Reconceptualizing Excitation Transfer as Motivational Activation Changes and a Test of the Television Program Context Effects

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Abstract

This study theorizes that activation and decay of dual motivational systems function as the mechanisms underlying excitation transfer theory. Following this reconceptulization, a physiological experiment simultaneously examines the influence of program valence and arousing content on subsequent ads. As predicted, sympathetic arousal (indicated by skin conductance) was greater during ads following arousing compared to calm programs and in both conditions, it decreased across ad blocks. Cognitive effort was higher (indicated by slower heart rate) during ads following the positive arousing program and was lower (indicated by faster heart rate) following the negative arousing program. The recognition and free recall data generally support the prediction that immediately following the program, they would be at the levels predicted by the motivational activation elicited by the program context.

This paper approaches the question of whether arousal is transferred from one media stimulus to another, as described in excitation transfer theory (Zillmann, 1971), from the theoretical perspective of the limited capacity model of motivated mediated message processing (LC4MP, A. Lang, 2006a, b). The reconceptualization is tested in a television program context experiment using real time psychophysiological measures. The context provided by television programs has been recognized for its role in influencing the processing of subsequent ads by inducing emotional and cognitive responses in viewers (Aylesworth & MacKenzie, 1998), for which excitation transfer theory provides a natural explanation (e.g., Zillmann, 1971; Mattes & Cantor, 1982). This paper does not dispute findings along this line of research. Instead, it simply seeks to extend the conceptualization of "arousal" and "transfer," the two key concepts in excitation transfer theory, based upon accumulated theoretical and empirical understanding from the LC4MP research over the recent decade. These two concepts are coherently conceptualized as predictable and measurable changes in the activation and deactivation of the appetitive and aversive motivational systems. Thereby, excitation transfer theory is expanded to include consideration of the emotional valence dimension of media messages, and importantly, its interaction with the arousing content dimension of the messages. This reconceptualization not only helps further explicate the underlying mechanism which causes the phenomenon known as excitation transfer, but also helps specify its consequences for the processing of information as evidenced by changes in the recognition and recall of subsequent messages.

"Arousal" and Directional Motivational Activation

Excitation transfer theory, developed by Zillmann (1971), posits that cognitive awareness of the source of arousal caused by a preceding stimulus will decay before the sympathetic arousal itself decays. Hence, residual arousal from preceding stimuli can be misattributed to subsequent stimuli and intensify emotional responses. Thus, emotional responses to ads following arousing programs are thought to be intensified.

This theoretical perspective has received a great deal of support (e.g., Zillmann, & Bryant, 1974; Mattes & Cantor, 1982). However, excitation transfer theory was first proposed in the 1970s, when most psychological theories were influenced by the general arousal theories of the 1950s and 1960s (e.g., Duffy, 1957, 1962). These theories suggested that arousal was a unitary force driving psychological, emotional, and physiological activities. In terms of measurement, it was generally thought that all physiological systems activated together when arousal increased. Later research in psychophysiology did not support the general arousal theories, but suggested that directional fractionation of physiological measures—that is, the tendency for some physiological measures to increase and others to decrease during tasks which participants reported to be arousing—was the norm (e.g., Lacey, 1967; Berntson, Cacioppo, & Quigley, 1993).

The LC4MP is built upon dimensional (e.g., P. J. Lang, Greenwald, Bradley, & Hamm, 1993) and dual-motivational (e.g., Cacioppo & Bernston, 1994; Cacioppo & Gardner, 1999) theories of emotion, which embrace directional fractionation as the norm and theorize that emotions arise from motivational activation. The LC4MP extends these theories by arguing that mediated portrayals are initially responded to as real, and therefore elicit automatic motivational activation and thereby give rise to emotional responses. Real time measures of motivational activation and cognitive processing have been borrowed from psychophysiology and cognitive science, and validated in the television viewing context (A. Lang, 2006a, b).

An essential argument in these theories of emotion is that, “Emotion fundamentally stems from varying activation in centrally organized appetitive and defensive motivational systems that have evolved to mediate the wide range of adaptive behaviors necessary for an organism struggling to survive in the physical world” (M. Bradley, 2000, p.602). The major dimensions of emotion are valence and arousal. *Valence* (ranging from being extremely positive to being extremely negative) is determined by the direction of underlying motivational activation. Appetitive activation elicits positive emotions; aversive (or defensive) activation elicits negative emotions, and; coactivation of both motivational systems induces mixed emotions. Activation of the appetitive and aversive motivational systems prepares the neural network to cope with appetitive or aversive events, facilitating appropriate responses to stimuli with congruent valence, and inhibiting inappropriate responses to incongruent cues. *Arousal* (ranging from being extremely calm to being extremely excited) does not have a separate neural substrate, but is an indicator of the intensity of activation in the motivational systems (P. J. Lang, M. Bradley, & Cuthbert, 1998). A majority of psychophysiological studies of media processing have followed this dimensional approach (Ravaja, 2004).

Since the LC4MP argues that emotion fundamentally stems from appetitive and aversive activation and is not dependent on cognitive attribution, a thorough understanding of how emotion influences message processing rests on understanding motivational activation and its influences on cognitive processing, that is, motivated cognition. The LC4MP (A. Lang, 2006a, b) proposes that a human being's "old brain" responds to the mediated environment in the same way it responds to the real world. Mediated messages, like any other real stimuli in a physical environment, activate the underlying motivational systems, which in turn influences the experience of emotion and higher levels of cognition, such as information encoding, storage, and retrieval. Mental resources are allocated to the subprocesses of encoding, storage, and retrieval both automatically (e.g., in response to message content and structure) and through controlled allocation mechanisms (e.g., related to the individual's goals). Because mental resources are limited, resource allocation is a competition among the subprocesses.

In particular, based upon the motivational activation functions posited by the dual-motivational theory (Cacioppo & Berntson, 1994; Cacioppo & Gardner, 1999), the LC4MP proposes: on the one hand, the appetitive system is more active than the aversive system in a neutral environment. This is called the "positivity offset" and provides organisms with the impetus to explore the environment and look for food and mates. On the other hand, the aversive system enjoys faster responses and a greater activation rate when the stimuli become more aversive. This is called "negativity bias" and functions to protect organisms from sudden threats. These characteristics of motivational activation are evolutionarily and biologically plausible, and they still affect our television viewing and other mediated experiences today.

Therefore, instead of arguing for the robustness of the excitation transferred, which is not altered by whether the preceding and subsequent messages are positive or negative but only focuses on their excitation or arousal levels, the LC4MP emphasizes the direction of the excitation transferred. The direction of the excitation is determined by directional activation of the motivational systems, which is further determined by the valence dimension of the messages. In typical excitation transfer experiments, context or preceding stimulus emotion has been manipulated using only positive or only negative media messages (e.g., Mundorf, Zillmann, & Drew, 1991; Perry et al., 1997), or a mix of positive and negative messages (e.g., Zillmann, 1971; Mattes & Cantor, 1982). Although some studies considered the valence of preceding stimuli, the emotion of subsequent stimuli varied widely across studies—from provocatively insulting remarks (Zillmann, Bryant, Comisky, & Medoff, 1981) to positive ads (Mattes & Cantor, 1982). These studies are valuable evidence showing the robustness of excitation transfer, but as explicated by the LC4MP, not only the excitation levels but also the direction of the excitation are expected to influence cognitive consequences of excitation transfer. This study systematically manipulates both dimensions of the preceding stimuli and controls for both dimensions of the subsequent stimuli. Their cognitive consequences are related to reconceptualization of the process "transfer" as explained next.

"Transfer" and Time-Dependent Motivational Activation

The second reconceptualization in this paper relates to the notion of the transfer of excitation. When excitation transfer theory was developed, theories of emotion often considered that people experienced arousal and then attributed that arousal to an emotional state (Schachter & Singer, 1962). The concept of attribution was a primary mechanism of emotional experience, and it made good sense to argue that residual arousal from the preceding message was cognitively misattributed to the subsequent message and thereby influenced responses to that message.

In the LC4MP theoretical framework, activation in the motivational systems is embodied as a basic, continuous physiological process. Activation in the motivational systems results in sympathetic nervous system activation (dominant during mobilization of a body's resources, such as fight-or-flight) and causes perspiration. Similarly, as activation in the motivational systems declines, arousal should decline. It is not, however, expected that the activated system goes from on to off in an instant. Rather, because of the time-dependent nature of the system (Wang, Lang, & Busemeyer, 2011; Wang, Morey, & Srivastava, 2010), it is expected that the system will gradually ramp down until it reaches a resting level. Within this conceptualization, the transfer of excitation is simply the reduction in arousal associated with the ramping down in the motivational system. As the motivational system, which is activated by the preceding stimulus, ramps down, it continues to influence processing of the concurrent message. This results in seeming influence of the arousing content of the preceding stimulus on responses to subsequent messages. Then, what is the influence?

Fundamental to the LC4MP is the concept of motivated cognition. Motivated cognition predicts that stimuli in the environment, including mass media stimuli, elicit automatic activation in underlying appetitive and aversive motivational systems, which then fine tune the functioning of the cognitive processing system. Specifically, when the appetitive system is activated, the cognitive and emotional systems are in an information intake or approach mode, and people tend to experience positive feelings. Information intake is associated with parasympathetic nervous system activation (dominant when the body is at rest), which results in heart rate (HR) deceleration; and positive emotional experience is associated with increased activity in the zygomatic (i.e., smiling) muscle. When the aversive system is activated, a different pattern of response is generated depending on the severity of the aversive stimulus. At low levels of aversive activation, the aversive system functions to identify and gather information about the potential threat. Thus, as with appetitive activation, there is increased information intake. Some level of negative emotional experience may also occur and result in increased corrugator (frowning) muscle activity. When negative activation increases, the function of the aversive system will cease information intake as the threat is identified, and shift to decision making and perhaps preparation to take protective action (e.g., hide, flight, or fight). This may lead to a gradual increase in HR, skin conductance, and corrugator activity and a decrease in information encoding, especially for peripheral information. At very high levels of aversive activation, protection is the primary goal of the aversive system and behavioral avoidance may occur, evidenced by yet greater increases in HR, skin conductance, and corrugator, and large decreases in encoding. To illustrate this, imagine that you are watching a very scary television show. Even though you know it is not real, your made-by-evolution body will still demonstrate aversive emotional response. When the arousing content level is high enough to make you hide your eyes (e.g., sufficient aversive activation to elicit behavioral avoidance), your physiological responses may demonstrate increased HR, skin conductance, and corrugator activity, along with a reduction in information encoding. Whereas, at the more moderate levels of aversive activation associated with most television messages, people are more likely to respond with an information intake set (e.g., decreased HR, increased skin conductance, and increased encoding—at least for central information). Similarly, motivational activation also influences resources allocated to storage and retrieval of information. These patterns of physiological, affective, and cognitive responses to positive and negative stimuli are determined by “positivity offset” and “negativity bias” features of motivational systems. Empirical studies have provided rich support for these LC4MP predictions (for a review, see A. Lang, 2006a, b).

Applying the Reconceptulization to the Program Context Effects

Applying the reconceptulization of “arousal” and “transfer” to the specific research situation of program context effects, more arousing programs will result in greater motivational activation. Activation ramps up during the programs, and the motivation systems do not return to zero activation the second the program stops and the ad begins. Instead, motivational activation decays over time. The decay will be slower for conditions where the activation caused by the programs is greater. Sympathetic arousal, indicated by skin conductance responses (SCRs), will reflect this difference in decay of the motivational activation. Thus, LC4MP, like the excitation transfer theory, predicts that sympathetic arousal (indicated by SCRs) will be greater during ads following arousing programs compared to following calm programs, and it will linearly decrease over the time course of the commercial break if the ads are neutral (*Hypothesis 1*). Similarly, the motivational system (appetitive or aversive) that is activated by the valenced program (positive or negative) and dominant during viewing is predicted to remain more active during subsequent neutral ads. Therefore, viewers will show greater positive responses (indicated by zygomatic major activities) and less negative responses (indicated by corrugator supercilii activities) during neutral ads following positive programs compared to following negative programs, and this difference will decrease over time (*Hypothesis 2*). However, it is unclear whether the decay rate of activation will be the same for the appetitive and aversive systems (*Research Question 1*).

Beyond the main effects of program arousing content and valence, the LC4MP reconceptulization predicts the interaction of the two dimensions of emotional programming. The characteristics of motivational activation functions—positivity offset and negativity bias—are proposed to determine mental resource allocation, resulting in differences in cognitive effort and information processing performance. First, for cognitive effort, as appetitive activation increases, the primary goal of the viewer is to take in information from the external mediated environment. The greater the activation, the more resources are allocated to the external focus. This will result in greater activation of the parasympathetic nervous system and slower HR. Aversive activation, on the other hand, is expected to show different influence on resources allocated to external stimulus. At low levels of aversive activation, the parasympathetic nervous system will still be more dominant and cognitive effort to external stimulus will be relatively high, and thus HR will be relatively slow; but as aversive activation ramps up to a certain turning point, the parasympathetic nervous system will be inhibited and cognitive effort to external stimulus will drop, and HR will accelerate. The negative arousing program manipulated in this study is expected to push aversive activation over the turning point, so the following interaction effect of program valence and arousing content is predicted: Cognitive effort (indicated by HR) will be the greatest (indicated by the slowest HR) following a positive arousing program, the lowest (indicated by the fastest HR) following a negative arousing program, and at some place in between following calm programs which are either positive or negative (*Hypothesis 3*).

Encoding and storage of media information is directly determined by the resources allocated to the information. The more resources, the better the encoding and storage. The LC4MP proposes that cognitive effort can predict these subprocesses unless cognitive overload occurs—at which point resources required by processing information exceed resources available and greater cognitive effort will not help information processing any more. Motivationally relevant messages result in automatic allocation of resources to encoding and storage, which determine later retrieval of the encoded and stored information. Hence, unless cognitive overload occurs, the same interaction effect of valence and arousing content proposed for cognitive effort is predicted for recognition (*Hypothesis 4a*) and free recall (*Hypothesis 4b*), which indicate information encoding and retrieval respectively (A. Lang, 2000).

Motivational activation can become associated with stimuli over time through classic conditioning that is similar to Pavlov's dogs and the dinner bell (e.g., Olson & Fazio, 2001). Thus, one might expect that appetitive activation might increase attitudes toward the ads (Aad) and aversive activation might decrease Aad. On the other hand, arousing content has been shown to affect Aad more than valence in that emotional ads are liked more and elicit more positive Aad than non-emotional ads (e.g., Holbrook & Batra, 1987; Hitchon & Thorson, 1995). It has also been suggested that high arousal is the major contributor to positive Aad (Holbrook & Batra, 1987). Interestingly, arousal induced by caffeine has been shown to enhance attitude change after exposure to persuasive messages (for a review, see Martin, Laing, Martin, & Mitchell, 2005). Taken together, Aad is predicted to be greater following positive compared to following negative programs, and following arousing compared to following calm programs (*Hypothesis 5*). Meanwhile, the interaction between program valance and arousing content on Aad will be explored (*Research Question 2*).

Finally, following the prediction that motivational activation will decay during the commercial break, it is predicted that these proposed effects on cognitive effort, recognition, free recall, and Aad will also decrease over the commercial break (*Hypothesis 6*).

Method

Design and Stimuli

This experiment was a 2 (Program Valence: positive, negative) × 2 (Program Arousing Content: arousing, calm) × 3 (Ad Block: Block 1, 2, and 3) repeated-measures factorial design. All factors were within-subjects. Each participant watched four program segments manipulated by the Program Valence × Program Arousing Content design, where four commercial breaks were imbedded by placing nine 30-sec ads after each program segment. The nine ads in each commercial break were categorized into three blocks, with three ads in each block. Each program segment lasted 4.5 min and each commercial break lasted 4.5 min. Thus, the total viewing time was 36 min for each participant. A Latin square design was used to rotate the presentation order of the stimuli. Participants were randomly assigned to one of the presentation orders.

The final stimuli of program segments and emotionally neutral ads were selected based upon a pretest, where 25 undergraduate students rated 12 program segments and 72 neutral ads selected from a pool of television shows aired on major U.S. network channels in 2000s. The 9-point pictorial Self Assessment Mannequin (SAM) arousal and valence scales (M. Bradley & P. J. Lang, 1994) were used to pretest the programs and ads. The four programs which best exemplified arousing positive, arousing negative, calm positive, and calm negative, and the 36 most emotionally neutral ads were selected. A repeated ANOVA on the SAM ratings of the four selected programs showed that the positive programs were more positive than the negative ones, $F(1, 24) = 42.26$, $p < .001$, $\varepsilon^2 = .62$, and the arousing programs were more arousing than the calm ones, $F(1, 24) = 8.81$, $p < .001$, $\varepsilon^2 = .11$ (see Table 1). The selected ads were rated as neutral, with the average valence ratings between 4 and 6, and the average arousal ratings below 4. In addition, perceived familiarity and persuasiveness of the ads were pretested and controlled. The selected ads were unfamiliar (the average ratings were less than 4.5 on a 9-point unfamiliar—familiar scale) and moderately persuasive (the average ratings were between 4 and 5 on a 9-point unpersuasive—persuasive scale). Of the 36 ads, three randomly selected ads were assigned to each ad block, with their product categories (e.g., cars, household goods, medicines) counterbalanced across blocks. Between ad blocks, no significant difference was found on valence, arousal, familiarity, and persuasiveness. The three randomly selected ad blocks composed a commercial break which was randomly paired with a program segment.

[Insert Table 1 about here.]

Dependent Variables

Physiological measures were selected to measure cognitive and affective responses for a couple of reasons. They are less likely to be influenced by factors such as the primacy or recency of emotional memory (Bolls et al., 2001). More importantly, they are time-locked and thus can help reveal the program effects that unfold across the sequence of ads. For all the physiological measures in this study, Coulbourn S-series modules with a LabMaster AD/DA board, synchronized by VPM 12.1 software (Cook III, 2000), was used for data acquisition.

Sympathetic arousal was indicated by frequency and amplitude of SCRs. More frequent and larger SCRs indicate increased activation in the sympathetic nervous system (Hopkins & Fletcher, 1994). The skin conductance data were acquired through two 7-mm Ag/AgCl electrodes placed on the non-dominant palmar surface, which applied a .5 volt AC excitation (Edelberg, 1967; M. Bradley & P. J. Lang, 2000). The range was 1 to 50 μSiemens, and the sensitivity was 50 millivolts/μSiemens. The sampling rate was 20 Hz. Offline, the SCR frequency and amplitude were scored for each ad.

Hedonic valence responses to ads were indicated by zygomatic and corrugator facial electromyography (EMG). Larger zygomatic EMG indicates positive emotional experience, and larger corrugator EMG suggests negative emotional experience (Hubert & de Jong-Meyer, 1990).

Zygomatic EMG data were acquired by two 4-mm Ag/AgCl electrodes under the left cheek (the zygomatic major muscle), and corrugator EMG by two 4-mm Ag/AgCl electrodes at the medial end of the left eye brown (the corrugator supercilii muscle). Contact impedance smaller than 10 KΩ was obtained before data collection started. The data were amplified 5000 ×, band-pass filtered 10 to 1000 Hz, and sampled at 20 Hz. Offline, the data were converted to Z scores for each participant (Hazlett & Hazlett, 1999; S. Bradley, 2007).

Cognitive effort to process ads was indicated by HR. During external attention, activation of the parasympathetic nervous system increases, resulting in measurable decreases in HR (Cacioppo, Tassinary & Berntson, 2000). Previous empirical research has largely supported the "intake-rejection" hypothesis (e.g., Lacey, 1967) of HR deceleration, which argues that cardiac deceleration facilitates information intake from the external environment. This has been shown during viewing TV (e.g., A. Lang, 1994; A. Lang et al., 2005; Fox et al., 2004). HR data were acquired through two 7-mm Ag/AgCl electrodes placed on right and left forearms. The high pass was 8 Hz and the low pass was 40 Hz. The amplifier coupling was 1 Hz and the gain was 5000. The interval between heart beats were recorded in ms and then the data were converted to beats per minute (BPM).

Recognition of ad content was assessed using four-alternative multiple choice questions. One recognition question was asked about the major audio claim in each ad, and questions were randomized. The test was administered by MediaLab software (Jarvis, 2002). A score of 1 was assigned to a question if the answer was correct; otherwise, a score of 0 was assigned.

Free recall, sometimes described as unaided recall, was measured for advertised brand names and content. Participants were asked to take 10 minutes to "write down the brand name and the ad content" for as many ads as they could remember. Two graduate students served as coders after three hours of training. In the inter-coder reliability test using randomly selected 20 recall answers, they reached 100% agreement. They coded all recall answers independently and the average of their scores was used as the final free recall score for each ad. Free recall for the brand name and for the ad content were scored and analyzed separately.[1]

Aad was assessed by summing four 9-point Likert scales compiled from previous Aad research (Miniard, Bhatla, & Rose, 1990; Yoon, Bolls, & A. Lang, 1998). The four scales were anchored by unpersuasive—persuasive, uninformative—informative, unbelievable—believable, and not likable—likable. For easier interpretation and comparison with other self-report variables, the raw Aad scores, which ranged from 4 to 36, were linearly transformed onto a 0-1 scale. Cronbach's α tests showed reasonable internal reliability of the four-item Aad scale ($M = .78$, $SD = .14$).

Participants and Experimental Procedure

Seventy undergraduate students at a large Midwestern university participated in this experiment for extra course credit. They were 18-27 years old ($M = 19.80$, $SD = 1.50$). Thirty-six (51.43%) were female; 54 (77.14%) were White and the others included Blacks, Asians, and Hispanics. SCR data were missing for two participants due to an equipment malfunction and HR data for four participants were excluded due to large movement artifact.

Participants completed the experiment individually and each took about 1.5 hours. After the participant was greeted and informed of the experiment procedures, consent was obtained. The experimenter attached electrodes to the participant as described above and an additional 7-mm Ag/AgCl electrode for grounding on the left forearm. While attaching the electrodes, the experimenter explained to the participant how the data collection procedures worked, and tried to relax the participant. The participant was instructed to watch television as if she/he was at home. Then, the stimulus video was played on a 17 inch computer monitor without pause. Physiological data were collected during viewing ads. After viewing, the participant completed a 15-min distractor task, and then answered the tests on free-recall, recognition, and finally Aad.

Results

Sympathetic Arousal

Supporting *Hypothesis 1*, the program arousing content significantly affected SCR frequency and amplitude during subsequent ads processing, $F(1, 67) = 21.89$, $p < .001$, $\varepsilon^2 = .24$ and $F(1, 67) = 8.75$, $p < .005$, $\varepsilon^2 = .10$ respectively. Compared to ads following calm programs, those following arousing programs elicited higher SCR frequency ($M_{arousing} = 1.08$, $SE = .15$; $M_{calm} = .77$, $SE = .11$) and larger SCR amplitude ($M_{arousing} = .70$, $SE = .10$; $M_{calm} = .54$, $SE = .09$). Also as predicted, SCR frequency and amplitude decreased over the ad blocks, $F(1, 134) = 8.58$, $p < .001$, $\varepsilon^2 = .10$ and $F(2, 134) = 13.52$, $p < .001$, $\varepsilon^2 = .16$ respectively. This is shown in Figures 1 and 2. Program valence was not expected to affect SCRs, and it did not.

[Insert Figures 1 and 2 about here.]

Further, the decay patterns of the appetitive and aversive activation were examined. Trend analyses were conducted on SCR frequency and amplitude for the positive and negative program conditions. For the frequency data, a significant linear decay trend emerged for both the positive and negative program condition, $F(1,67) = 11.50$, $p < .005$, $\varepsilon^2 = .13$ and $F(1,67) = 4.83$, $p < .05$, $\varepsilon^2 = .05$, respectively. Similarly, for the amplitude data, a significant decreasing linear trend was found for both the positive and negative program conditions, $F(1,67) = 14.86$, $p < .001$, $\varepsilon^2 = .17$ and $F(1,67) = 8.49$, $p < .01$, $\varepsilon^2 = .10$, respectively. No higher degree polynomial trend was observed. As shown in Figures 3 and 4, the decreasing rate in the two valence conditions suggests that the appetitive system (dominant during the positive program context) had a more rapid decay compared to the aversive system (dominant during the negative program context), especially during the first two blocks. This difference, however, did not reach statistical significance.

[Insert Figures 3 and 4 about here.]

Hedonic Valence Responses

Hypothesis 2 is not supported. There were no significant effects of program valence (all Fs < 1) on zygomatic activity although the means were in the predicted direction (M_{pos} = .011, *SE* = .12; M_{neg} = .006, *SE* = .12). No significant effects of valence were found on corrugator data either (all Fs <1) although, again, the means were in the predicted direction (M_{pos} = -.003, *SE* = .07; M_{neg} = .002, *SE* = .07). No effect was expected from program arousing content on the facial EMG data and none was found.

Cognitive Effort

Hypothesis 3 was partially supported by a significant Valence × Arousing Content interaction on HR during the first ad following the programs, $F(1, 64) = 5.66$, $p < .05$, $\varepsilon^2 = .07$ (see Figure 5). The means showed a pattern similar to but not exactly the one predicted. Unexpectedly, HR was the slowest following negative calm messages—followed, as expected, by positive arousing, positive calm, and finally negative arousing with the fastest HR ($M_{calm\text{-}neg}$ = 73.65, *SE* = 1.24; $M_{arousing\text{-}pos}$ = 73.98, *SE* = 1.21; $M_{calm\text{-}pos}$ = 74.56, *SE* = 1.36; $M_{arousing\text{-}neg}$ =75.21, *SE* = 1.36). Planned post-hoc comparisons showed that HR following the negative arousing program was faster than that following the negative calm and positive arousing programs, $t(64)$ = 2.82, $p < .01$ and $t(64) = 1.72$, $p = .09$, respectively. Other pairwise comparisons were not significant or marginally significant. In addition, supporting *Hypothesis 6,* the Valence × Arousing Content interaction effect on HR during the first ad disappeared by the end of the first ad block and HR had become similar to each other across conditions.

[Insert Figure 5 about here.]

Recognition, Free Recall, and Aad

To test *Hypotheses 4a* and *4b* concerning the Valence × Arousing Content interaction effect as well as *Hypothesis 6* concerning the decay of the effects across ad blocks, first, MANOVA for repeated measures was conducted on recognition, free recall of the brand name, free recall of the ad content, and Aad simultaneously to test the overall effects on these variables from the Valence × Arousing Content × Block treatment. Hotelling's T^2 was significant for all the main effects and interaction effects (all *p*s < .01). Among these effects, the Valence × Arousing Content interaction effect pertains to our *Hypotheses 4a* and *4b*, $F(4, 65) = 4.45$, $p < .005$. Following this omnibus test, ANOVAs were conducted on each variable to specify the effects.

Recognition of Ad Content. *Hypothesis 4a* is supported by the significant Valence × Arousing Content interaction on recognition data of the first two ad blocks, $F(1, 69) = 5.17$, $p < .05$, $\varepsilon^2 = .06$, although this interaction was not significant on the data of all three blocks, $F(1, 69) = 2.05$, $p = .16$, $\varepsilon^2 = .02$. Both showed the same predicted pattern of means (see Figure 6). Of the first two blocks, recognition in the positive arousing condition was significantly better than the negative arousing condition, $t(69) = 2.10$, $p <.05$, but the remaining pairwise comparisons were not significant. Main effects of valence and arousing content on recognition were not predicted and indeed were not significant.

Supporting *Hypothesis 6*, the context effects on recognition decayed across ad blocks, and across conditions, recognition became similar over time. There was a significant interaction of Valence × Arousing Content × Block, $F(2, 138) = 3.30$, $p < .05$, $\varepsilon^2 = .03$, as shown in Figure 7. The Valence × Arousing Content interaction was significant during the first two blocks (*p*s < .05), but disappeared during the last block ($F < 1$). During the last bock, there was no difference between means (all *F*s < 1). This also explains why, as reported earlier, the Valence × Arousing Content interaction was significant over the first two blocks, but not over all the three blocks.

[Insert Figures 6 and 7 about here.]

Free Recall of the Brand Name. *Hypothesis 4b* predicted the same Valence × Arousing Content interaction on recall as for cognitive effort and recognition. First, this was tested on recall of the brand name, and it was significant, $F(1, 68) = 4.30$, $p < .05$, $\varepsilon^2 = .05$. As shown in Figure 6, the means are in the predicted direction. Further planned comparisons revealed: recall in the positive arousing condition was better than that in the negative arousing and positive calm conditions (ps < .05), but recall in the negative arousing condition was not significantly poorer than that in the calm conditions although it was the lowest as predicted. No significant main effect of valence and arousing content was expected, and indeed neither was found.

Hypothesis 6 predicted the decay of the program context effects on recall. For the recall of the brand name, this is partially supported. During the first block, the main effect of valence was marginally significant, $F(1, 68) = 3.09$, $p = .08$, $\varepsilon^2 = .03$, and the main effect of arousing content is not significant but still showed a small effect size, $F(1, 68) = 2.64$, $p = .11$, $\varepsilon^2 = .02$. However, these effects disappeared during the second and third blocks (Fs < 1). There was not any significant interaction effect of valence and arousing content at the level of a single block.

Free Recall of the Ad Content. Partially supporting *Hypothesis 4b*, recall of the ad content was significantly affected by the Valence × Arousing Content interaction, $F(1, 68) = 10.10$, $p < .005$, $\varepsilon^2 = .12$. As seen in Figure 6, recall for the negative calm condition unexpectedly was the best—then, as expected, followed by the positive arousing, positive calm, and finally negative arousing condition. Recall of the ad content in the negative calm and positive arousing conditions were significantly better than the other two (ps <.05), and they were not different from each other ($F < 1$). The other two conditions were not different from each other. It is worth noting that this is the exact pattern found with HR data. Significant main effects of valence and arousing content were not expected and neither was found. In addition, the significant Valence × Block interaction, $F(2, 136) = 4.07$, $p < .05$, $\varepsilon^2 = .04$, shown in Figure 8, demonstrates that recall indeed became similar across blocks as predicted by *Hypothesis 6*. Block did not significantly interact with the program arousing content.

[Insert Figure 8 about here.]

Attitudes toward the Ads. Supporting the prediction of *Hypothesis 5* on arousing content, Aad was greater when following arousing (M = .55, SE = .002) than when following calm programs (M = .53, SE = .002), $F(1, 69) = 99.02$, $p < .001$, $\varepsilon^2 = .58$. However, opposite to the prediction of *Hypothesis 5* on valence, Aad was greater when following negative (M = .54, SE = .002) than when following positive programs (M = .53, SE = .002), $F(1, 69) = 13.01$, $p < .005$, $\varepsilon^2 = .15$. In addition, the Arousing Content × Block interaction, $F(2, 138) = 34.93$, $p < .001$, $\varepsilon^2 = .33$, and the Valence × Block interaction, $F(2, 138) = 29.56$, $p < .001$, $\varepsilon^2 = .29$, revealed that the main effects of arousing content and valence were significant during the first and the second block (ps < .005); but in the third block, Aad became similar across conditions. This supports *Hypothesis 6.*

In addition to their main effects, program arousing content and valence also interacted with each other to influence Aad, $F(1, 69) = 17.42$, $p < .001$, $\varepsilon^2 = .19$. Again, the arousing positive condition trumped other conditions (see Figure 6). However, it is closely followed by the arousing negative condition ($F < 1$). At calm levels, the calm negative condition had significantly higher Aad than the calm positive condition ($p < .005$). In addition, this two-way interaction was tempered by block, $F(2, 138) = 43.69$, $p < .001$, $\varepsilon^2 = .38$. As Figure 9 shows, first, immediately following the program, Aad was better for the positive program than the negative one only when the programs were arousing ($p < .005$); second, for the first two blocks, Aad was the worst for calm positive programs ($p < .005$); third, by the third block there were minimal program context differences remaining on Aad, which supports *Hypothesis 6.*

[Insert Figure 9 about here.]

The results were summarized in Table 2.

Discussion

This study attempts to reconceptualize excitation transfer theory from the theoretical perspective of the LC4MP. It extends our understanding of excitation transfer in three ways. First, it provides evidence that appetitive and aversive motivational activation and decay are plausible mechanisms for excitation transfer phenomena, such as program context effects. Second, it demonstrates the importance of simultaneously considering both the valence and arousal dimensions of emotion and studying their interaction effects on cognitive responses as the LC4MP emphasizes. Third, the data show how the excitation transfer process can be explained by time-dependent motivational activation changes, which unfold over time and therefore must be studied over time to be better understood.

Motivational Activation and Affective Responses

Not surprisingly—and as would be predicted by the excitation transfer theory—arousing programs elicited sympathetic arousal, as evidenced by skin conductance data, which carried over into the commercial break. However, surprisingly, there were no significant carryover effects of program valence on either zygomatic or corrugator EMG, though the means were in the predicted directions. One possible explanation is that facial EMG responds to the here and now, but does not exhibit carryover effects. In other words, it is possible and in retrospect, even plausible, that facial musculature responds to immediate experience as it is occurring but the response disappears quickly at the offset of the experienced event. As a result, when the emotional programming ends, the facial EMG activity ends or decreases rapidly. Indeed, further analysis on EMG data during programs showed expected response patterns during the negative vs. positive program condition, and no EMG activity during the subsequent neutral commercial break as we would expect if the facial muscles were responding in real-time to the lack of emotion during the ads. This reaction pattern of facial EMG needs further research.

Motivational Activation and Cognitive Responses

Supporting the theorized “positivity offset” and “negative bias” features of motivational activation in mediated information processing, this study found a quite robust interaction effect between program valence and arousing content on cognitive responses to subsequent ads. This emphasizes the importance of considering both the valence and arousal dimensions in excitation transfer research as our LC4MP reconceptualization aims to do.

Cognitive effort, as expected, was high following arousing positive programs which presumably elicited strong appetitive activation and low following arousing negative programs which presumably elicited strong aversive activation. They suggest that neither arousing content nor valence alone are driving cognitive effort; rather, the combination of which motivational system is activated (related to the preceding stimulus valence) and how intensely it is activated (related to the preceding stimulus arousing content) influences the level of cognitive effort. In addition, although initially cognitive effort during neutral ads seems to be driven by the preceding program context, across the commercial break the effect of motivational activation wanes and cognitive effort becomes similar. In general, the recognition and recall data support the prediction that following emotional programs, information encoding and storage were at the level predicted by the motivational activation elicited by the programs. However, by the end of nine neutral ads, there was no difference remaining, suggesting that the motivational systems had returned to near resting levels. It is worth pointing out that although HR decelerations can be attributed by the dynamic relationship between the activations of parasympathetic and sympathetic nervous systems, including increased parasympathetic and/or decreased sympathetic activation (Cacioppo et al., 2000), the consistent patterns of the HR data and the memory data, especially the free recall of ad content, suggest that decreased HR in this research context indicates increased parasympathetic activation concomitant to cognitive effort to external stimuli.

Finally, the Aad data are interesting. As expected, more arousing context led to greater Aad; but unexpectedly, the main effect of valence showed that ads following negative, rather than positive, programs received better Aad. However, when the data were compared across the three ad blocks, it appeared that the predicted direction indeed occurred, but only when ads immediately followed the arousing programs. Following calm programs, Aad was better when the program was negative rather than positive during the first two ad blocks. There are two possible reasons. First, it is possible that only when motivational activation is strong (in this case, when it is greatly activated by arousing content and has not decayed much yet), the appetitive activation results in better Aad than the aversive activation. Second, for the calm programs used in this study, the negative program was rated more arousing than the positive program although this difference was not significant. Thus, it is possible that better Aad following the negative calm program was caused by relatively more arousing—although not significantly different—content of the negative calm program. Both possibilities are consistent with the documented positive effect of arousal on attitude (Holbrook & Batra, 1987; Martin et al., 2005). Also, the HR, recognition and recall data support the second reason: when the programs were calm, the negative condition showed slower HR (indicating larger cognitive effort), better recognition and recall than the positive condition although these differences mostly were not statistically significant. Additionally supporting the strong effect of arousing content on Aad, the greatest Aad was when ads followed arousing programs, both positive and negative. These created a different valence and arousing content interaction pattern than that of the other cognitive variables examined in this study.

Decay of Motivational Activation and Program Context Effects over Time

The real-time physiological measures associated with the LC4MP provide opportunities to explore the time course of the excitation transfer process—specifically in this study, the program context effects during 0:00-1:30, 1:31-3:00, and 3:01-4:30 after the programs. First, the results show that physiological arousal of a viewer decayed across ads in a linear fashion, but still remained larger after nine ads (4.5 minutes) when they followed arousing programs. This indicates that motivational systems activated during viewing emotional television content, such as popular shows *Friends* and *Fear Factor* used in this experiment, do not return to their resting levels of activation even after 4.5 minutes. Because most commercial breaks embedded in television programs actually are shorter than 4 minutes, media planning and advertising professionals should take into account the program context effect in their practice. Furthermore, the decay pattern suggests that the more closely an ad follows a program, the more likely it will be affected by the program's elicited motivational activation. Also, the larger the motivational activation during the program, the stronger and longer the influence of this activation will be on processing following ads. These may seem intuitively simple, but physiological data in this study provided solid real-time evidence for these theory-driven propositions.

The "positivity offset" and "negativity bias" features of motivational activation proposed in the LC4MP theoretical framework have been tested and generally supported in empirical studies, including the current study. However, do the decay patterns also differentiate these two motivational systems? This is an interesting new question and may be crucial for explaining some media effects such as more enduring effects of violent media (e.g., Bushman & Bonacci, 2002). This study did not find significant differences in decay patterns for appetitive and aversive activation, but it is possible that such a difference theoretically exists. Considering their different adaptive functions, it is plausible that the two motivational systems deactivate in different fashions when a stimulus is no longer presented. It is plausible that the aversive system, which has a quicker activation speed adaptive to the quick onset of danger (i.e., "negativity bias"), decays more slowly compared to the appetitive system. In the physical environment, an aversive stimulus (e.g., a predator or a nature disaster) can be life-threatening. Therefore, although the danger is out of sight, it is probably an adaptive advantage not to throw it out of mind immediately, but instead, be protective for a while until the organism is more certain that the environment has become safe. Hence the aversive system should deactivate relatively slowly at the offset of an aversive stimulus and return to its resting level after further incoming information has justified a safe environment. In contrast, generally an appetitive stimulus (e.g., a sex partner or food) is not as critical to survival as an aversive stimulus—at least in a short time period. Therefore, when an appetitive stimulus disappears, it does not seem necessary to keep an eye on the disappeared stimulus. Instead, it is probably more beneficial for the organism to move on and search for other positive things. SCR data in this study suggests this difference of the decay functions, but the difference was not significant. As discussed earlier, decay of motivational influences was also observed in cognitive and attitudinal data although their changes across time blocks were less smooth than what was observed in the sympathetic arousal data. This probably reflects more complicated functions of motivational activation, both sympathetic and parasympathetic activation, as well as nonlinear decay of the cognitive processes. Future research should continue to explore this question by manipulating more positive and negative stimuli to increase the variance between experimental conditions and thus increase the observed effect size. In addition, a longer time period of decay should be examined to observe more complete decay trajectories, and more sophisticated dynamic analytic methods, such as time series and cognitive computational modeling, should be employed to analyze the decay patterns.

In all, the results of this study suggest that program context effects are particularly important in the first minute or two of a commercial break. As the commercial break goes on, motivational activation decreases and so do its effects on subsequent ad processing. From a practical point of view, these results suggest that if you are buying an ad spot, you need different media plans depending on your ad campaign strategies. If the strategy is to help increase viewers' memory of the advertised content or brand (i.e., informative ads for new products or new features of a product), you may want to buy ad spots following positive arousing programming and to avoid negative arousing programming. When the strategy is to help augment the likeness or evaluation of the ad, arousing programming seems to be a better choice than calm programming. However, all these are talking about neutral ads. This study did not examine how program context will affect the processing of emotional ads, and future research should explore that. In addition, this study pretested and selected stimuli using self-report data, and examined the context effects using physiological measures. Future research is needed to compare people's responses to emotional messages revealed by these two types of measures. A few other limitations require further examination, including: First, in this study, only one recognition question targeting the major claim was tested for each ad. Future research should include tests on both main and peripheral detailed information of the ads to further specify how arousing content and valence influence the recognition memory (e.g., Burke, Heuer, & Reisberg, 1992). Second, to increase external validity, real commercial breaks in real programs should be used. Finally, employing time series analytic methods (Wang et al., 2010; Wang et al., 2011), future research should better model the dynamic responses to continuously changing messages.

Note:

1. Free recall of the brand name was coded as either 0 (failed to recall) or 1 (successfully recalled). Free recall of the ad content was coded as the sum of the following two scores. First, overall whether the main content of the ad was recalled was coded as 0 (failed to recall any

content), .5 (partially correctly recalled the main content), or 1 (correctly recalled the main content). Second, .5 point was given to any visual or audio content detail that was correctly recalled (e.g., “a woman in blue suit” “green zucchinis were shown in the refrigerator,” and “give 10 years back to the look of your skin”), and up to 2 points can be awarded for the details. Thus free recall of the ad content range from 0 to 3.

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Table 1. Program Segments Used to Manipulate the Program Contexts.

Condition	*Title*	*Genre*	*Content*	*Valence M (SD)*	*Arousal M (SD)*
Positive and calm	*Donny and Marine*	Talk show	Showing how to make stewed lamb.	5.88 (1.27)	2.64 (1.29)
Negative and calm	*Local News (New York)*	News	Local news on closed hospital, theft, fires, and hit and run.	3.82 (1.60)	3.60 (2.19)
Positive and arousing	*Friends*	Situation comedy	Hilarious conversations about sex among close friends.	8.08 (1.32)	5.96 (2.34)
Negative and arousing	*Fear Factor*	Reality show	A contest of chewing and eating worms in a dark cave.	2.64 (1.36)	6.44 (1.94)

Note: The valence and arousal scales are 9-point Likert scales, where 1 identifies "very negative/unpleasant" and 9 indicates "very positive/pleasant" for the valence scale, and 1 identifies "very calm/boring" and 9 indicates "very arousing/exiting" for the arousal scale.

Table 2. Summary of Results.

Hypothesis/Research Questions	*Measure*	*Finding*	*Supported*
H1: Greater sympathetic arousal during ads following arousing programs, and decrease of arousal over the commercial break	SCRs	Higher SCR frequency and larger SCR amplitude for arousing conditions; Decreased SCR frequency and amplitude across ad blocks	Yes
RQ1: Decay functions for the appetitive and aversive systems	SCRs	Faster decay of the aversive system, but not significant	—
H2: Greater positive response and less negative response during ads following positive programs	zygomatic and corrugator EMG	Larger zygomatic for positive, but not significant; larger corrugator for negative, but not significant	No

H3: An interaction between program valence and arousing content on cognitive effort: the greatest when following a positive arousing program, and the smallest when following a negative arousing program	HR	Significant Valence × Arousing Content interaction during the first ad: fastest HR for negative arousing than for positive arousing and negative calm	Partial
H4a: An interaction between program valence and arousing content on recognition: the best when following a positive arousing program, and the worst when following a negative arousing program	recognition	Significant Valence × Arousing Content interaction during the first two ad blocks: Better recognition for positive arousing than for negative arousing	Yes
H4b: An interaction between program valence and arousing content on free recall: the best when following a positive arousing program, the worst when following a negative arousing program	free recall of the brand name and the ad content	Significant Valence × Arousing Content interaction for both recall measures: better free recall of the brand name and the ad content for positive arousing than for negative arousing	Yes
H5: Better Aad when following arousing programs; better Aad when following positive programs.	Aad scales	Main effect of valence and arousing content: higher Aad score for arousing and for positive programs	Yes
RQ2: An interaction between program valence and arousing content on Aad	Aad scales	Valence × Arousal interaction on Aad: better Aad for arousing positive and arousing negative	
H6: Cognitive effort becomes similar across conditions overtime	HR, recognition, free recall, and Aad	Significant interactions between ad block and program emotional context, and/or significant program emotional context effects during the earlier ads or blocks, which disappeared in later ads or blocks	Yes

Figure 1. SCR Frequency per Block Decreased across Ad Blocks (*M*s with Error Bars Representing *SE*s)

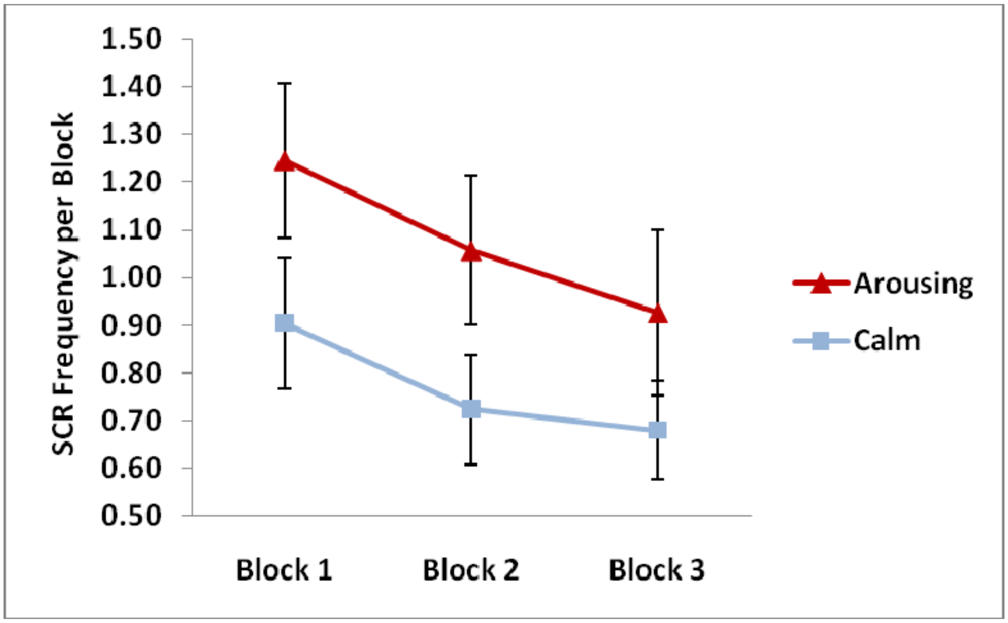

Figure 2. SCR Amplitude (μs) Decreased across Ad Blocks (*M*s with Error Bars Representing *SE*s)

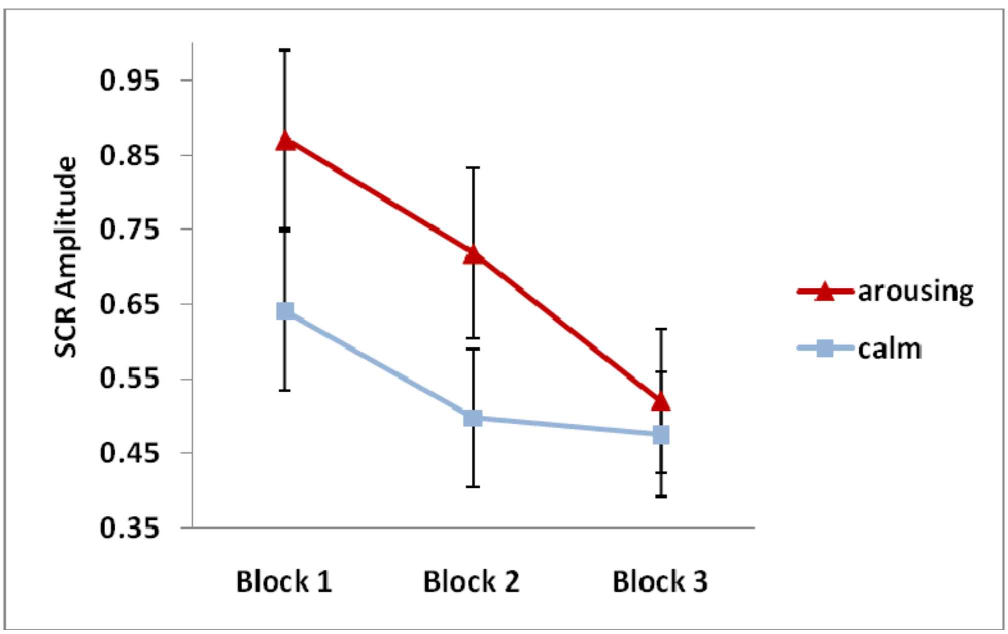

Figure 3. The Linear Decreasing Trends of SCR Frequency per Block for the Positive and Negative Conditions (*M*s with Error Bars Representing *SE*s)

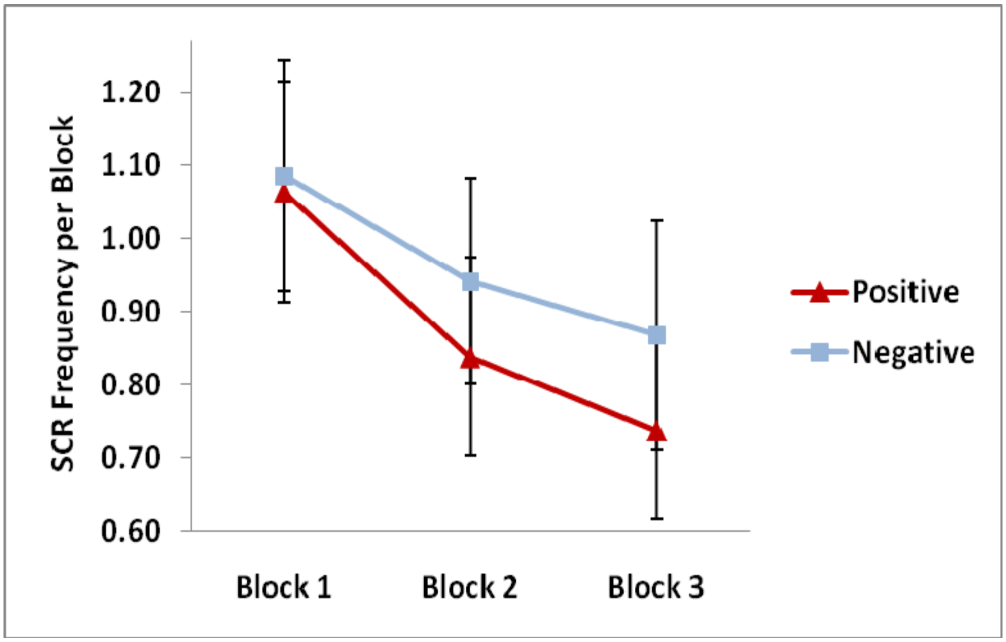

Figure 4. The Linear Decreasing Trends of SCR Amplitude (*μs*) for the Positive and Negative Conditions (*M*s with Error Bars Representing *SE*s)

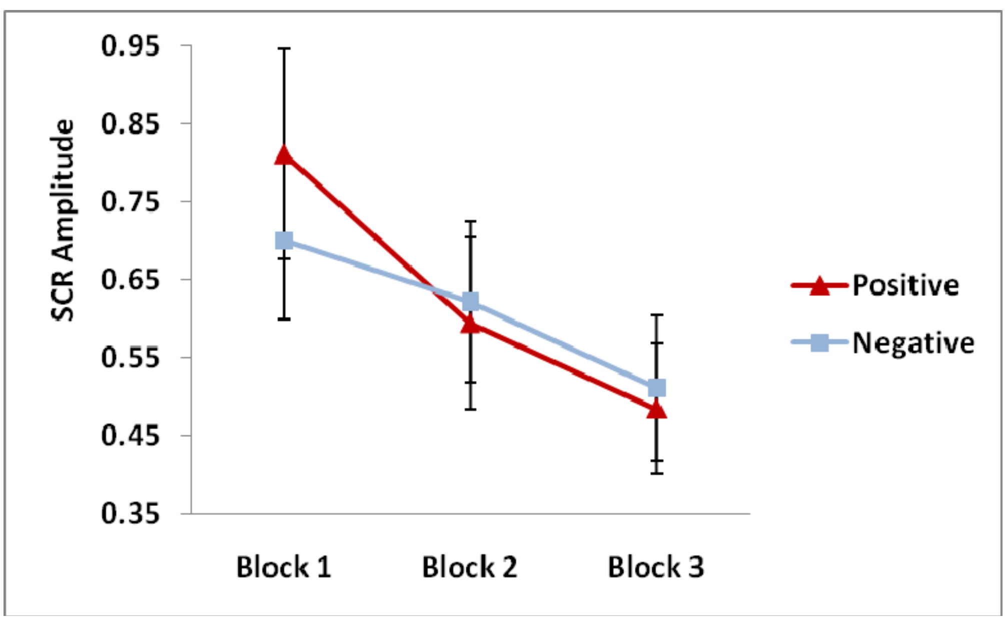

Figure 5. The Valence × Arousal Interaction on HR (bpm) during the First Ad (*M*s with Error Bars Representing *SE*s)

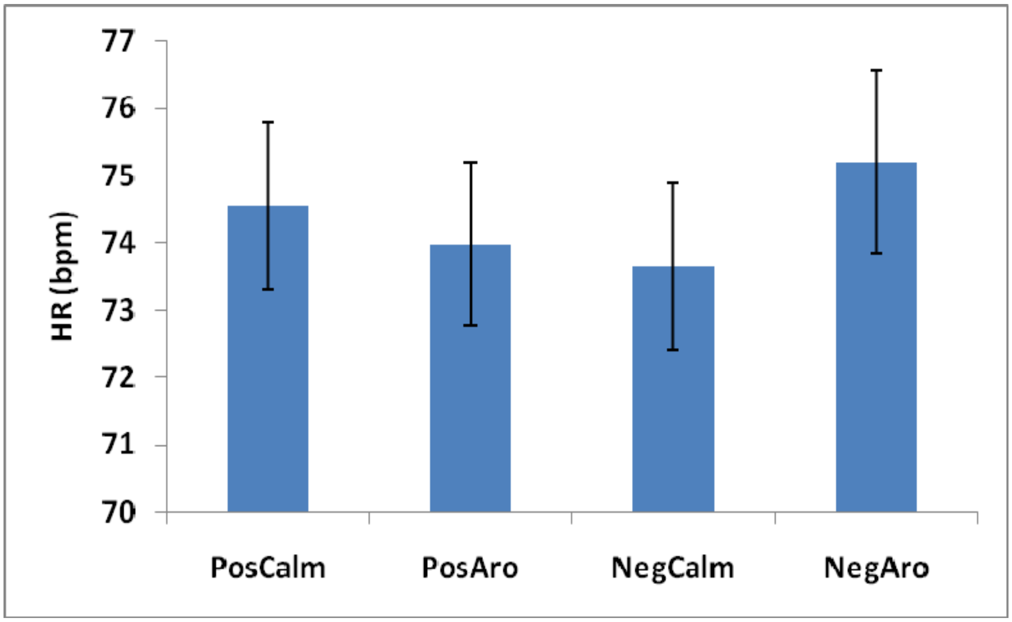

Figure 6. The Valence × Arousal Interaction on Recognition, Free Recall of the Brand Name and the Ad Content, and Aad (*M*s with Error Bars Representing *SE*s)

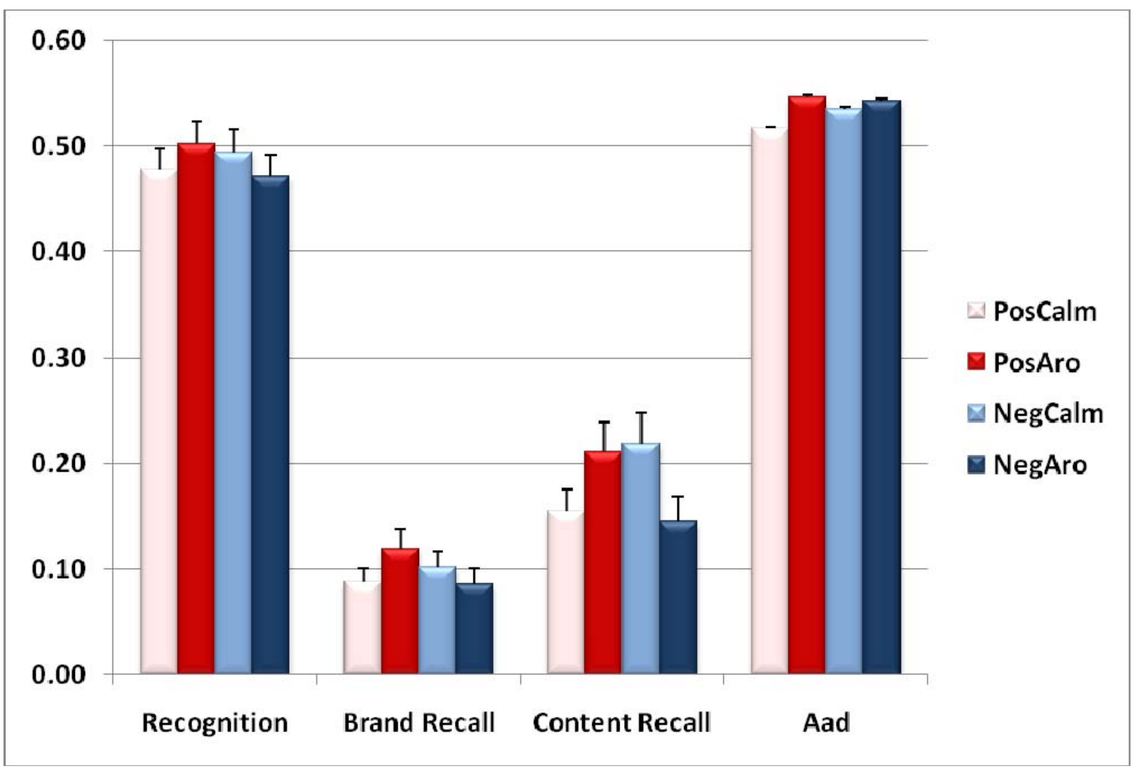

Figure 7. The Valence × Arousal × Block Interaction on Recognition (*M*s with Error Bars Representing *SE*s)

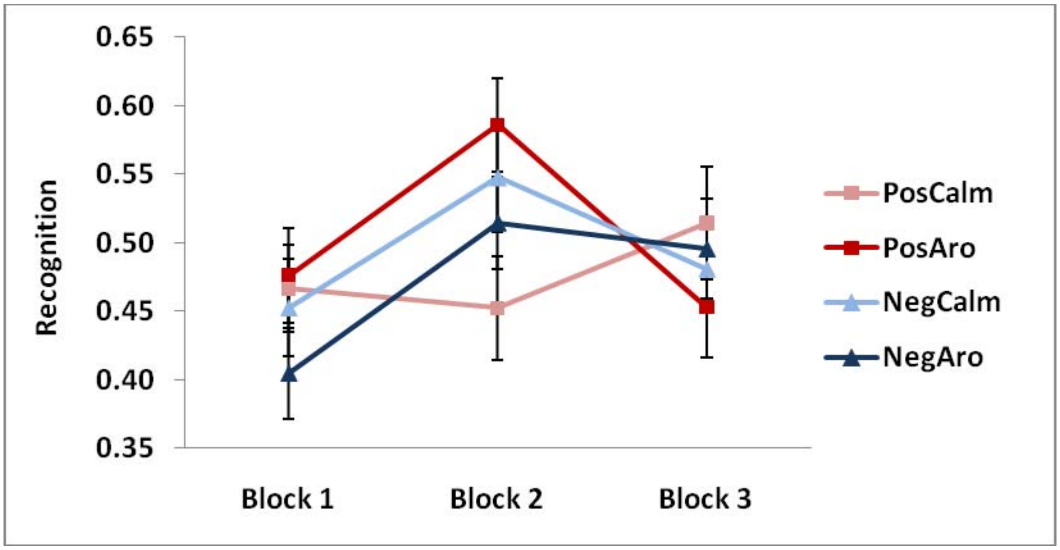

Figure 8. The Valence × Block interaction on Free Recall of the Ad Content (*M*s with Error Bars Representing *SE*s)

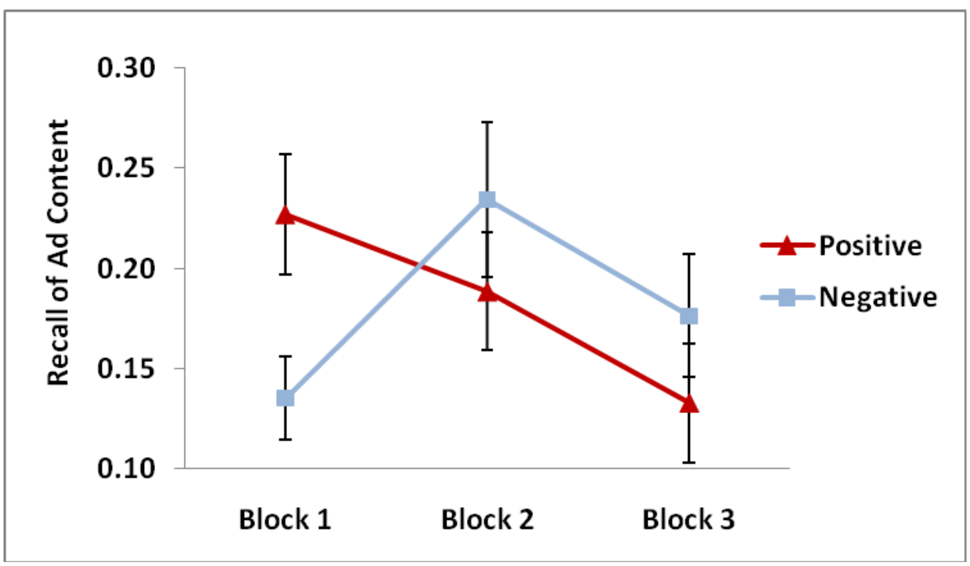

Figure 9. The Valence × Arousal × Block Interaction on Aad (*M*s with Error Bars Representing *SE*s)