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Measuring Emotion in Advertising Research

With the current interest in the role of emotion in advertising and advertising research, there has been an increasing interest in the use of various brain activity measures to access nonverbal emotional responses. One such approach relies on measuring the difference between left and right hemisphere prefrontal cortical activity to assess like and dislike. This approach is based on electroencephalography (EEG) and neuroimaging work, suggesting that the approach/withdrawal (frequently but not always associated with like/dislike) dimension of emotion is indicated by the balance of activity between the left and right prefrontal cortex.

Prefrontal Brain Activity

Much of this work was initiated by Richard Davidson in the early 1990s. An early study by Davidson et al. measured brain electrical activity to assess patterns of activation during the experience of happiness and disgust [2]. The authors reported that disgust was found to be associated with increased right-sided activation in the frontal and anterior temporal regions compared with happiness. In contrast, happiness was found to be accompanied by left-sided activation in the anterior temporal region compared with disgust. Early reports

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suggested that frontal laterality indexes motivational valence with positive emotions (happy, like) associated with left greater than the right frontal activity and vice versa. Although these findings appear to be consistent with personality traits (e.g., optimism–pessimism), state changes in frontal laterality appears to index approach withdraw rather than emotional valence [3]. Interestingly, the behavioral and motivational correlates of prefrontal asymmetric activity are not restricted to humans or even primates but have been observed in numerous species such as birds and fish (see [4]). Henceforth, we use the term *motivational valence* (MV) rather than the more cumbersome term *approach withdraw*.

In this study, we evaluated the use of steady-state topography (SST), a neuroimaging methodology to measure MV changes in response to naturalistic stimuli, specifically television advertising. In the study, male and female participants viewed the Diet Coke "11:30 Appointment" television advertisement (see http://www.youtube.com/watch?v=MpizkWEmg1g) released in 1998. In the advertisement, a number of women are seen arriving in an office waiting room for their 11:30 appointment. As the women were waiting, an attractive male window cleaner stripped to the waist (actor Robert Merrill) starts to clean the external window of the waiting room. The advertisement goes on to show the women ogling the window cleaner in a manner that makes it clear they find him sexually attractive, which is the reason for their 11:30 appointment. SST was used to estimate MV in the female and male groups as participants viewed the advertisement. At the time the advertisement was released, Diet Coke was primarily targeting the female market, and it was clear that the actor chosen to play as window cleaner was selected on the basis of his appeal to the female target audience. We therefore hypothesized that females would exhibit a stronger approach response than males when the window cleaner was prominently featured in the advertisement.

We include a brief description here as the reader may be less familiar with SST. SST is an event-related potential-based methodology that originated in the work of Silberstein et al. [6]. The key feature is that a dim ongoing oscillating visual stimulus is presented in the peripheral visual field while subjects are performing a cognitive task or, in this case, viewing a television advertisement. This oscillating visual stimulus is present all the time, and it elicits a small brain rhythmic sinusoidal response at the stimulus frequency that is termed the *steady-state visually evoked potential* (SSVEP). The SSVEP is completely characterized by the amplitude and the phase difference between the stimulus signal and the SSVEP which is frequently represented as a complex number. Variations in the SSVEP phase difference reflect changes in latency or delay between the SSVEP signal and the visual stimulus. These latency changes reflect summed changes in synaptic transmission time related to excitatory or inhibitory synaptic processes. A latency reduction is considered to index increases in synaptic excitation (or a reduction in synaptic inhibition), while a latency increase is considered to index a reduction in synaptic excitation [7]. For simplicity, we will subsequently refer to SSVEP latency reduction or increased excitation as *SST activity* and express it in radian units. In this study, SST activity of 2π radians corresponds to a latency difference of 77 ms or one stimulus cycle. For a recent review on the use of SSVEP in cognitive neuroscience, the reader is referred to Vialette et al. [9].

FIGURE 1 Brain activity was recorded from participants viewing the common material in groups of eight.

Three specific features of SST methodology make it a useful technique in cognitive neuroscience research as well as neuroscience-based advertising research.

1) High temporal resolution: The SST technique continuously tracks rapid changes in brain function [7]. This is an important feature as many changes in brain function associated with TV advertising reflect the pace and changes in the advertisement that can occur in less than a second.
2) High signal strength (or high signal-to-noise ratio) and resistance to interference and noise: The mathematical technique used to estimate SST activity means that it is possible to tolerate very high levels of noise or interference due to things such as head movements, muscle tension, blinks, and eye movements [7]. This makes SST well suited to cognitive studies where eye, head, and body movements occur as a matter of course.
3) High signal to noise: This means that it is possible to work with data based on a single trial per individual [6] as opposed to the typical situation encountered in event-related potential or functional magnetic resonance imaging studies where there is a need to average multiple trials recorded from each individual to achieve adequate signal-to-noise levels.

Materials and Methods

The participants comprised 53 females and 57 males aged 19–45 (mean age 36.3 years) and were recruited through a market research recruitment agency. The study was conducted in a purpose-built facility at Brain Sciences Institute, Swinburne University of Technology and was approved by the Swinburne University Human Experimentation Ethics Committee (Figure 1).

After giving informed consent, brain electrical activity was recorded from eight participants at a time while they viewed the video material. The video material comprised a prime time television program with an advertising break comprising four advertisements. The Diet Coke advertisement was located in the

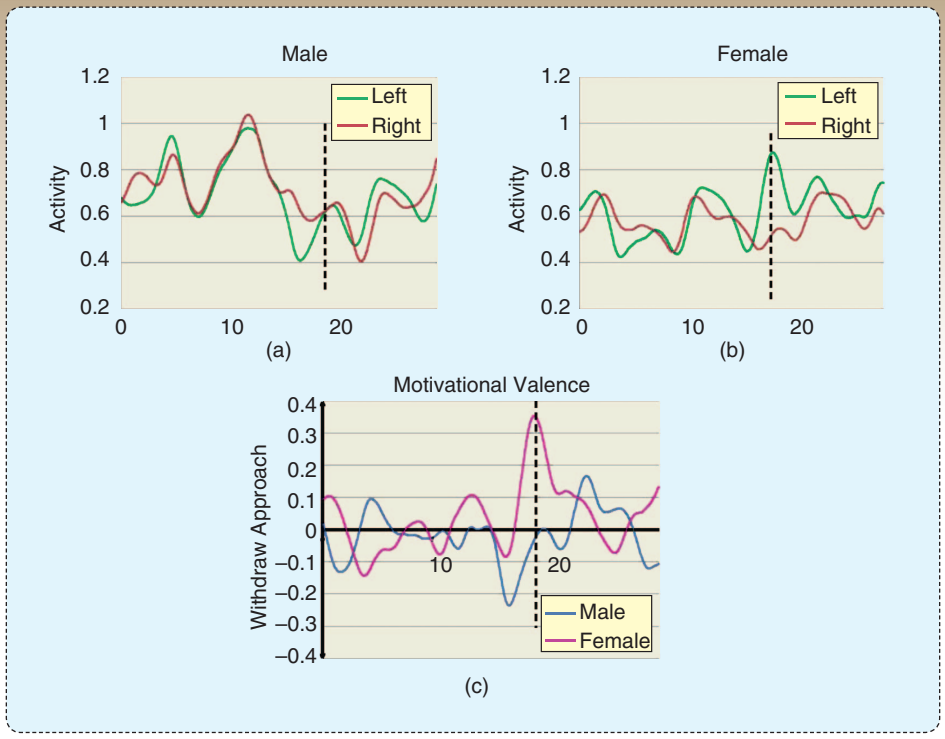

FIGURE 2 (a) Averaged SST activity for a male group viewing the advertisement. The green trace illustrates activity for the left hemisphere prefrontal sites, whereas the brown trace illustrates the corresponding right hemisphere prefrontal sites. The vertical dotted line illustrates the time in the advertisement that featured the window cleaner most prominently. (b) The corresponding left and right prefrontal averaged SST activity for the female group. A prominent increase in left prefrontal SST activity is noted at the time the window cleaner is featured. (c) MV for males (blue trace) and females (purple trace). The scene featuring the window cleaner [vertical dotted line and (d)] is associated with a prominent approach response in the female group. This effect is statistically significant at $P < 0.005$ (permutation test). Readers interested in the event coinciding with the withdraw response in the males 2.3 s before the window cleaner scene are invited to view the advertisement at http://www.youtube.com/watch?v=MpizkWEmg1g.

second position for approximately half the program and the third position for the remainder. It should be stressed that participants viewed the advertisements in a naturalistic setting in that each advertisement was viewed only once.

For this study, brain activity at left (Fp1 and F3) and right (Fp2 and F4) prefrontal sites was used to assess MV. The stimulus used to evoke an SSVEP was a white 13-Hz sinusoidal flicker subtending a horizontal angle of 160° and a vertical angle of 90°. The modulation depth of the stimulus when viewed against the background was 45%. A set of goggles that permitted the sinusoidal flicker to be superimposed on the viewing field was used to present the stimulus [6]. The major features of the signal processing have been already described [7]. Briefly, the SSVEP was determined from the smoothed 13-Hz EEG Fourier coefficients derived from EEG data recorded while participants viewed the video material. The smoothed Fourier coefficients were pooled separately for the male and female groups.

We used a nonparametric statistical methodology, specifically a multivariate permutation test [1], to assess the statistical significance of the SST difference between the female and male groups at the point of time the window cleaner is featured. In this approach, we compare the actual SST difference between the two populations with the distribution of 10,000 differences derived by randomly reallocating the individual SST differences. This yields an exact P value that does not rely on any assumptions of equality of variances or normal distribution and also tends to be more conservative than the parametric methodologies.

Results and Discussion

The SST activity was calculated separately for the male and female groups. Left prefrontal SST activity was then derived from the average of the SST activity at the left prefrontal sites Fp1 and F3 SST, whereas right prefrontal SST activity was correspondingly derived from the average of SST activity at the right prefrontal sites Fp2 and F4. The left and right prefrontal activities for the male and female groups were illustrated in Figure 2(a) and (b). The MV measure for each group is derived by subtracting the right prefrontal activity from the left prefrontal activity. This is illustrated in Figure 2(c), where the vertical dashed line indicates the point of time in the advertisement where the window cleaner was prominently featured.

Compared to the male group, the female group showed greater left frontal activity at the appearance of the seminaked window cleaner in the advertisement. The MV measure illustrates this more clearly. The female group shows a pronounced approach response compared with the male group at this point in time. A multivariate permutation test comparing the male and female motivational measures at this point in time indicates the effect is statistically robust ($P < 0.005$).

As hypothesized, we observed a larger approach response by the female group compared with the male group when the window cleaner appears most prominently in the advertisement. Thus, these findings lend additional weight to the existing body of research, indicating that differences in MV are mediated by the left prefrontal cortex for the approach component and the right prefrontal cortex for the withdraw component. The findings also demonstrate the apparent sensitivity and specificity of the SST methodology in tracking the differences in prefrontal activity to reveal the MV differences based on a single trial or a single viewing of the advertisement. Previous research reported by Davidson's group used EEG measures of prefrontal activity, and these necessitated the averaging of multiple viewing of the same material to enhance signal to noise.

In this study, it was clear that the female approach response to the window cleaner was primarily driven by an increase in left prefrontal activity rather than a reduction in right prefrontal activity. This would be consistent with the state being associated with an attraction to the portrayed male rather than a reduction in repulsion that would have been indicated by a reduction in right prefrontal activity. We have observed SST evidence of the right prefrontal cortex mediating a withdraw response to unpleasant images. A study by Kemp et al. [5] used SST to examine the effects of antidepressant medication on brain responses to viewing unpleasant images. They found that unpleasant images compared with neutral images were associated with greater right prefrontal activity when subjects had taken the placebo. When the subjects viewed the unpleasant images after taking the antidepressant, right prefrontal activity was reduced.

Early research by Davidson et al. suggests that the left prefrontal cortex was preferentially active when the participants were experiencing positive emotional states such as happiness while the right prefrontal cortex was preferentially active during negative emotional states such as sadness. More recent work suggests that this is an oversimplification. In particular, it was noted that the left hemisphere approach response occurred during positive emotional states such as happiness and also during states of anger [3]. In other words, the left prefrontal activity appears to index approach irrespective whether the approach is due to positive emotion such as happiness or due to negative emotion such as aggressive approach. Thus, in the context of advertising research, the MV measure, when used in isolation, cannot differentiate an approach response based on a positive emotion from one motivated by anger or aggression. However, this is rarely an issue as one does not view the motivational measure in isolation. The advertisement itself provides the context and additional information that enables one to differentiate positive approach from aggressive approach.

In the context of advertising research, MV is one of a series of psychological measures derived from SST measures at various scalp locations. Others include long-term memory encoding (what is being stored in long-term memory), engagement (a sense of personal relevance), emotional intensity (closely related to arousal), and visual attention. Of these, long-term memory encoding during the advertisement appears to be the parameter most closely associated with advertising effectiveness [8]. MV and the other measures give important insights into the emotional response to different components of the advertisement. In summary, our findings suggest that SST can make a useful contribution to the study of the MV dimension of emotional responses to advertise or any form of communication.

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