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Sexy and humorous content increase attention and memory for television advertising. This paper suggests that different biological mechanisms underlie their similar effects. Results show that sexy content elicits immediate appetitive activation and increased resource allocation. Humorous content elicits an incongruity/mismatch orienting response followed by an increase in appetitive activation, resulting in increased resource allocation and memory for the humorous ads. More resources are allocated to ads with an overall unpleasant compared to pleasant tone and the addition of sexy and humorous content to unpleasant compared to pleasant ads results in better memory.

Keywords: Sex; Humor; Motivation; Processing; Limited capacity; Advertising

A great deal of research has shown that two commonly used and effective features of advertising are the inclusion of sexy and/or humorous content. Research demonstrates that both lead to increased attention to and memory for advertising as well as increasingly positive emotional experiences (Cline & Kellaris, 2007; Eisend, 2009; Reichert, 2002, 2003; Reichert & Carpenter, 2004; Soley & Reid, 1988; Woltman Elpers, Mukherjee, & Hoyer, 2004). Although these effects have been amply demonstrated, researchers know little about the biological and cognitive mechanisms that produce these effects or whether the same or different mechanisms are operating for sexy and humorous content.

The study reported here uses the Limited Capacity Model of Motivated Mediated Message Processing (A. Lang, 2006a, 2006b; A. Lang, Sanders-Jackson, Wang, &

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Rubenking, 2013) to test the prediction that slightly different biological mechanisms underlie the processing of sexy and humorous advertising. The study predicts that sexy content activates the underlying mechanism of automatic activation in the biological appetitive (approach) motivational system and the resulting appetitive activation then leads to increased attention and memory for the messages. In contrast to the prediction about sexy content, the study predicts that humorous content elicits an automatic mismatched content/novelty orienting response that increases attention, followed by a sense of pleasure once the humor has been cognitively processed. This process then leads to self-initiated activation of the appetitive system resulting in increased memory and positive experience.

Motivational and Emotional Model

The LC4MP is a motivated cognitive model that conceives of humans as limited capacity information processors and conceives of cognition as being modulated by biological motivational activation. Information processing involves three subprocesses —encoding, storage, and retrieval (A. Lang, 2000). Encoding involves the selection of information in the message and the creation of a cognitive representation of the message. Storage involves linking encoded information to previously stored information and improves as the number of linkages to existing knowledge structures increases. Retrieval is the ability to retrieve previously stored information. The operation of these sub-processes requires cognitive resources that are allocated through controlled and automatic mechanisms. Automatic mechanisms are defined as responses to a stimulus that are fast (i.e., occur within milliseconds of stimulus onset), cannot be stopped, and are outside conscious awareness. The two theorized mechanisms for automatic resource allocation are the orienting response and activation in the biological motivational systems.

The orienting response (OR) is an attentional reflex comprised of a group of behavioral and physiological indicators elicited by stimuli that are novel (i.e., things that are new or unexpected in the environment) or the signaling of stimuli (i.e., things that signal important or relevant information). The elicitation of an OR leads to the automatic allocation of resources to the process of encoding the stimulus that elicited it (Ohman, 1979, 1997). This increase has been shown to briefly increase memory if sufficient resources are allocated to encode the new information (A. Lang, 1990; A. Lang, Geiger, Strickwerda, & Sumner, 1993; A. Lang, Kurita, Gao, & Rubenking, 2013).

The presence of motivationally relevant material is thought to automatically activate the motivational systems resulting in the allocation of resources to processing the material. Research has provided evidence that more resources are allocated to processing motivationally relevant content and that those resources are actually used to process the motivationally relevant content (A. Lang, Kurita et al., 2013). Thus, motivationally relevant content tends to increase attention (defined as the increased allocation of resources) and memory (because those resources are actually used to encode and store the motivationally relevant content).

The dual system motivational model incorporated into the LC4MP assumes that the human motivational system is comprised of two independent motivational systems, the appetitive or approach system and the aversive or defensive/avoidance system (Cacioppo, Gardner, & Berntson, 1999). These systems have evolved to automatically activate in response to motivationally relevant (i.e., opportunities and threats) information in the environment so as to promote survival and goal fulfillment (Bradley & Lang, 2000; Cacioppo et al., 1999; P. J. Lang, 1995). Activation in the motivational systems, in turn, underlies emotional experience with appetitive activation leading to positive emotional states, aversive activation leading to negative emotional states, and simultaneous activation (or co-activation) of the systems leading to mixed or ambivalent emotional states (Cacioppo et al., 1999; P. J. Lang, 1995).

Stimuli that represent opportunities or threats (both for the species as a whole and for a given individual in an environment) are motivationally relevant and will elicit automatic activation. The more intense or immediate the opportunity or threat the greater the level of activation will be. The dual system's activation is thought to be the biological mechanism underlying dimensional emotional theories that map emotional experience into an emotional space delineated by two major dimensions. Valence is the extent to which something is experienced as pleasant or unpleasant and is determined by which motivational system (appetitive or aversive) activates. Arousal is related to the intensity with which the emotion is experienced and is related to the level of activation in the motivational system (P. J. Lang, 1995). For example, an immediate and pressing threat will elicit a great deal of aversive motivational activation resulting in an arousing and negative emotional experience, but a non-pressing threat will elicit a low level of activation and a calm but negative emotional experience (P. J. Lang, 1995).

Fundamentally, however, activation of the motivational systems evolved to support actual approach and withdrawal behavior (Bradley & Lang, 2000). Appetitive activation supports approach to pleasant stimuli to sustain life. Aversive activation supports withdrawal from unpleasant stimuli to protect life (Bradley & Lang, 2000). Simultaneous activation supports both approach and avoidance—cautious approach when appetitive activation is higher than aversive, backing away when aversive is higher than appetitive, and freezing when they are essentially equal (Cacioppo, Larsen, Smith, & Berntson, 2004; P. J. Lang, Bradley, & Cuthbert, 1990).

Research has demonstrated that motivationally relevant content in mediated messages automatically activates the motivational systems and leads to the same expected direction and relative intensity of experiential emotional responses. Further, the valence and intensity of motivationally relevant material in audiovisual messages has been shown to result in predictable time-locked variation in both the physiological indicators of motivational activation and self-reported emotional responses. In general, pleasant mediated content elicits appetitive activation and positive emotional experiences, unpleasant mediated content elicits aversive activation and negative emotional experiences, and ambivalent content elicits activation in both systems and concurrently pleasant and unpleasant emotional experiences

(A. Lang, 2006b; A. Lang, Sanders-Jackson, et al., 2013; Wang, Lang, & Busemeyer, 2011).

In addition to being automatically activated by environmental and mediated stimuli, an individual's own thoughts can also activate the motivational systems. If individuals in a neutral state are asked to imagine various motivationally relevant stimuli—the act of imagining these thoughts will elicit signs of activation in the relevant motivational systems (Henderson, Bradley, Mastria, Kroytor, & Lang, 2013; P. J. Lang, 1979, 2012).

Sex and Appetitive Motivational Activation

Sexy content manifests as portrayals of partial nudity (Alexander & Judd, 1978), explicit or implied sexual behavior (Soley & Kurzbard, 1986), and/or sexual innuendo (Lin, 1998) in advertising. In general, sexual content has been identified as a primary biological motivator (P. J. Lang, Greenwald, Bradley, & Hamm, 1993). That is, sexual content is a category of stimuli whose simple physical properties possess inherent motivational primacy (McRae, Misra, Prasad, Pereira, & Gross, 2012). The appetitive system has evolved to prioritize motivational processing of sexual stimuli because the survival of the species depends on sexual reproduction. Thus, sexual content in advertisements represents a type of content to which the motivational system evolved to respond. Not surprisingly, a great deal of research demonstrates increases in multiple indicators of appetitive activation in response to sexual content in multiple media including still images, audiovisual messages, and audio messages. In theoretically relevant studies in psychophysiology, viewers had increased activation in facial muscles related to pleasant emotions, inhibited startle responses associated with appetitive activation, and self-reported positive and arousing emotional experiences in response to sexy content (P. J. Lang et al., 1993). Similarly, researchers have also observed increased positive emotional experience in response to sex in advertising messages (Geuens & De Pelsmacker, 1998). Therefore, sexy content in advertising should be a primary motivationally relevant content feature that should automatically elicit appetitive activation and, therefore, increase resource allocation to encoding and storage of the sexy content.

Humor, Orienting, and Appetitive Activation

A number of theoretical approaches to humor exist. A common theme amongst them is the notion that humor is not so much an emotion as it is a cognitive recognition of something that is incongruous or somehow wrong—in a relatively benign way. Early theorists/philosophers of emotion such as Bergson (1911) and Freud (1960) argued that humor was not emotional but was rather aimed at the intellect and based on the juxtaposition of logic and illogic. More recent theories of humor have suggested that humor occurs when there is frame blending or slippage, as when two situations are juxtaposed (Hofstadter & Gabora, 1989) or blended (Coulson & Kutas, 2001; Coulson & Williams, 2005). Similarly, other theories suggest that humor comes

from the benign violation of norms (McGraw & Warren, 2010), which is thought to be cognitive. Indeed, if the violation is not benign, then it will be shocking (and therefore aversively relevant) rather than humorous.

Research on humor processing suggests that the incongruity in humor, or the mismatch between stimuli and expectations, may automatically elicit an OR (Deckers & Hricik, 1984). Schmidt (2002) suggests that psychophysiological responses to humor support the theoretical interpretation that humor is initially recognized and processed essentially cognitively (through the mechanism of an OR). Once recognized, humor triggers a positive emotional response and an increase in arousal. Schmidt (2002) suggests that this emotional response may also be a contributor to the increased memory seen for humorous content. To test this hypothesis, Schmidt (2002) had participants view three versions of the same humorous cartoons—the original version, a version that removed the incongruous information (called the literal version), and a version in which an element was changed in such a way that the incongruity was maintained but the humor was removed (called weird). Results of the study showed that the humorous versions were remembered better than both the literal and the weird conditions, which were similarly remembered. Thus, these results suggest that the positive emotional response played a role in increasing memory for the humorous versions of the cartoons.

From the perspective of the LC4MP, it makes sense to conceptualize humorous content as content that initially elicits an automatic incongruity OR that results in increased resources allocated to encoding the information and increased attention and memory. Sometime after the OR, conscious recognition of the humor leads to an emotional experience of pleasure that triggers a self-induced automatic activation of the motivational system and leads to an additional increase in resources allocated to encoding and storage, as well an increase in the positive emotional response.

Thus, this study predicted that the mechanism underlying the increased attention, memory, and positive emotional experience elicited by sexy content is automatic motivational activation, but the mechanism underlying the same effects for humorous content is an OR followed by self-induced automatic appetitive activation. Therefore:

Hypothesis 1: The onset of humor should elicit an OR, but the onset of sex will not.

Hypothesis 2: Humor should elicit a delayed increase in appetitive activation that is not present in the sexy condition.

Humor and Sex, Orienting, and Appetitive Activation

In order to test these hypotheses, this study will include two other conditions for comparison purposes. The first of these is periods of time during which messages contain both sexy and humorous content. Here we would expect to see evidence of both orienting and appetitive activation. The expectation is that the two together should result in more total resource allocation (as a function of the OR plus appetitive activation) and greater appetitive activation (as a function of being

activated first by the sexy content and then by the recognition of the humorous content) compared to either one alone. The second is periods of time during messages that contain neither sexy nor humorous content. It is expected that these periods would have the fewest cognitive resources allocated and the least appetitive activation.

Emotional Tone

As previously discussed, both humorous and sexy content are conceptualized as types of content that are present at specific points within messages. However, these two types of content are only present at specific points in any given message. Most messages also have an overall ongoing emotional tone that also elicits some level and direction of motivational activation that is already present when the sexy and/or humorous content begin. This overall emotional tone could be neutral, primarily pleasant, primarily unpleasant or somewhat mixed. As a result of this ongoing emotional tone, the message will have already elicited some level of combined automatic motivational activation at the point at which these specific content types occur. In primarily pleasant messages, there will be some level of already ongoing appetitive activation when the sexy or humorous content occurs. In a primarily unpleasant message, there will be already ongoing aversive activation when the sexy or humorous content occurs.

If the overall emotional tone is pleasant, then the occurrence of sexy content should further increase both the level of appetitive activation and the experience of positive emotion. Similarly, the occurrence of humorous content, once the humor has been recognized, should further increase appetitive activation. Thus, in primarily pleasant messages the addition of sexy, humorous, or sexy and humorous should lead to an increase in appetitive activation, resulting in an additional allocation of resources to processing the pleasant content. But what will happen if the overall emotional tone is negative?

In this case, the appearance of sexy or humorous content will be occurring at a point when the aversive system is already active and will automatically activate the previously inactive appetitive motivational system and result in dual or co-activation of the motivational systems. When this happens, according to the LC4MP, both the aversive system (activated by the unpleasant emotional tone of the message) and the appetitive system will be automatically allocating resources to encoding and storing the message resulting in greater attention, as has been seen in other studies of coactive messages (Wang, Solloway, Tchernev, & Barker, 2012). Consequently, overall resource allocation should increase.

It should be noted that some types of humor also contain unpleasant elements that may elicit the automatic activation of the aversive system. For example, satire is thought to be aggressive (Test, 1991). Although an attempt was made in this study to select messages in which the humorous content was pleasant, some of the unpleasant messages did contain humor that had unpleasant elements. In this case, the humor would be expected to elicit both appetitive and aversive activation. Because this will

primarily occur in messages with ongoing aversive activation, this may lead not only to additional appetitive activation but also to additional aversive activation. Therefore, unpleasant messages with humorous or with sexy and humorous should have the greatest resource allocation.

Emotional Tone and Content Type

As is obvious from the above discussion, based on the LC4MP perspective, we expected to see effects of emotional tone and content type on the three dependent variables—total resource allocation, appetitive activation, and memory. To test these expectations, an experiment was conducted in which participants viewed advertisements that had either an overall pleasant or unpleasant emotional tone. One fourth of them contained neither sexy nor humorous content, one fourth of them contained sexy content, one fourth contained humorous content, and one fourth contained both sexy and humorous content. During viewing, indicators of appetitive motivational activation and total resource allocation were collected during the period of time when the correct type of content was present (sexy, humorous, sexy and humorous, neither sexy nor humorous). After viewing all the messages, a recognition memory test was conducted. The following specific predictions follow from the previous theoretical discussion:

First, because we expect co-activation of the appetitive and aversive motivational systems when viewing ads with a primarily unpleasant emotional tone and only single motivational system activation during ads with a primarily pleasant emotional tone—it is expected that:

Hypothesis 3: Overall, total resource allocation and memory for unpleasant ads will be higher than for pleasant ads.

At the same time, because the aversive system is active during the unpleasant ads, and because its prior activation is likely to inhibit or reduce activation in the appetitive system in response to sexy and humorous content (A. Lang, Sanders-Jackson et al., 2013; Wang et al., 2012), it is also expected that:

Hypothesis 4: Appetitive activation will be higher during primarily pleasant compared to unpleasant ads.

Similarly, content type should also influence all three dependent variables (appetitive activation, resource allocation, and memory). Sex, as a primary motivationally relevant content type, should elicit a large automatic increase in appetitive activation, resulting in a large increase in resource allocation. Humor, on the other hand, should initially increase resource allocation through the elicitation of an OR that will be followed by the activation of the appetitive system once the humor has been recognized. Because humor is not a primary motivationally relevant stimulus and because the activated stimulus is cognitive (e.g. recognition of the humor) rather than environmental—it is expected that the appetitive system will activate to a lower level during humorous compared to sexy content resulting in

lower resource allocation from appetitive activation. However, because of the additional allocation of resources from the initial OR, it is expected that sexy and humorous content will elicit similar levels of resource allocation.

Hypothesis 5: Appetitive activation should be lowest for messages containing neither sexy nor humorous content followed by humorous content, sexy content, and finally the combination of sexy and humorous content.

Hypothesis 6: Resource allocation should be lowest for messages containing neither sexy nor humorous content, followed by those containing only sexy or only humorous content alone, followed by the combination of sexy and humorous content.

In general, one would expect memory results to follow the resource allocation hypothesis which would lead to the prediction that the neither condition should have the worst and the both condition should have the best recognition with sexy alone and humorous alone in between.

Hypothesis 7: Memory will be worst for messages containing neither sexy nor humorous content, followed by those containing only sexy or only humorous content, followed by the combination of sexy and humorous content.

Interactions of emotional tone and content type are not expected.

Method

Design

The design of the experiment was an Emotional tone (pleasant, unpleasant) × Type of content (sexy, humorous, both sexy and humorous, neither sexy nor humorous) × Ads (4 ads in each condition) × Order (4) mixed factorial design. Order was the only between-subjects factor. Four presentation blocks consisting of eight ads were constructed with each of the eight categories appearing at least once in each block. Each block appeared in each position (1–4) across the four orders. Participants viewed ads that were randomized within blocks. The probe measures were collected during the best 6 s. The audio recognition targets were located in the two best 6 s periods. Over-time analyses conducted to test H1 and H2 also included a Time factor. For H1, the time factor had 6 levels consisting of the first 6 s of the sexy or humorous time period. For H2, the time factor had 20 levels consisting of the 20 s of the sexy or humorous time period.

Stimuli Selection

A researcher selected television ads that were thought to possess content that varied according to the requisite conditions for pretest evaluation and potential inclusion in the experiment. Sexy ads were selected based on the presence of partial nudity with explicit or implied sexual behavior or sexual innuendo in the ads. Humorous ads included content that the researcher expected for viewers to experience as funny.

Selected pleasant ads were expected to result in an overall positive emotional experience among viewers, and unpleasant ads were expected to result in an overall negative emotional experience among viewers. Crossing emotional tone (pleasant, unpleasant) and the four combinations of sexy and humorous content (neither, sexy, humorous, both) resulted in the eight required conditions. A pretest was conducted to validate the selected stimuli conditions as experimental manipulations and to identify the specific time periods during those ads in which sexy, humorous, pleasant, and unpleasant content most saliently occurred.

Undergraduate students (N = 81) completed the pretest for extra—or required-course credit. Participants viewed and rated the 40 ads (five in each of the eight conditions) selected by the researcher to contain the appropriate types and combinations of content over time using a continuous response measure (CRM: Biocca, David, & West, 1994).

Continuous ratings were obtained on four difference scales: (1) how good/positive they felt; (2) how bad/negative they felt; (3) how sexy they thought the content was, or (4) how funny they thought the content was. Participants used the computer's mouse to move a cursor along a sliding scale located on the computer screen underneath the viewing window. Each scale ranged from 0 (not at all good/positive, bad/negative, sexy, or humorous) to 10 (very good/positive, bad/negative, sexy, or humorous). Participants viewed the ads in four blocks of 10 ads. Each block contained one each of the eight categories plus one additional ad from two of the categories. Ad presentation was randomized within the block for each participant. Four orders of the blocks were created so that each block appeared in each of the four positions. Participants rated one fourth of the ads, or one block (N = 10), on each of the four scales (positivity, negativity, sexy, humorous). No participant rated any single message on more than one scale. Twenty participants rated each ad on each scale.

Four ads were chosen for each of the 8 categories. Visual examination of the CRM plots for each ad was used to identify messages with an overall pleasant or unpleasant tone. Because length of the selected ads ranged from 20 s to 150 s, the CRM plots were used to identify the 20 s in each ad that best exemplified the requisite content types in order to equalize data collection time. In addition, the CRM plots of each ad were used to select the best 6 s within each 20 s period to determine placement for the probe measures. The average CRM ratings/second for each scale for each type of ad are shown in Figures 1–8.

As a test of the visual inspection, means were calculated for the best 20 s and the rest of the seconds in each ad for each rating scale. Single factor ANOVAs with Time (20 best seconds, remainder of time) were run for each of the relevant scales. These results are shown in Table 1.

In addition, because arousing content strongly influences motivational activation and memory for media, all ads were selected to be moderately arousing (A. Lang, 2006b; A. Lang, Bolls, Potter, & Kawahara, 1999). After each ad, participants were asked for a summative rating of their emotional experience of arousal during the previous ad on a 1 (not at all arousing)-to-9 (very arousing) scale. Across

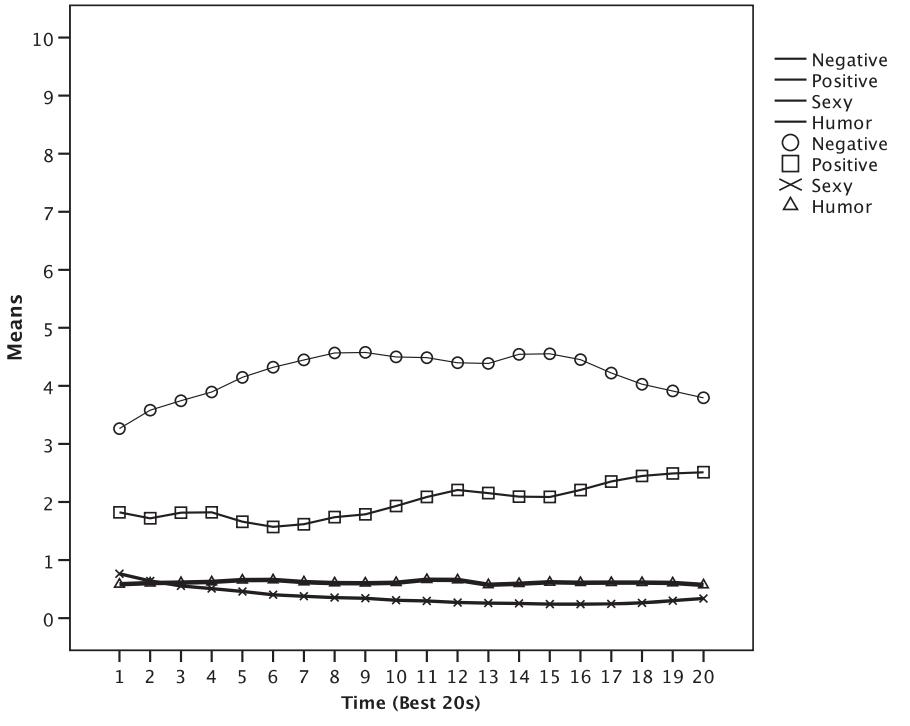

Figure 1. CRM means over best 20 s for Unpleasant Neither condition.

participants, the selected ads were rated as moderately arousing with means between 3.95 and 5.58 on the 9-point scale. Mean pretest ratings for the four selected advertisements in each category are presented in Table 2.

Dependent Variables

Measuring Appetitive Activation

The post-auricular reflex. The post-auricular reflex (PAR) magnitude is used here as an indicator of appetitive activation. PAR is a fast-acting, phylogenetically old response that can be elicited by an audio probe with zero rise time. In response to this probe, a reflexive contraction occurs in the post-auricular (PA) muscles within 8–12 ms of the onset of sudden onset or intense auditory stimulus (Kiang, Crist, French, & Edwards, 1963). The PA muscles located at the back of the ear draw the outer ear toward the scalp, and result in the perking up of ears in in non-human mammals. Although human ears are permanently retracted, a vestigial contraction of the PA muscles remains (Hackley, Woldorff, & Hillyard, 1987).

The PAR is a component of the Startle Reflex (SR, which is elicited by a zero rise time audio probe). When elicited during media use, SR components are potentiated by the ongoing emotional state when matched and attenuated when mismatched

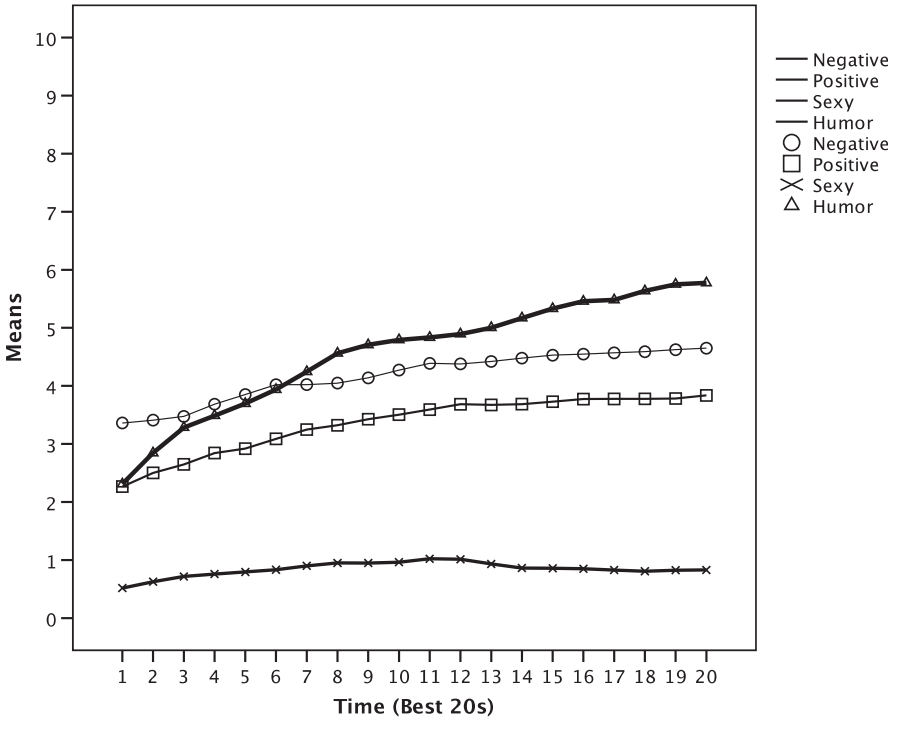

Figure 2. CRM means over best 20 s for Unpleasant Humorous condition.

(P. J. Lang et al., 1990). For example, the magnitude of the aversively activated protective eyeblink component of the SR is greatest when aversive activation is greatest and smallest when appetitive activation is greatest resulting in the largest eyeblink startle during arousing unpleasant content and the smallest during arousing pleasant content (P. J. Lang et al., 1990). Unlike the protective eyeblink, the PAR component of the SR appears to be appetitively activated with studies demonstrating the opposite modulation pattern with larger magnitudes when viewing pleasant compared with neutral and unpleasant content (Ames, Merritt, Stout, & Hetrick, 2003; Hess, Sabourin, & Kleck, 2007; Hetrick, Ames, Prause, & Kieffaber, 2004; Sabourin & Hess, 2006; Sandt, Sloan, & Johnson, 2007). In fact, the largest PARs are observed when participants view the most arousing pleasant stimuli (Sparks & Lang, 2010) and the smallest during the most arousing unpleasant content (Benning, Patrick, & Lang, 2004).

To measure PAR, two reusable Silver-Silver Chloride electrodes with a 4 mm diameter sensor in a 7.2 mm housing were placed on the participant's scalp behind each ear to measure electrical potentials occurring during the acoustically evoked reflexive contraction of the PA muscle. The experimenter located the muscle by pulling the outer ear forward and finding the fibrous strip of skin in the middle of the outer ear that connects the ear to the scalp. After the skin over the muscle was

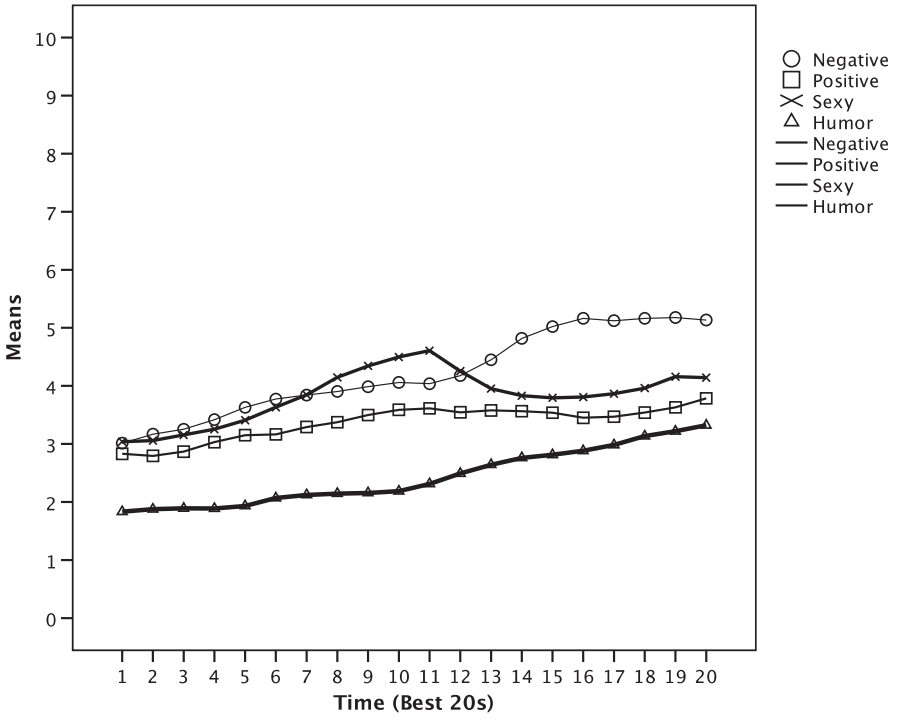

Figure 3. CRM means over best 20 s for Unpleasant Sexy condition.

cleaned with an alcohol pad, the experimenter wiped electrode gel on the sites, attached the electrodes, and impendence of below 5 kΩ was obtained.

White-noise probes of 95 dBs with a near-instantaneous rise time were used to elicit the PAR. Data were collected immediately before, during, and after the probes. The PAR probes sounded 2.5 s into the 6-s periods determined to be most representative of its assigned treatment category. A Coulbourn Instruments (Allentown, PA) Lablinc V was used to sample raw EMG signals. The PAR has a latency of 12.5–15 ms and a frequency spectrum of between 25 and 200 Hz (O'Beirne & Patuzzi, 1999). Thus, EMG signals were 1,000 Hz for 300 ms following probe onset. Signals were passed through a high-gain amplifier and bandpass filtered (8–1,000 Hz). The signal was rectified and integrated over 100 ms online using a contour following integrator. Millisecond-by-millisecond response means were compiled for each individual trial from 25 ms before the noise probe onset, during the 50 ms probe, and until 25 ms after the probe.

Aggregate waveforms were compiled for each treatment level over each ear by averaging the ms-by-ms response means across ads within a treatment level for the left and right ears individually. The method of analysis replicated Benning et al. (2004). Average EMG activity 25 ms prior to the probe was used as a baseline for each treatment level's aggregate waveform for a total of eight waveforms for each ear. The peak electrical response 8–30 ms following the noise probe onset was identified

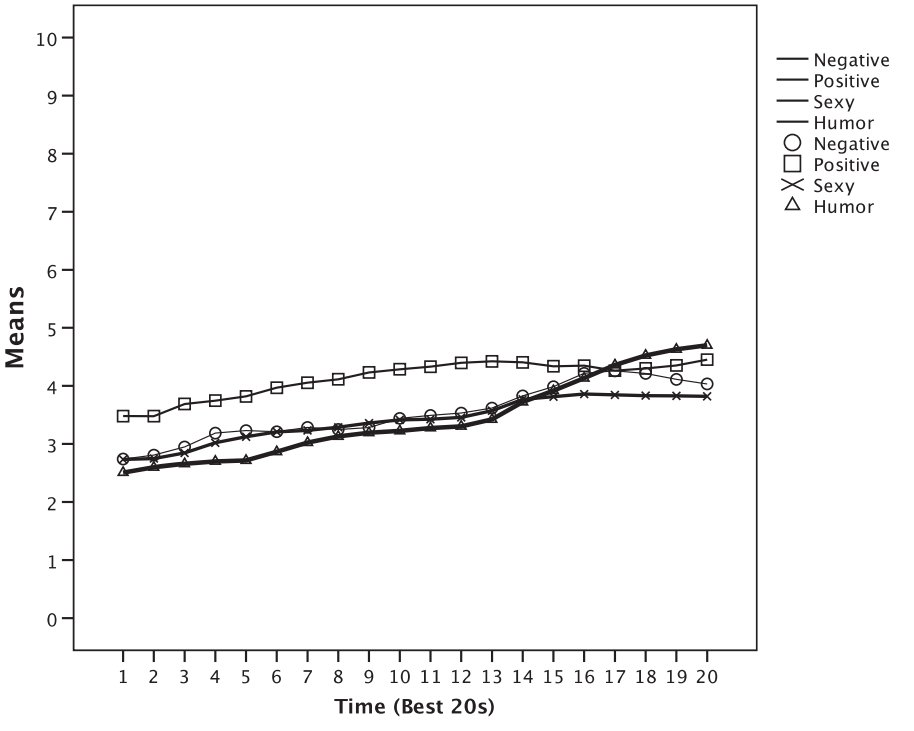

Figure 4. CRM means over best 20 s for Unpleasant Both (Sexy + Humorous) condition.

on each treatment condition's aggregate waveform for both ears. The baseline was subtracted from the peak resulting in a magnitude score for each ear at each level. The average magnitude for each level was then averaged across ears providing an average magnitude for each treatment level.

Orbicularis oculi. The orbicularis oculi (OO) muscles encircle each eye. Activation of the OO is strongly correlated with appetitive activation and the experience of positive emotion (P. J. Lang et al., 1993). Two reusable Silver-Silver Chloride electrodes were placed over the OO muscle beneath the left eye. OO was sampled at 50 Hz and the signal was amplified, bandpass filtered then rectified and integrated online using a Coulbourn contour following integrator. Average OO activation was calculated per second.

Measuring Total Resource Allocation

Heart rate. In the television-viewing situation, LC4MP research has validated the use of heart rate (HR) as an indicator of total resource allocation. The rate with which the heart beats is jointly determined by activation in both the sympathetic (SNS) and the parasympathetic (PNS) nervous systems. SNS activation, which is

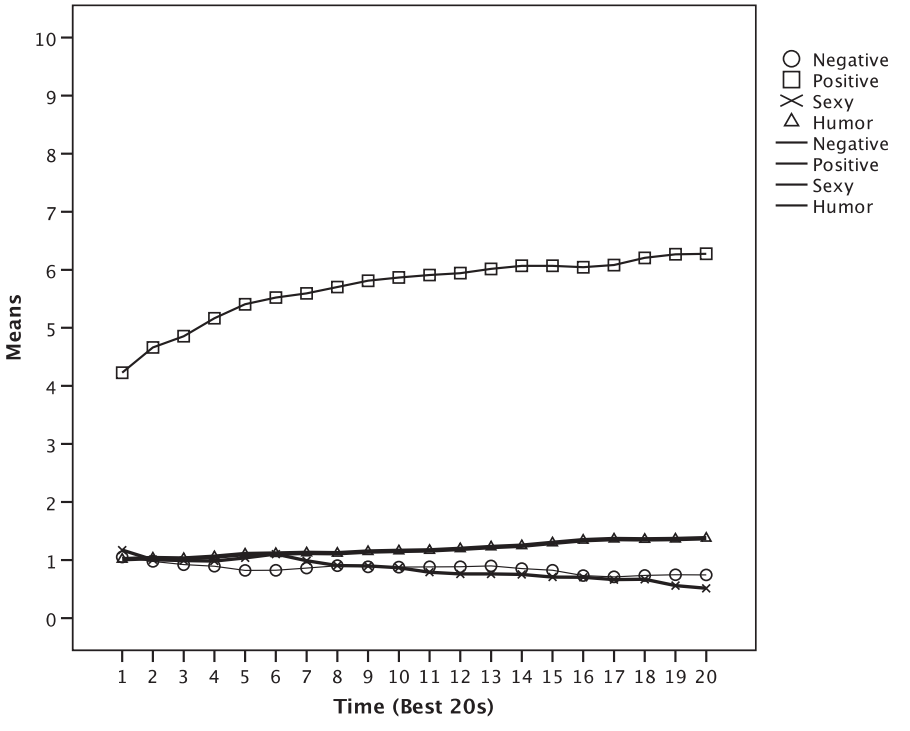

Figure 5. CRM means over best 20 s for Pleasant Neither condition.

generally related to arousal, leads to increased HR. PNS activation, which is generally related to attention and resource allocation, leads to decreased HR. Substantial research in the audiovisual-viewing context demonstrates that although audiovisual content elicits both arousal (SNS activation) and attention (PNS activation) the HR response is dominated by the PNS activation. This research has shown that these decelerations in HR when viewing audiovisual messages closely track other measures of attention to messages and that this is the case even when messages are arousing (Bolls & Lang, 2003; Fox, 2004; A. Lang, Chung, Lee, & Zhao, 2005). Thus, slower HR is generally indicative of greater overall resource allocation.

Additionally, a great deal of research using still images (P. J. Lang et al., 1993) and some research with audiovisual stimuli (Bolls & Lang, 2003; A. Lang, 1990) suggests that HR is also sensitive to the valence of the message. Specifically, HR, following an initial deceleration, stays slow during unpleasant messages but actually accelerates during pleasant messages. Thus, late acceleration of HR is indicative of appetitive activation.

HR was recorded during the best-20 s period of each audiovisual advertising message to assess total resource allocation. An alcohol pad was used to remove dead skin cells and three standard Beckman silver-silver chloride (8 mm) electrodes were attached to the participant to measure the electrical activity of the heart. Two sensors with one serving as a ground were placed on the inside of the subject's dominant

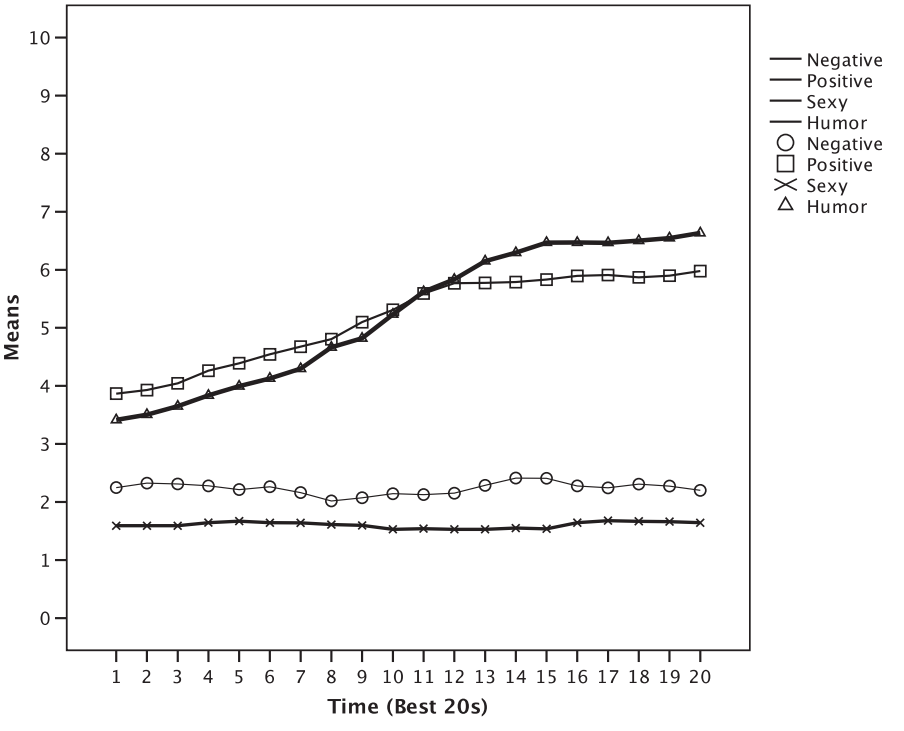

Figure 6. CRM means over best 20 s for Pleasant Humorous condition.

forearm and another on the non-dominant forearm. HR was recorded as inter-beat intervals and converted to average beats per second over the best-20 s (A. Lang, 1994).

Measuring Encoding

Signal detection analysis of audio recognition. Forced choice yes/no speeded audio recognition tests were constructed for each message. A 2 s audio segment located in each of the previously identified two best 6-s periods was selected for use in the test. Targets were constructed by having the researcher record the exact words of the selected audio segments. The researcher constructed foils by recording a version of the same segment in which two words were changed but the meaning of the segment was not changed. The audio recordings were randomly presented through stereo earphones in a 128-item, forced-choice memory sensitivity test administered on a laptop via *MediaLab* software (Jarvis, 2004). Participants were instructed to click yes if they had heard the exact segment during the ads previously viewed and to click no if they had not.

Signal detection analysis was used to calculate memory sensitivity (A'). Increases in sensitivity indicate an increasing ability to discriminate signal from noise (Fox, 2004; Fox, Park, & Lang, 2007). Targets correctly identified with a yes response were

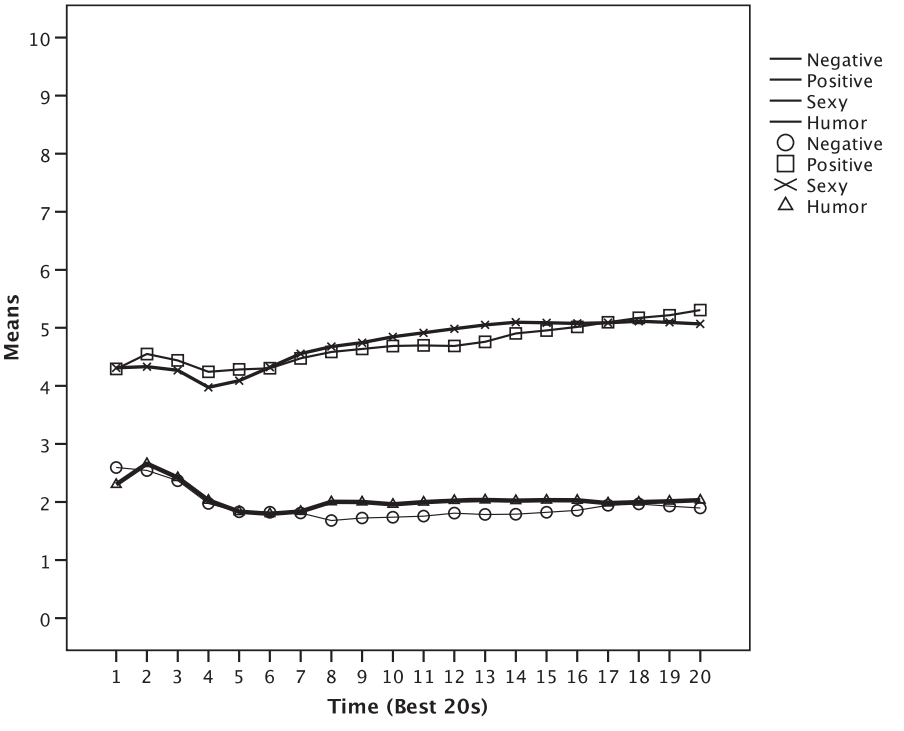

Figure 7. CRM means over best 20 s for Pleasant Sexy condition.

scored as hits. Foils incorrectly identified with a yes response were scored as false alarms. The probabilities of hits (*phit*) and false alarms (*pfa*) were used to calculate sensitivity for each treatment level using the following formula for A' (Grier, 1971):

$$\text{If } phit > pfa, \text{ then } A' = .5 + (phit - pfa)(1 + phit - pfa)/4(phit)(1 - pfa)$$

$$\text{If } phit < pfa, \text{ then } A' = .5 + (pfa - phit)(1 + pfa - phit)/4(pfa)(1 - phit)$$

Procedure and Participants

Undergraduate participants (N = 77) were seated in a comfortable armchair facing a 19-inch computer monitor in a psychophysiological research laboratory. The experimenter obtained consent, attached PAR, HR, and OO sensors, and instructed participants to view the messages. In order to prevent noise artifact in the PAR measurement potentially produced by traditional over-the-ear headphones, experimental audio and noise probes were delivered to participants via Etymotic Research (Elk Grove Village, IL) ER 3A insert earphones. White noise probes were generated using a Coulbourn Instruments (Allentown, PA) V85-05 noise generator and amplified with a RCA SA-155 integrated stereo amplifier and delivered through the ER·3A insert earphones. PAR, OO, and HR were recorded using a Coulbourn Instruments (Allentown, PA) Lablinc V system.

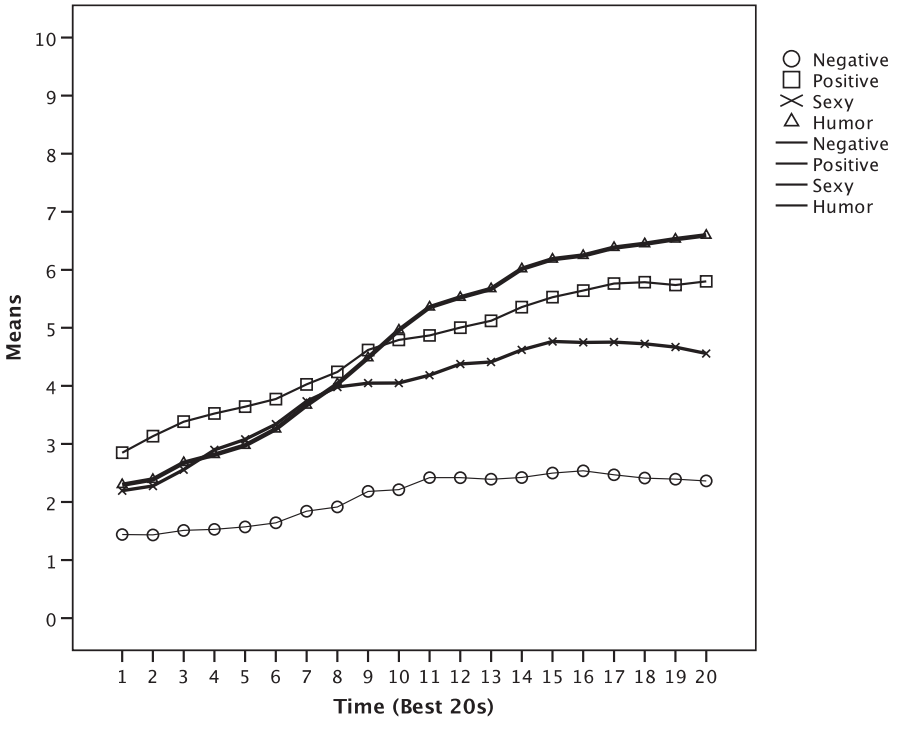

Figure 8. CRM means over best 20 s for Pleasant Both (Sexy + Humorous) condition.

MediaLab software (Jarvis, 2004) controlled stimuli presentation. An IBM computer with a Labmaster A/D board running VPM (Cook, 2003) software controlled the experiment. A recognized programming error on the first day of the experiment resulted in the exclusion of initial participants' physiology data. The problem was resolved and HR data were obtained for 58, OO data were recorded for 53, and PAR data were collected from 56 participants. After viewing the stimuli, the sensors were removed and participants completed the recognition test. Recognition data were obtained for 76 participants. The appropriate institutional review board approved the protocol.

Table 1 Comparisons between identified best-20 s to the remainder of the time by condition and measure.

	Scale	Best 20 s	Remainder of time	*p*<	eta-squared
Type of message		Mean (SD)	Mean (SD)		
Pleasant	Positivity	5.05 (2.69)	3.37 (1.90)	.001	.37
Unpleasant	Negativity	4.03 (2.93)	2.67 (1.72)	.001	.23
Sexy	Sexy	3.96 (2.50)	2.89 (1.81)	.001	.23
Humor	Humor	4.49 (2.67)	2.41 (1.75)	.001	.49

Table 2 Mean summative valence and arousal ratings for each selected ad in each condition.

	Rating scale				
Message type	Negative	Positive	Sexy	Humor	Arousal
Unpleasant neither	4.19	2.01	0.34	1.02	4.85
Unpleasant humorous	4.17	3.35	0.74	4.65	5.32
Unpleasant sexy	4.21	3.35	3.84	2.43	5.69
Unpleasant both	3.53	4.12	3.61	3.73	5.35
Pleasant neither	0.85	3.85	0.80	1.21	3.92
Pleasant humor	2.26	4.25	1.75	5.33	5.40
Pleasant sexy	1.93	4.03	5.65	2.09	5.59
Pleasant both	2.08	4.38	3.60	4.48	5.58

Results

Hypothesis 1

Hypothesis 1 predicted the onset of humorous content should elicit an OR, but the onset of sex would not elicit an OR. Ascertaining the existence of an OR is a multi-step process. An OR takes between 6 and 10 s. The shape of the effect is ascertained using a combination of visual inspection and trend analysis (A. Lang, 1994). A significant OR should show a decrease in HR over 3–4 s followed by a return to baseline level and a significant quadratic trend component of the time factor. The prediction here is that for humorous content there will be a decrease and then an increase in HR over the first 6 s with a significant quadratic trend component of the HR while the sexy content will produce a continuous deceleration with a significant linear component. Results of the time (6 s) within subjects ANOVA on the humorous data revealed a significant quadratic component of the time effect, $F(1, 57) = 3.82$, $p = .057$, $\eta_p^2 = .06$, of the predicted shape (Figure 9). The same analysis performed on the sexy data revealed a significant linear decelerating trend (also shown in Figure 9), $F(1, 57) = 9.727$, $p < .05$, $\eta_p^2 = .15$. Thus, humorous does appear to elicit an OR while sexy content elicits a continuous deceleration indicative of sustained resource allocation.

Hypothesis 2

Hypothesis 2 predicted that humorous content should elicit a delayed increase in appetitive activation that is not present in the sexy condition. Hypothesis 2 was tested using a Content Type (humorous, sexy) × Time (20 s) within subjects ANOVA on the HR and the OO data. For both sets of data, the prediction is for greater increase in the latter part of the time period. The interaction of content type and time was significant for both the HR, $F(19, 1083) = 5.44$, $p < .001$, $\eta_p^2 = .09$, and the OO data, $F(19, 969) = 2.81$, $p < .001$, $\eta_p^2 = .05$. The interactions are shown in Figure 10 (HR) and Figure 11 (OO). In addition, both also had significant linear contrast

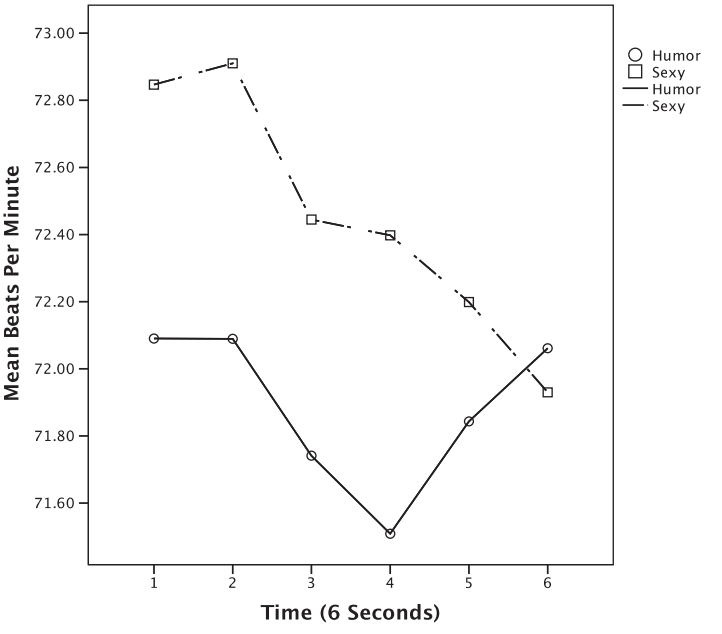

Figure 9. Cardiac Response Curves over first 6 s of humorous and sexy content.

components of the interaction, $F_{HR,\ linear}(1, 57) = 17.11$, $p < .001$, $\eta_p^2 = .23$, $F_{OO,\ linear}(1,51) = 7.95$, $p < .01$, $\eta_p^2 = .14$. Both HR and OO increased, indicative of appetitive activation and positive emotional experience, starting in the 11th second while sexy content shows no such late increase.

Hypothesis 3

H3-H8 were tested using an Emotional tone (2: pleasant, unpleasant) × Content Type (4: neither humorous nor sexy, humorous, sexy, humorous and sexy) × Order (4) × Sex (2: male, female) mixed measures ANOVA on the PAR, HR, and *A′* data. Order and Sex were between-subjects variables and were included as control variables. There were no significant interactions of either Order or Sex with any of the experimental factors. Emotional tone and content type were within-subjects factors. Planned paired t-tests were used to determine differences among means.

Hypothesis 3 predicted that, overall, total resource allocation and memory for unpleasant ads would be higher than for pleasant ads. Thus, slower HR (indicative of more total resource allocation) and higher *A′* (indicative of higher memory sensitivity) were expected during messages with an unpleasant compared to pleasant emotional tone. The main effect of emotional tone was significant on both the HR, $F(1, 150) = 5.39$, $p < .02$, $\eta_p^2 = .10$, and the *A′* data, $F(1,67) = 8.65$, $p < .01$, $\eta_p^2 = .11$. As predicted: 1) HR was slower during messages with a generally unpleasant (M = 71.50, SD = 1.45) compared to a pleasant tone (M = 71.83, SD = 1.49), and; 2)

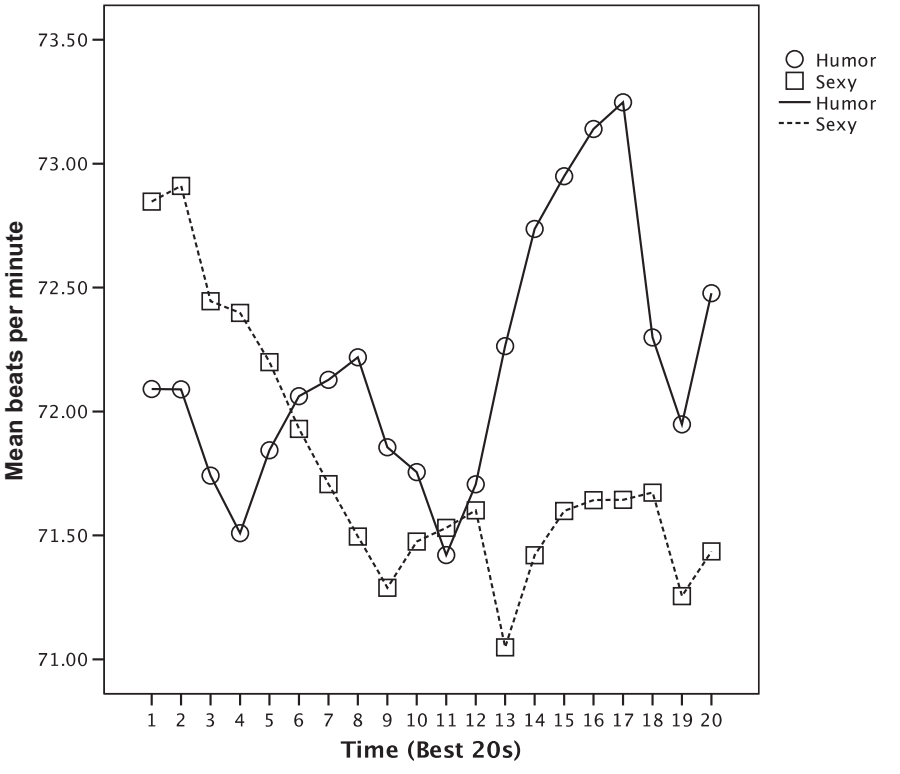

Figure 10. HR data over the best 20-s periods containing either sexy only or humorous only content.

Memory sensitivity was higher during messages with a generally unpleasant (M = .55, SE = .003) compared to a pleasant tone (M = .54, SE = .003).

Hypothesis 4

Hypothesis 4 predicted that appetitive activation would be higher during primarily pleasant compared to unpleasant ads**.** As expected, there was significant main effect of emotional tone on the PAR data, $F(1, 55) = 3.99$, $p < .05$, $\eta_p^2 = .07$, with larger PARs during pleasant (M = .06, SE = .07) compared to unpleasant (M = .04, SE = .06) messages.

Hypothesis 5

Hypothesis 5 predicted that appetitive activation should be lowest for messages containing neither sexy nor humorous content followed by humorous content, then sexy content, and then the combination of sexy and humorous content. The predicted main effect of content type on the PAR data was not significant (p = .21). Instead, there was a significant interaction of emotional tone and content type, F(3,

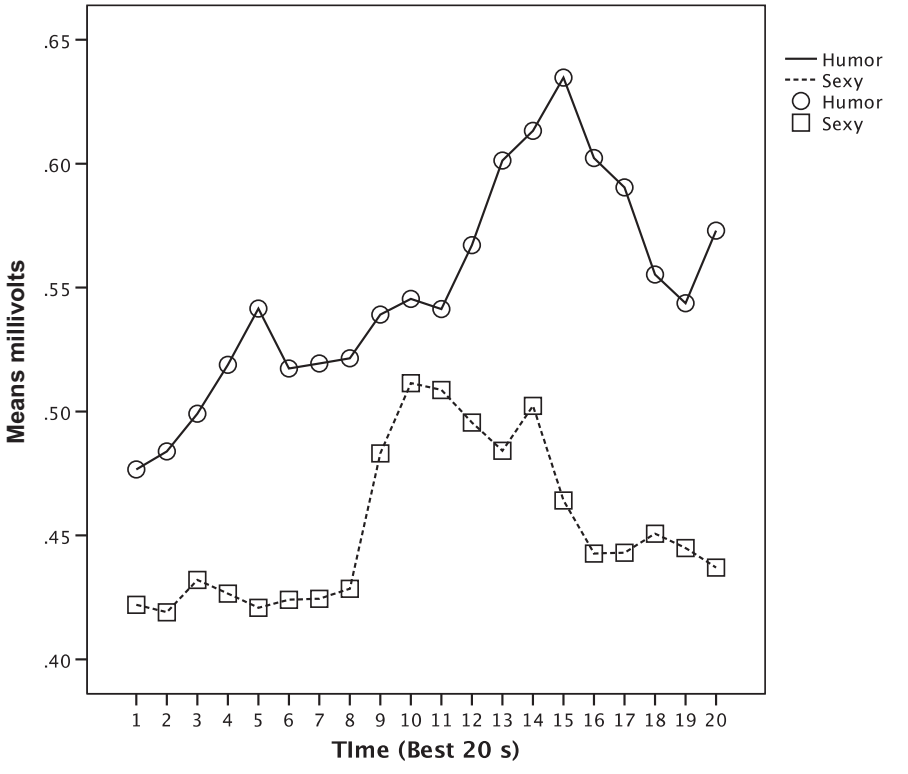

Figure 11. OO over the 20-s periods containing either sexy only or humorous only content.

165) = 4.45, $p < .01$, $\eta_p^2 = .08$, which is shown in Figure 12. During pleasant messages, PAR is higher for the both and the humorous conditions than for the neither and sexy conditions but there are no significant differences among means for the different content types. During unpleasant messages, PAR increases significantly from neither, to humorous, and from humorous to sexy, as expected, but then is lowest overall for the both condition (which does not differ significantly from the neither condition).

Hypothesis 6

Hypothesis 6 predicted resource allocation should be lowest for messages containing neither sexy nor humorous content, followed by those containing only sexy or only humorous content, followed by the combination of sexy and humorous content. The predicted main effect of content type on the HR data was significant, $F(3, 150) = 18.06$, $p < .001$, $\eta_p^2 = .27$. The predicted order was found with the fastest HR, indicative of the fewest resources allocated to messages with neither sexy nor humorous content ($M = 72.90$, $SE = 1.47$), followed by humorous ($M = 71.73$, $SE = 1.51$), sexy ($M = 71.17$, $SE = 1.49$), and both ($M = 70.85$, $SE = 1.45$). The neither

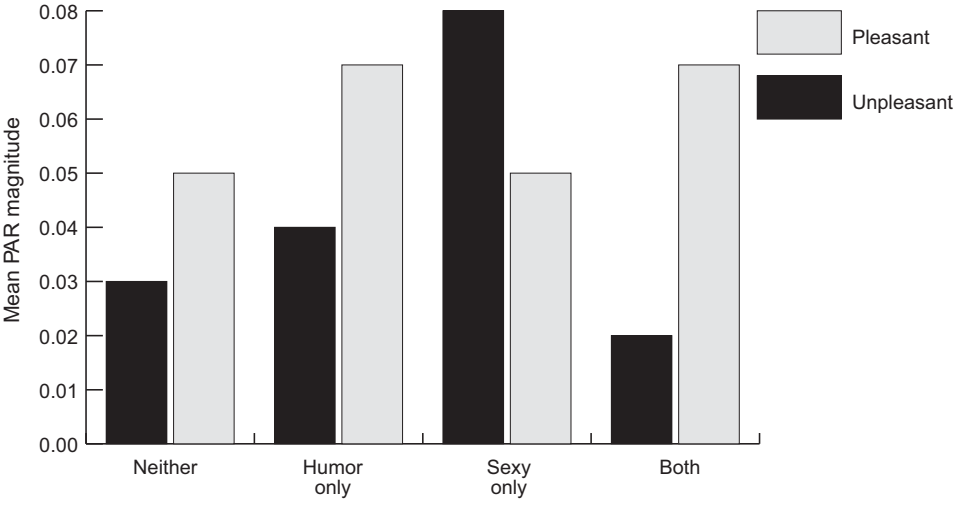

Figure 12. Emotional Tone x Content Type Interaction on the PAR data.

condition was significantly faster than all other conditions. The sexy only and humorous only conditions did not differ from one another. The both condition was significantly slower than the humorous but not the sexy condition. As predicted, there was no interaction with emotional tone ($F < 1$).

Hypothesis 7

Hypothesis 7 predicted that memory would be worst for messages containing neither sexy nor humorous content, followed by messages containing only sexy or only humorous content, followed by sexy and humorous content. The predicted main effect for content type only approached significance, $F(3, 201) = 2.11$, $p < .10$, $\eta_p^2 = .031$. Instead the interaction of emotional tone and content type was significant, $F(3, 201) = 5\ .89$, $p < .001$, $\eta_p^2 = .08$, and is shown in Figure 13. As can be seen in Figure 13, memory sensitivity increases from neither to humorous to sexy and then to both, as expected, for unpleasant messages. However, the only significant differences among means were between neither and both and between humorous only and both. Sexy only does not differ significantly from any of the other unpleasant means.

For pleasant messages, we see an unexpected finding with the lowest memory for the two conditions containing sexy content (sexy and both), which do not differ from one another, followed by neither and humorous which also do not differ from one another. The neither and humorous conditions, however, are significantly better than the two sexy conditions.

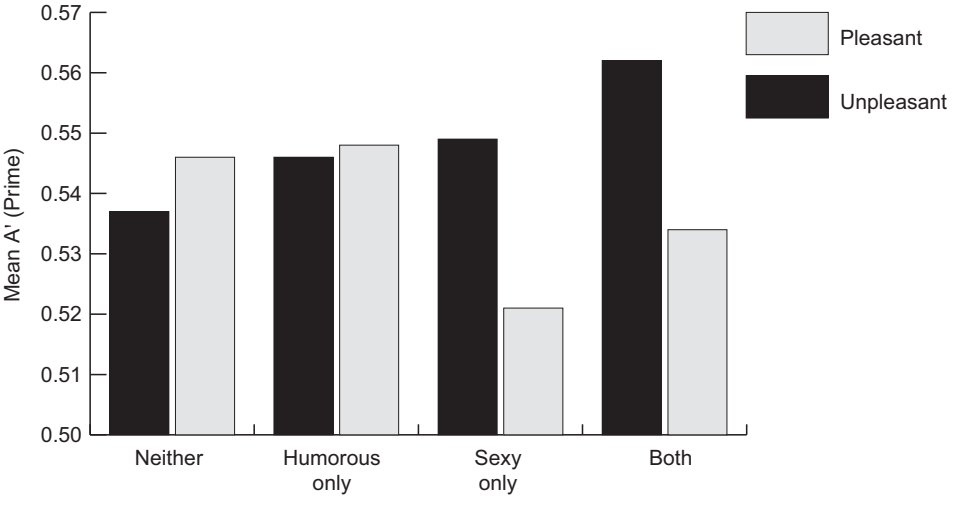

Figure 13. Emotional Tone x Content Type Interaction on the A' data.

Discussion

This study tested the hypothesis that the cognitive and biological mechanisms underlying the processing of humor and sex were somewhat different with both content types eliciting appetitive activation and humor also eliciting an OR. This hypothesis was tested in three ways, first by comparing ads with only sexy or only humorous content for differences in ORs, second by examining overtime indicators of appetitive activation for late increases in appetitive activation, and third, by comparing summative measures of resource allocation, appetitive activation, and memory in the context of messages that had either an ongoing pleasant or an ongoing unpleasant emotional tone. The most crucial predictions were those that tested for predicted over-time differences in indicators of orienting and appetitive activation. Here results showed: 1) that humorous content did elicit an OR and sexy content did not; 2) a late increase in OO, an indicator of appetitive activation and pleasure (P. J. Lang et al., 1993), for humorous but not for sexy ads, and; 3) a late increase HR, indicative of appetitive activation and pleasure (Bolls & Lang, 2003; A. Lang, 1990), for humorous but not for sexy ads. Thus, the predicted patterns of these indicators were found supporting the prediction that in humor the mismatch between stimuli and expectations elicits an OR (Deckers & Hricik, 1984) that is followed by a self-induced increase in appetitive activation (Henderson et al., 2013; P. J. Lang, 1979, 2012) while sexy content elicits only appetitive activation.

The second set of predictions tested for evidence of these mechanisms, in two different emotional contexts (pleasant or unpleasant messages) at the message, rather than the over time, level on the indicators of appetitive activation and resource allocation and on the outcome measure of memory sensitivity. The most direct test here was the prediction for lower appetitive activation, as indicated by PAR magnitude (Sparks & Lang, 2010), for humorous compared to sexy ads. Overall,

average PAR was lower for the humorous compared to the sexy ads, but that difference was not significant. However, there was also an interaction with overall emotional tone. PAR was significantly lower for humorous compared to sexy ads during unpleasant ads but did not differ for pleasant ads. Indeed, there were no significant differences in PAR based on content type during the pleasant ads. The absence of differences could conceivably be the result of a ceiling effect brought about by the fact that during pleasant messages appetitive activation was already high and the additional content did not lead to a significant increase in PAR. Two things support that interpretation. First, there was a significant emotional tone main effect (regardless of content type) on PAR with magnitudes larger during pleasant compared to unpleasant messages. Second, the significant increases in PAR in the predicted direction are seen during the unpleasant messages. Here the neither sexy nor humorous condition had significantly lower PAR than either sexy or humorous, and humorous was significantly lower than sexy, as would be expected if sexy content elicited greater motivational activation compared to humorous content. Taken together, these results seem to clearly support the prediction that generally pleasant compared to unpleasant messages elicit greater appetitive activation. They also support the prediction that sexy content elicits more appetitive activation than humorous content.

The second important prediction concerns message level resource allocation. Here the prediction is that resource allocation will not differ significantly between sexy and humorous ads because, even though appetitive activation and its associated resource allocation will be greater for sexy ads, the additional allocation humorous ads receive as a function of the OR should equalize the resource allocation. The reported results are in line with this prediction with no difference in total resource allocation, as indicated by HR (Bolls & Lang, 2003; A. Lang, 1990), between the sexy and humorous condition and both receiving significantly more resources than the neither condition and the both condition receiving the most resources. Further, the difference between total resources allocated to sexy and humorous content did not differ as a function of emotional tone. Thus, there appears to be general support for the contention that sexy and humorous content receive similar and high levels of total resource allocation.

The final prediction was that recognition would generally follow resource allocation resulting in similar levels of memory for both sexy and humorous content regardless of emotional tone with better memory for unpleasant compared to pleasant ads, as has been seen in other studies of coactive messages (Wang et al., 2012). This second expectation was supported with unpleasant ads being remembered better than pleasant ads. But, unexpectedly, memory for the content types did vary as a function of emotional tone.

For the unpleasant ads, the predicted pattern of increasing resource allocation across the four content types (from neither to both) with no significant differences between sexy and humorous was nearly replicated. Sexy and humorous did not differ from one another and, as in the resource allocation data, sexy and both did not differ, but sexy and humorous did. The only difference here is that the neither condition

does not differ from either sexy or humorous (though it does differ from the both condition).

For the pleasant ads, however, a totally different pattern emerged. Here the main pattern is for worse memory for the two conditions that contain sexy content (sexy and both) compared to the two conditions that do not (neither and humor). At first glance, this is quite puzzling given that the sexy ads elicited greater appetitive activation and at least equal resource allocation. One possible explanation for this may lie in the decision made in this study to use an audio recognition measure. This choice was made for two reasons: 1) the audio channel frequently carries the bulk of a message's information, and; 2) audio recognition is a more sensitive measure of memory than is visual recognition (A. Lang, Potter, & Bolls, 1999). In retrospect, however, it is fairly clear that although the informational content may be primarily present in the audio track, the sexual content is not. Indeed, a condition of the initial selection of ads for the pretest was that there must be some amount of nudity in the visual track, thus, the vast majority of the sexual information is probably contained in the visual track. Because the theoretical prediction is that motivational activation allocates resources to the processing *of the motivationally relevant material*, this may mean that memory for the visual information did increase at the expense of memory for the audio information. In other words, allocating additional resources to processing the visual motivationally relevant material may actually have drawn resources away from processing the audio, which could account for the very low memory seen for the ads with sexual content.

The same would not be true of the neither and humorous ads because there is no sexy content to decrease audio processing in the neither condition. However, in the humorous condition, the elicitation of the OR by the incongruous information would focus attention on the incongruity that might be between the channels, in the audio channel, or in the video channel. Thus the resolution of the incongruity—in order to recognize the humor—might very well have distributed the resources across all the information in the message. Taken all together, this pattern of message-level results also seems to provide reasonable support for the notion that different mechanisms underlie the processing of sexy and humorous content with sexy content eliciting primarily appetitive activation and humorous content eliciting an OR followed by later appetitive activation.

These results also tell us that the overall tone of the message will influence the processing of sexy and humorous content. Specifically, unpleasant ads with either sexy or humorous content will receive high levels of resource allocation and have good memory. Unpleasant ads with both sexy and humorous content have the highest resource allocation, high levels of appetitive activation, and the best memory. Pleasant messages across the board have lower levels of resource allocation (because of the lack of dual activation in the motivational systems) and correspondingly lower memory (though this effect may be caused partially by the mismatch of visual sexual content with an audio recognition test). They also show no significant variation in appetitive activation, as indicated by PAR. Overall, this may mean that messages will elicit more variation in appetitive activation, better memory, and high resource

allocation when sexy, humorous, or both sexy and humorous content are present in messages with a somewhat unpleasant tone rather than adding them on to pleasant messages.

Using real-world ads strengthened the experiment's external validity. However, despite our best efforts in stimuli selection and pretesting, pleasant, unpleasant, sexy, and humorous content were not necessarily completely independent. The experiential manipulations potentially presented a challenge to the experiment's internal validity. Pretest CRMs were compared using basic between-subjects ANOVAs. To advance precision of over-time measurement of the influences of sexy and humorous content on dynamic motivational processing of audiovisual advertisements as indicated by real-time psychophysiological responses, time series cross-sectional analysis and model fitting of CRM data (Wang, Solloway, Tchernev, & Barker, 2012) should be performed.

Future research should also control whether sexy content is introduced in the relatively automatically processed visual channel or the more resource intensive audio channel. Further, audio and visual recognition sensitivity should be separately measured and compared when the sexy content is in audio only, visual only, or in both the audio and visual channels. Visual sexiness should be operationalized across various dimensions including gender of model(s), number of models, level of nudity, and intensity of sexual behavior in audiovisual ads. The operationalization of sexiness in the audio channel of television ad content represents an important frontier for future research advancement, as the area has been ignored to date. As the realism of virtual environments continually improves, researchers should consider producing animated ads with the demanded manipulations of sexiness, as an alternative to using existing ads or producing actual ads. The present conceptualization of humor demonstrates the complexity of humor as a mediated stimulus. Future studies of humor should explore the influence of differing humor genres on specific motivational and cognitive mechanisms. Extending from these advancements, researchers should revisit adult humor in advertising.

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