 Self-Assessment Manikin (SAM)

response, which measures changes in the skin's electrical resistance in response to a stimulus, is typically used to measure how arousing an advertisement is (Peacock *et al.*, 2011). The theory of facial expressions, on the other hand, focuses on subtle changes in facial musculature in the experience of positive and negative emotion. The Facial Action Coding System (Ekman and Friesen, 1978), which instructs researchers to visually code facial muscular movements and facial electromyography, which measures facial muscular movements with electrodes, have been used to assess emotional responses in advertising research (Poels and Dewitte, 2006). Although the latter is a more precise measure of facial expressions than the former, it is susceptible to noises caused by sudden movements of the subject (Poels and Dewitte, 2006).

Both galvanic skin response and facial electromyography techniques collect responses of the peripheral nervous system, but the "ultimate way of studying the role of emotions in advertising is by directly looking into the brain" (Poels and Dewitte, 2006, p. 26). Although the idea that emotion involves the limbic system is far from new, it was not until recently, thanks to technological breakthroughs in neuroscience, that neuroimaging techniques began to be widely used to identify brain regions associated with emotional responses (Phan, Wager, Taylor, and Liberzon, 2002). Currently available techniques include electroencephalography, magnetoencephalography, and positron emission tomography.

However, fMRI is used in roughly 50 percent of all brain imaging studies and the popularity of this technique makes it a promising measurement for advertising research (Kenning, *et al.*, 2007). In an fMRI study, a participant is instructed to perform a task while lying inside an MRI scanner. The MRI scanner records blood oxygenation level dependent (BOLD) signals throughout the brain while the task is being performed. The physiological response indicated by BOLD signals is known as the hemodynamic response or increase of oxygenated blood in activated brain regions. Comparing brain regions with and without the hemodynamic response makes it possible to infer the brain function of the activated regions (Kenning *et al.*, 2007).

Numerous brain imaging studies (Anders, Lotze, Erb, Grodd, and Birbaumer, 2004; Gerber *et al.*, 2008; Lane, Chua, and Dolana, 1999; Lane *et al.*, 1997) have been conducted to identify brain regions associated with arousal, which in this context is now known as *engagement*, and emotional valence, which is alternatively referred to as pleasure (Lang *et al.*, 1998) and is now called *appeal*. The standard procedure in these studies involved both neuroimaging techniques and self-reporting techniques, reflecting the complementary approach. Although fMRI was the most frequently used neuroimaging technique, SAM was the most frequently used self-reporting technique. Specifically, SAM was used to validate that pleasant/unpleasant stimuli did induce a sufficient amount of pleasure/displeasure, while arousing stimuli did induce enough arousal, whereas the dominance dimension was usually not assessed because of the lack of stimuli with dominance differences (Lang *et al.*, 1998). Next, neuroimaging responses to the stimuli, such as BOLD signals of fMRI, were used to identify brain regions associated with the pleasure and arousal dimensions.

A majority of these studies used emotional pictures as the stimuli to focus on discrete emotions such as fear, anger, disgust, or happiness. The discrete approach assumes that these feelings have their own specific areas in the brain and therefore fails to recognize that the interconnections in the brain are vast and are linked by something other than a specific feeling (Phan *et al.*, 2002). Hence, certain brain regions may become activated from the demand to categorize or label discrete emotions rather than from the natural emotional responses to given stimuli. A number of neuroimaging studies in previous research have treated emotions as "pleasant" and "unpleasant," while ignoring the nuances along the pleasure dimension and the additional explanatory power of the arousal and dominance dimensions. For example, the intensity of fear has been associated with brain activities in the left inferior frontal gyrus (Morris *et al.*, 1998), whereas anger and disgust have been associated with different degrees of intensity or arousal (Iidaka *et al.*, 2001).

The alternative dimensional approach to emotion attempts to simplify the representation of responses by identifying a set of common dimensions that can be used to distinguish specific emotions from one another. In this study, the brain was examined for locations of appeal, engagement, and empowerment. The three dimensions are independent of one another, and cross tabulation can be used to identify discrete emotions. The method by which individual feelings may be classified by dimension might be better understood with reference to Figure 2. Each emotion adjective is shown in a two-dimensional space: appeal and engagement. Each adjective or feeling has been positioned using SAM to measure the feelings associated with that specific adjective. It is theorized that the brain works in the same way to establish the feelings.

Emotional Response to Television Commercials

Previous research has shown that the amygdala and prefrontal cortex are consistently activated by emotional pictures. In addition to a strong connection between the amygdala and the engagement

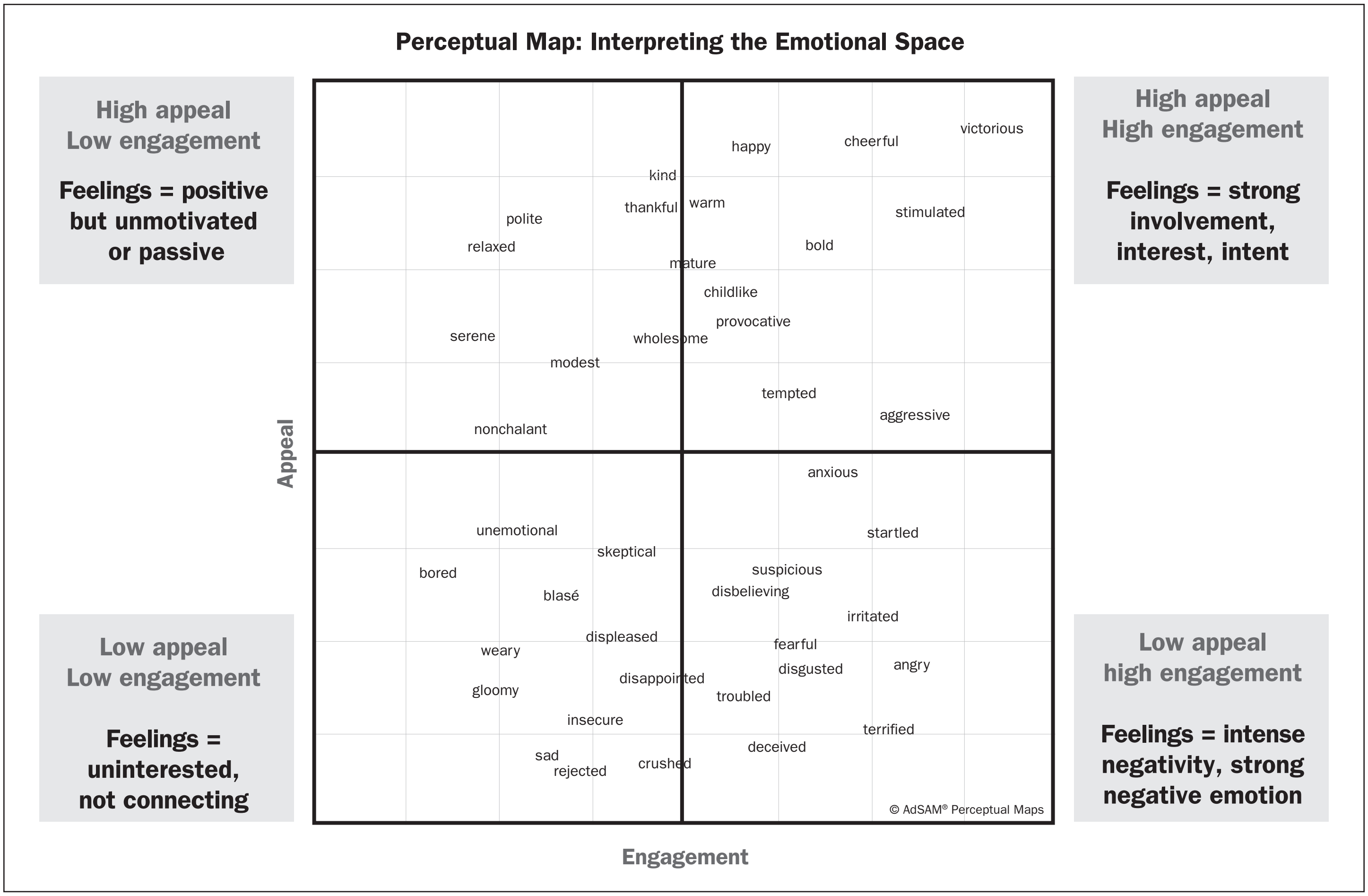


Figure 2 Perceptual Map of Feelings

dimension, engagement is associated with the superior frontal gyrus in the prefrontal cortex, whereas appeal is related to the inferior frontal gyrus in the prefrontal cortex (Decety and Chaminade, 2003). Compared with pictures, television commercials and public service announcements carry audio, visual, and verbal stimuli as well as semantic information. The dynamic nature of television commercials tends to not only reinforce activation in the prefrontal cortex but also increase brain activities in the temporal cortex. For example, both audio and visual stimuli along the appeal dimension are associated with activation in the middle temporal gyrus of the temporal cortex (Suzuki *et al.*, 2008), whereas visual stimuli along the engagement dimension are associated with activation in the superior temporal gyrus of the temporal cortex (Trautmann, Fehr, and Herrmann, 2009).

There is also evidence that the temporal and prefrontal cortices form a reciprocal pathway essential for integrating the processing and interpretation of both sensory and semantic information of audio, visual, and verbal stimuli (Adolphs, 2002). In addition, neural projections from the prefrontal cortex to the amygdala may modulate the amygdala's processing of socially constructed emotional stimuli (Adolphs, 2002).

On the basis of close anatomical and functional relationships among the amygdala, prefrontal cortex, and temporal cortex, and the characteristics of television commercials as sensory, semantic, and social stimuli, the authors propose an amygdala-prefrontal cortex-temporal cortex neural connection to model emotional response to television commercials along the appeal and engagement dimensions. On the basis of the above-mentioned findings about brain reactions to emotional pictures and audio stimuli along the appeal dimension at the gyrus level (Decety and Chaminade, 2003; Suzuki *et al.*, 2008), the authors hypothesize the following:

H1: The inferior frontal gyrus is activated by the appeal dimension of the emotional responses.

H2: The middle temporal gyrus is activated by the appeal dimension of the emotional responses.

Similarly, according to the findings about brain reactions along the engagement dimension at the gyrus level (Decety and Chaminade, 2003; Trautmann *et al.*, 2009), the authors also hypothesize

H3: The superior temporal gyrus is activated by the engagement dimension of the emotional responses.

H4: The superior frontal gyrus is activated by the engagement dimension of the emotional responses.

To the best of the authors' knowledge, the literature of both advertising/marketing and neuropsychology is largely silent about brain activities associated with the empowerment dimension. This dimension refers to a continuum of naturally occurring feelings, ranging from submissive to powerful in response to an advertisement in this article. Therefore, it is the belief of the authors that empowerment is important, in real rather than vicarious experiences. To that end, if an advertisement or public service announcement can stimulate thoughts of real and overwhelming experiences, empowerment is expected to play an important role.

METHOD

The literature review above indicates that visual scales such as SAM have a few advantages over verbal scales. AdSAM®, which extends SAM to advertising research (Morris *et al.*, 2002), was chosen as the self-reporting technique for this study. AdSAM® not only collects AEE ratings on the SAM scales but also converts the ratings to the previously shown perceptual map.

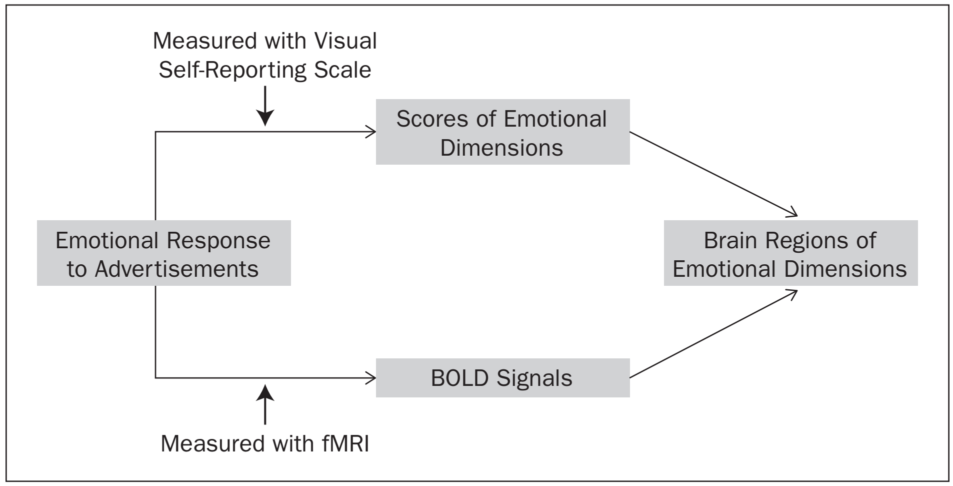


Figure 3 An Integrative Approach to Emotion Measurement

The discussion above also indicates that in many neuroimaging studies, SAM is used to identify emotional dimensions and fMRI is used to identify brain regions of the emotional dimensions. This integrative approach is adopted as the method for this study. Furthermore, built on the discussion about brain reactions to sensory and semantic information, four hypotheses are proposed and will be tested in this section. The integrative approach emerging from the Literature Review section and used in the Method section to test the hypotheses is described graphically in Figure 3. The Method section is composed of a pretest and an experiment.

Pretest

A total of 250 respondents were shown a series of advertisements and public service announcements. Respondent scores, collected through AdSAM®, were analyzed to identify significant differences in appeal and engagement at the 0.05 level. Through this procedure, three advertisements and two public service announcements were selected. The majority were high in appeal and engagement, with the exception that one video was high in appeal but significantly higher in engagement than the other three, and another video was significantly lower in appeal than the other four but significantly higher in engagement than the other three. No difference was found in empowerment.

This resulted in two discrete groups of stimuli. In one, there were four advertisements high in appeal and one significantly lower in appeal. In the other group of the same videos, two were significantly higher in engagement than the other three.

Experiment

Twelve healthy, right-handed young adult participants (6 males/6 females, age range 22–28, mean age 24.8) watched the five videos inside of a scanner. Their emotional responses included both BOLD signals recorded through fMRI and self-reported feelings on AdSAM®.

The first video was a public service announcement called, "Be a Hero." It shows children answering a question—"Who is my hero?" Some respondents named celebrities, but one boy named his teacher. The video urges those interested to get involved in teaching and make a difference.

The second video was an Evian water advertisement. It portrays beautiful mountains, blue sky, and the sun sparkling on snow in the French Alps. The third video was a Coca-Cola advertisement. It shows a boy offering his Coke bottle to Mean Joe Greene of the Pittsburgh Steelers. At first Mean Joe Greene politely declines but then changes his mind, accepts the Coke bottle, and passes his jersey to the boy as a return gift.

The fourth video was a Gatorade advertisement. It showcases special effects of a 23-year-old Michael Jordan, in a Chicago Bulls uniform, playing the modern-day Michael Jordan in a one-on-one grudge match. The older-but-wiser Jordan schools his younger, more energetic self by demonstrating his superior skills.

The fifth and final video was a public service announcement condemning the use of animal fur for clothing. The video starts with scenes from a fashion show with several models showcasing fur coats. The spectators are clapping and admiring the fur coats. As one model turns around there is blood dripping from her coat, and it is splattered all over the spectators who are now terrified and disgusted. It closes with an announcement: "It takes up to 40 dumb animals to make a fur coat but only one to wear it."

The videos were presented by back-projection using a 17-in. LCD screen through the Integrated Functional Imaging System (IFIS, MRI Devices, Inc., Waukesha, WI). An MRI-compatible auditory system (Resonance Technology, Inc.), with stereo earphones and a microphone, protected participants from scanner noise while permitting verbal communication with the operator and transmitting the sound of the commercials. Resting blocks, consisting of the view of a red cross on a black screen for 30 s, were interspersed between each commercial block.

The functional scan consisted of six runs with each run (except for the initial resting-state run) separated into three blocks: 1) a resting period, 2) a task of viewing a video, and 3) the AdSAM® task. The initial run started with a 30-s resting block and then included two sets of the AdSAM® tasks in response to "How do you normally feel?" and "How do you feel right now?" Following the commercial block, the participants performed the AdSAM® task, which consisted of three trials of rating appeal, engagement, and empowerment. The participants were asked to convey their feelings in terms of appeal, engagement, and empowerment by selecting the most appropriate manikin immediately after viewing a video. The responses and reaction times were recorded with a right-handed button response glove (IFIS, MRI Devices, Inc., Waukesha, WI). The participants were instructed to indicate how they felt after watching each video by rating the AdSAM® scales without spending a lot of time thinking about the questions.

RESULTS

AdSAM® Data

The analysis of the data (See Table 1) indicated that, in terms of appeal, the Anti-Fur video (M = 2.7) rated significantly lower than the other four videos. Although the other videos produced positive appeals and feelings of kindness and maturity, the Anti-Fur video created feelings of anxiety and aggressiveness. On the basis of this difference, the BOLD signals from viewing the Anti-Fur video were contrasted with those videos of Teacher, Evian, Coke, and Gatorade, to locate appeal-related brain regions. It was the differences among these responses on this one-and-only dimension that created the contrast in appeal.

The research also showed that the Anti-Fur (M = 3.9) and Gatorade (M = 3.7) videos rated significantly higher than the Teacher (M = 2.9) and Coke (M = 2.9) videos on the engagement dimension. The Gatorade and the Anti-Fur videos were seen as creating high energy or involvement, because of the basketball court action in the Gatorade video and the shock value of smearing blood everywhere in the Anti-Fur video. After viewing the Anti-Fur and Gatorade videos, the BOLD signals were compared with the combined viewing of the Teacher and Coke videos to uncover engagement-related brain regions. No difference among the stimuli was found in the data along the empowerment dimension, and this investigation has been proposed for future research.

Imaging Data

Changes in the BOLD signal for the combined blocks viewing the Teacher, Evian, Coke, and Gatorade videos were compared relative to the viewing of the Anti-Fur video with a threshold criterion of $p < 0.05$ and a minimum cluster size of 150 voxels. It was observed that the BOLD signal increased in the bilateral inferior frontal gyri [IFG/Brodmann area (BA) 47] and bilateral middle temporal gyri (MTG/BA 21), but the BOLD signal decreased in

TABLE 1

AEE Responses to the Five Videos

Dimension	Teacher	Evian	Coke	Gatorade	Anti-Fur
Appeal	3.8 (0.7)[a]	4.1 (0.5)[a]	3.8 (1.0)[a]	3.7 (0.8)[a]	2.7 (1.2)[b]
Engagement	2.9 (0.7)[a]	3.2 (1.2)[a,b]	2.9 (0.8)[a]	3.7 (1.0)[b]	3.9 (0.9)[b]
Empowerment	3.7 (1.0)[a]	3.5 (0.5)[a]	3.3 (1.2)[a]	4.2 (0.7)[a]	3.3 (1.1)[a]

Note: Different letters denote significant differences ($p < 0.05$). The appeal score of the Anti-Fur video was significantly different from the other videos, but the scores of the other videos did not significantly differ from one another. The engagement score of the Evian advertisement was not significantly different from the other videos; therefore, the Evian advertisement was not used in the engagement-related neuroimaging analysis. Standard deviations are reported in parentheses.

TABLE 2

Localization of Brain Activation During Commercials With a High Level of Appeal

Region	BA	Side	X	Y	Z	Size	*t* value
Inferior Frontal Gyrus	47	R	46	37	–8	447	5.64
Inferior Frontal Gyrus	47	L	–43	35	–4	289	5.69
Middle Temporal Gyrus	21	R	59	–19	–12	3,139	5.81
Middle Temporal Gyrus	21	L	–55	–19	–5	302	5.21
Superior Parietal Lobe	7	R	13	–77	44	168	–5.13

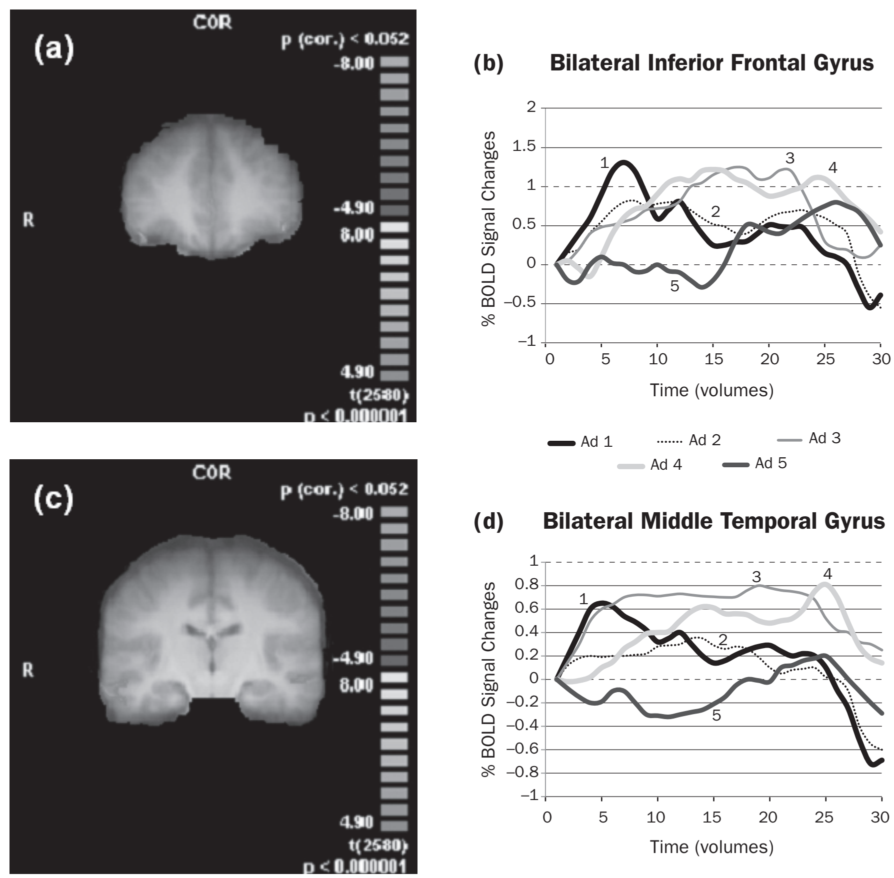
Note: $p < 0.05$; Only clusters >150 voxels are shown. BA = Brodmann area; Size = number of $1mm^3$ voxels; X, Y, and Z refer to Talairach coordinates.

the right superior parietal lobe (BA 7, see Table 2 for details).

There are three steps in the selection of regions of interest in the appeal dimension based on the results in Table 2. First, beta weights were acquired with a general linear model (GLM) on the imaging data to search for significantly activated regions, as listed in Table 2. Beta weights are estimates of the fMRI hemodynamic responses to the modeled condition. Second, the beta weights were contrasted to the AdSAM® data to examine the correspondence between the two types of measures. Third, time-locked average response plots of significantly activated regions were used to identify regions of interest where the patterns of activations also highly corresponded to the pattern of the AdSAM® data for the appeal dimension. Through these three steps, the bilateral IFG and bilateral MTG were selected to indicate the appeal dimension (See Figure 4).

In a similar vein, changes in the BOLD signal for the combined blocks of the Anti-Fur and Gatorade videos were compared relative to the viewing of the Teacher and Coke videos with the same threshold criterion of $p < 0.05$ and a minimum cluster size of 150 voxels. It was observed that the BOLD signal increased in the left hemisphere regions including the middle frontal gyrus (MFG/BA9), middle occipital gyrus (BA19), inferior temporal gyrus (ITG/BA37), and thalamus, and in the right hemisphere regions including the cerebellum, middle frontal gyrus (MFG/BA10), and optic radii (See Table 3).

The above-mentioned three steps were again used to select regions of interest for the engagement dimension. The right MFG and right superior temporal gyrus (STG) were selected to indicate the engagement dimension (See Figure 5). As shown in the figure, the time-locked average responses



Note: The Anti-Fur video (4X balanced) is contrasted against the other four videos for comparison of the appeal dimension. The regions of interest shown in Figure 4a and in Figure 4c include bilateral inferior frontal gyri: right at Tal (46, 37, –8) $t = 5.64$ and left at Tal (–3, 35, –4) $t = 5.69$ and the bilateral middle temporal gyri: right at Tal (59, 19, 12) $t = 5.81$ and left at Tal (–55, –19, –5) $t = 5.21$. The graphs in Figures 4b and 4d depict an increased BOLD signal in all four videos relative to the Anti-Fur video block for the selected voxels. Each of the five videos is represented by a different number (Teacher = 1, Evian = 2, Coke = 3, Gatorade = 4, Anti-Fur = 5).

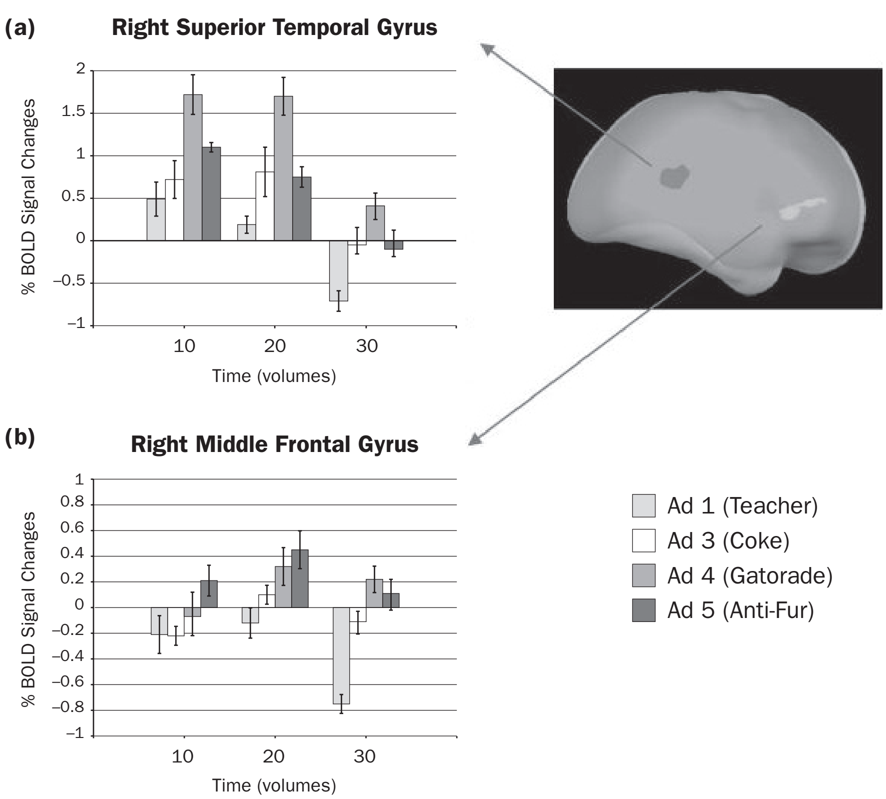
Figure 4 Neural Activities of the Appeal Dimension

TABLE 3

Localization of Brain Activation During Commercials With a High Level of Engagement

Region	BA	Side	X	Y	Z	Size	*t* value
Cerebellum	–	R	19	–41	–39	1,629	5.30
Inferior Temporal Gyrus	37	L	–48	–43	–11	1,896	5.43
Middle Frontal Gyrus	9	L	–36	28	30	477	5.27
Middle Frontal Gyrus*	10	R	26	32	5	1,113	5.40
Middle Occipital Gyrus	19	L	–46	–65	5	159	5.07
Pulvinar of the Thalamus		L	–24	–26	4	349	5.04
Superior Temporal Gyrus*	22	R	64	–37	14	808	5.69

*Notes: $p < 0.05$; Only clusters >150 voxels are shown. BA = Brodmann area; Size = number of $1mm^3$ voxels; X, Y, and Z refer to Talairach coordinates. * Appears in Figure 5.*



Note: The Gatorade and Anti-Fur videos were contrasted against the Teacher and Coke videos. The regions of interest shown include the right superior temporal gyrus: at Tal (64, –37, 14) $t = 5.69$ and the right middle frontal gyrus: at Tal (26, 32, 5) $t = 5.40$. The graphs in Figure 5a and in Figure 5b depict an increased BOLD signal in the blocks containing the Gatorade and Anti-Fur videos relative to the blocks containing the Teacher and Coke videos for the selected voxels.

Figure 5 Neural Activities of the Engagement Dimension

in these regions of interest corresponded well to the AdSAM® data of engagement.

In summary, the results not only indicated that the prefrontal and temporal cortices were activated by both appeal and engagement but also pinpointed smaller and more distinct brain regions associated with the two dimensions. That is, the bilateral IFG and bilateral MTG were activated by appeal, and the bilateral MFG and the right STG were activated by engagement. Further investigation of the activations led to the selection of the bilateral IFG and bilateral MTG for the appeal dimension. The evidence, therefore, fully supported Hypotheses 1 and 2, which stated that the inferior frontal gyrus and middle temporal gyrus were activated by the appeal dimension.

The right STG was activated by engagement, supporting Hypothesis 3 that the superior temporal gyrus was activated by the engagement dimension. However, the activation of the superior frontal gyrus was insignificant, rejecting Hypothesis 4 that the superior frontal gyrus was activated by the engagement dimension.

DISCUSSION

Consumers are overwhelmed by the number of advertising messages available. Although many of the messages broadcast in the media or distributed online may be tested for their emotional impact, it is difficult to determine if the measurement is accurate. It is clear from previous research and experience that emotions are important for creating positive and involving messages. In addition, these feelings, generated by advertising, can be transferred to brands. Therefore, one area that requires substantial improvement is how emotional response to advertising is measured in the brain. Several researchers hold a competitive view of emotion measurement and argue that physiological techniques are superior to self-reporting techniques (Hazlett and Hazlett,

Moving forward, understanding these connections is more important than ever given the fragmentation of media and the expanding need for creating appeal and engagement.

1999; Peacock *et al.*, 2011), but now there is evidence that these two approaches are not mutually exclusive.

Neither of the two types of measures need to be inherently better than the other (Poels and Dewitte, 2006). They are just used for different purposes and in different situations. This study proposed a complementary view of emotion measurement and integrated both self-reporting and fMRI techniques in assessing emotional responses to television commericals and public service announcements. On the basis of the experiences self-reported on the visual scale, contrasts for appeal and engagement were set up. BOLD signals from fMRI scans were compared when subjects were exposed to high- and low-appealing advertisements and similarly to high- and low-engaging advertisements. The analysis led to the discovery of frontal and temporal locations for two key dimensions of emotion: appeal and engagement.

By pinpointing brain regions associated with specific aspects of emotion, such as appeal and engagement, the process is also different from methods used by companies such as Nielsen to identify brain regions of arousal (an aspect of emotion) and attention (an aspect related to emotion). Such activations are difficult to separate (Gerber *et al.*, 2008), especially when only physiological measures are used (Poels and Dewitte, 2006).

ACTIONABILITY, LIMITATIONS, AND FUTURE RESEARCH

So why then are the findings in this study important to advertising and marketing communications development and research? First, without the distinctiveness of agency-developed advertising and public service announcements, uncovering the emotional response centers in the brain would not have been possible. Thanks to the succinctness and the great storytelling ability of advertising, it was possible to divide and sort the trail of emotional connections to advertising and public service announcements and capture in a minute or less the emotion of viewers so that brain scan tracking was possible. The variation in emotional appeal and engagement in the advertising messages and public service announcements in this study permitted us to pinpoint the location of the brain centers of emotion.

Second, as we move into an age of more extensive two-way marketing communication, it is important to have a standard by which measures of emotion can be developed, verified, and calibrated. Understanding the method by which the brain interprets emotion is key to understanding which tools to use in evaluating communications and marketing. If we know how to measure emotions in the brain, then we will have a clear method for evaluating physiological and self-reporting measures of emotional response to advertising and marketing communications. Researchers will be able to more accurately determine the connections that advertising and public relations have created. Moving forward, understanding these connections is more important than ever given the fragmentation of media and the expanding need for creating appeal and engagement. This study helps to uncover these issues and bring to the forefront the process of human emotional response.

Although it is an exciting idea to apply neuroimaging techniques to consumer research, cost, participant view, and ethics may limit the value of neuromarketing (Eser, Isin, and Tolon, 2011). There are concerns that neuroimaging techniques are too costly for consumer research, but they are often not as expensive as sometimes estimated. A medium-sized fMRI-based neuromarketing study would be only slightly more expensive than a typical quantitative industry study (Eser *et al.*, 2011). Portable MRI machines, now under development, should reduce the cost even further. There are also concerns that the practice of placing an individual in a brain scanner may cause physiological and psychological discomfort in the individual and therefore threatens the validity of fMRI studies. However, previous research indicates that participants in fMRI research view the procedure positively and find their experience interesting, and the practice per se does not appear to substantially interfere with the validity of fMRI research (Eser *et al.*, 2011).

Finally, there are concerns that neuroimaging techniques allow researchers to invade the privacy of consumers and manipulate consumer purchase decisions, but neuromarketing may not be as powerful as is sometimes suggested (Flores, Baruca, and Saldivar, 2014). Neuroimaging techniques can help researchers better understand consumer behavior, but the understanding itself is quite limited or preliminary (Flores *et al.*, 2014).

The authors concur with the limited-power view of neuromarketing. Although this study shows promising results in identifying emotional responses in the brain, continuous effort is needed to explore the interconnectivity in the brain and to calibrate the levels of AEE in the BOLD signals.

Empowerment was not differentiated in this study and that might explain why the amygdala was not shown to be active in this study. The missing activation of the amygdala should be addressed in future research by identifying messages that create differences in empowerment on the self-reporting measure used in this study.

In addition, emotion assessment should not be limited to advertising but extended to areas such as branding impact and tracking (McClure *et al.*, 2004), brand personality (Yoon, Gutchess, Feinberg, and Polk, 2006), and trade-off decision making (Hedgcock and Rao, 2009). It would be worthwhile to apply the measurement program developed in this study to these areas, to evaluating other physiological measures used today in marketing, including electrocardiogram, electroencephalogram, skin conductance and heart rate, and facial expression. The program would allow more comprehensive neuromarketing models to be constructed.

CONCLUSION

In the last 10 years, there has been a surge in interest in physiological measures of emotion (Dennis, Buss, and Hastings, 2012). That interest has found its way into marketing communications with research companies offering such services, but these techniques are promoted with little investigative research (Dennis *et al.*, 2012). This study demonstrated an integrative procedure that uses both a visual self-reporting scale and fMRI to assess emotional response to advertising and marketing communications. Self-reporting scores were used to identify emotion dimensions in the advertisements, and fMRI was used to identify brain responses to the emotion dimensions. Managerially speaking, it is recommended that advertising researchers adopt this integrative procedure rather than the current practice that regards physiological measures as superior, at least until further research is conducted into physiological techniques. By pinpointing brain responses to emotions in advertising at the gyrus level, this study enriches the knowledge base of neuromarketing and indicates to researchers and practitioners the key brain areas to investigate when neuroscience is applied to advertising research. JAR

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