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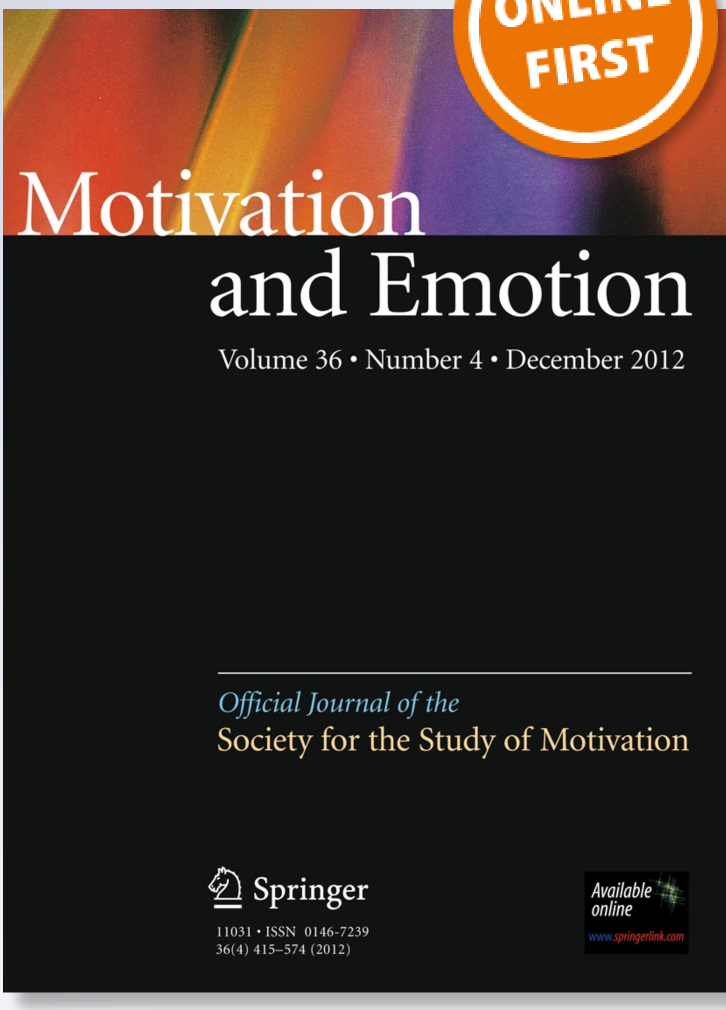

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ORIGINAL PAPER

Motivated message processing: How motivational activation influences resource allocation, encoding, and storage of TV messages

Annie Lang · Ashley Sanders-Jackson · Zheng Wang · Bridget Rubenking

Abstract This paper investigates differences in overtime processing of television messages with three types of emotional trajectories—those which begin neutral and become negative, begin neutral and become positive and begin neutral and become equally positive and negative. The limited capacity model of motivated mediated message processing is used to predict how the type of emotional content influences real-time activation of the appetitive and aversive motivational systems which then alter concurrent and subsequent message processing. Results show that during the first time period, when motivational activation is low, more resources are allocated to coactive and positive compared to negative messages supporting the positivity offset hypothesis. In the middle time period, when activation is moderate, more resources are allocated to negative than to positive messages, supporting the negativity bias hypothesis. Further, the different patterns of motivational activation do result in different patterns of messages processing. During positive messages, encoding increases and storage decreases over time. During negative messages, encoding decreases and storage increases overtime. During coactive messages initial encoding and storage are high though both decrease slightly over time.

Keywords Memory · Attention · Motivation · Emotion · Media

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Introduction

Based upon the limited capacity model of motivated mediated message processing (LC4MP, Lang 2006a, b; 2009; Lang and Yegiyan 2009), this study examines how real-time change in the emotional content of television messages influences concurrent and subsequent activation in the motivational systems, which in turn, influences resource allocation to encoding and storing the messages. The LC4MP theoretical perspective incorporates Cacioppo's dual motivational system model (Cacioppo and Gardner 1999), Lang's dimensional theory of emotion (Bradley et al. 2001) and a limited capacity media processing model (Lang 2000) to predict how the overtime variation in television messages' emotional content automatically activates and deactivates the motivational systems, which in turn fine tune cognitive processing and support emotional experience.

LC4MP assumes that human motivational and cognitive systems continuously interact with external stimuli, including media messages, in a host of automatic (i.e. unconscious, fast, and reflexive) ways and that those interactions influence cognitive processing as well as viewer experience. Within this perspective, message

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processing consists of three primary cognitive subprocesses: Encoding, storage and retrieval (Lang 2000, 2006b; Lang and Yegiyan 2009). Encoding is the process of selecting important information from the media stimulus for further processing. The process is idiosyncratic and non-veridical, reflecting automatic responses to structural and content features in the message as well as controlled and automatic processes related to the ongoing interest, goals, and states of individual audience members. Storage is the process of linking new information to old information within an associative network memory model. Information is better stored when there are more and stronger links between old and new information. Retrieval is the ability to reactivate previously stored information.

The LC4MP is a single fixed pool limited capacity model. Resources are thought to be independently allocated to encoding and storage through both automatic and controlled processes. Controlled allocation is under the control of the viewer and may be related to viewer goals and choices. Automatic allocation is under the control of the message. The LC4MP includes two automatic allocation mechanisms, the orienting response and motivational activation.

Many aspects of television structure and content have been shown to elicit orienting responses (ORs) in attentive viewers (Lang, 1990). The OR is thought to elicit a brief increase in resources allocated to processing the message (Ohman 1979, 1997). The extent to which these additional resources are required depends on the amount of new information introduced by or with the OR eliciting feature. As the amount of new information introduced increases, resources required increases and available resources (that is resources allocated—resources required) declines. Secondary task reaction times (STRTs) have been shown to be a good indicator of available resources during television viewing getting slower with decreases in available resources (Lang and Basil 1998; Lang et al. 2006; 2007c).

The second mechanism of automatic resource allocation is motivational activation. LC4MP argues that the cognitive processing system is embodied within a biological system, designed by evolution to appropriately respond to threats and opportunities in the environment to protect and sustain individuals and thereby the species. Following Cacioppo's dual systems model (Cacioppo and Gardner 1999; Lang et al. 1997) at the heart of the motivated cognitive system are two independent motivational systems called the *appetitive* (or approach) and the *aversive* (or avoid/defensive) systems. The appetitive system responds automatically to positive stimuli and functions to support approach behavior such as paying attention to and gathering information stimuli. The aversive system responds automatically to negative stimuli and functions to defend against potential harm and avoid imminent threats (Lang 2006b, 2009; Lang and Yegiyan, 2009).

Dual system theory describes these two motivational systems as functioning relatively independently of one another and as having different activation functions. As threats or opportunities become more arousing, more imminent, or closer, the appropriate motivational system(s) increase in activation. In a neutral environment, where there are neither threats nor opportunities, the appetitive system is thought to be more active than the aversive system, a characteristic referred to as the *positivity offset* (Cacioppo and Gardner 1999). The positivity offset functions as a biological impetus for organisms to leave the nest and explore the environment for food and mates. The aversive system, on the other hand, is thought to activate more quickly in response to negative stimuli. That is, greater activation is elicited more quickly by negative compared to positive stimuli as stimuli become more arousing, imminent, or closer. This faster and larger response is called the *negativity bias* (Cacioppo and Gardner 1999). These two characteristics of the motivational systems are thought to be functionally adaptive because failure to respond quickly to a threat can result in injury or death; whereas failure to respond quickly to an opportunity results merely in the loss of the opportunity but not the loss of life or limb.

Of particular interest here, and somewhat at variance with other motivational theories, is the notion that in an environment which contains both threats and opportunities both systems can activate simultaneously and to differing degrees, depending on the relative imminence of the threats and opportunities (Larsen et al. 2001; Wang et al. in press).

Recent research within this perspective has investigated the extent to which negative and positive television messages activate the appetitive and the aversive motivational systems respectively. These studies have collected time-locked psychophysiological measures used to index appetitive and aversive activation during media use. Results have shown that positive messages appear to activate the appetitive system as evidenced by increases in activation in the zygomatic (smiling) muscles (e.g., Bolls et al. 2001; Lang et al. 2007a, under review), facilitation of the post auricular reflex (e.g., Sparks and Lang 2010), inhibition of the startle response (e.g., Bradley 2007; Lang et al. 2006, 2007a; Sparks and Lang 2010), and increased self-reported positive emotional experience (e.g., Lang et al. 2005, 2007a; Shin 2006). Similarly, negative messages appear to activate the aversive system as evidenced by increases in activation in the corrugator (frowning) muscles (e.g., Bolls et al. 2001; Lang et al. 2007a, under review), inhibition of the post auricular reflex (Sparks and Lang 2010), facilitation of the startle response (e.g., Bradley 2007), and increased self-reported negative emotional experience. In addition, skin conductance has been used to index the overall level of activation in the combined motivational systems (Lang et al. 2007a, submitted). Dynamic time series modeling of these interactions suggests that initial physiological changes indicative of motivational activation lag the change in emotional media content by a few seconds (Wang et al. 2011, 2012, in press). Other work suggests that deactivation of the motivational systems may occur more slowly than their activation (Wang and Lang 2012).

Unique to the LC4MP is a set of predictions about how the level of activation in the appetitive and aversive motivational systems might alter the allocation of cognitive resources to encoding and to storing the message information. LC4MP argues that because information intake is a primary function of approach behavior, increases in appetitive activation should lead to increases in resources allocated to encoding. Further, because survival can depend on remembering survival related information (e.g., where food and water have been found) increasing appetitive activation should also lead to increases in resources allocated to storage (Lang et al. 2006). For the same reason, increasing aversive activation is predicted to lead to increases in resources allocated to storage. However, aversive activation, in conjunction with the defense cascade model (Bradley et al. 2001), is predicted to support multiple cognitive tasks depending on the imminence of the threat and the level of aversive activation. As a result, the direction of the influence of aversive activation on resource allocation to encoding is predicted to depend on the level of activation in the aversive system. At low to moderate levels of threat, aversive activation is thought to increase allocation of resources to encoding, in support of tasks related to scanning for and then identifying and tracking potential threats in the environment. As threats become more imminent, aversive activation increases, and the supported tasks shift from scanning and identifying threats to retrieving threat relevant information and making protection related decisions. Thus, it is predicted that low to moderate increases in aversive activation result in rapid and large increases in resources allocated to encoding. However, if aversive activation increases from moderate to high levels, resources allocated to encoding are predicted to decrease (Lang 2006a, b, 2009; Lang et al. 2007b; Shin 2006; Wang et al. in press).

Recent research has shown initial support for these theoretical hypotheses. Shin (2006) had participants view positive and negative television messages at six levels of arousing content ranging from extremely calm to extremely arousing. Recognition for message content was measured as an indicator of encoding. As predicted, results showed a linear increase in recognition for positive messages and an increase followed by a decrease in recognition for negative messages across the six levels of arousing content. In addition, at low levels of arousing content, positive messages were encoded better than negative messages, as predicted by the positivity offset, and at moderate levels of arousing content negative messages were encoded better than positive messages, as predicted by the negativity bias.

In addition, Wang et al. (in press) used time-series models to examine single and dual activation of the motivational systems during television viewing. Second by second ratings of the negativity and positivity of messages were used to predict cardiac-somatic coupling patterns as an indicator of resource allocation (e.g. attention). Consistent with LC4MP, they found that motivational activation elicits resource allocation to message processing and that the level is moderated by emotional intensity. Further, coactive content, at low and moderate levels of arousal, results in greater resource allocation than single activation. Further, at high levels of intensity aversive activation is greater than appetitive activation (due to the negativity bias) and resource allocation shifts from information intake to behavioral preparation.

This study is designed to extend this work by using the LC4MP to predict both global (between messages) and local (within message) encoding and storage of information contained in positive, negative, and simultaneously positive and negative television messages. A set of 12 real television messages, four with each of the three emotion trajectories, were selected for the study. All the messages begin neutral and thus, theoretically, should elicit, initially, slightly more appetitive than aversive activation due to the positivity offset. Over-time, four of the messages either increased monotonically in positive content (positive messages), four increased monotonically in negative content (negative messages), and four increased simultaneously in positive and negative content (called coactive messages). The messages used are 30-second public service announcements and are only moderately arousing (e.g. no sexual behavior, nudity, blood, gore, and mayhem). Thus, motivational activation is not likely to reach high levels. Therefore, theoretically, over the course of the message positive messages should elicit increasing appetitive activation, resulting in increased allocation of resources to encoding and storage. The negative messages should elicit increasing aversive activation also resulting in increased allocation of resources to encoding and storage since, in this context, high levels of aversive activation are not likely to be attained.

During coactive messages, LC4MP predicts that both systems will activate simultaneously. Thus, initially, as both systems activate at a low level, both systems should allocate resources to encoding—resulting in more resources being allocated to encoding for coactive compared to singly active messages. However, early in the messages, when activation is low, more resources should be allocated by the appetitive than by the aversive systems due to the positivity offset. As activation increases from low to moderate both systems should continue to allocate increasing resources to encoding, but that increase should be larger for the aversive system due to the negativity bias. As activation in both systems increases to high levels the appetitive system should continue to allocate more resources to encoding while the aversive system should allocate fewer resources to encoding though this is not expected to happen in this study.

A slightly different picture is predicted for how resources will be allocated to storage during coactive message. Both systems are predicted to continue to allocate increasing resources to storage with increasing activation resulting in continuously increasing storage for coactive messages.

Within the LC4MP encoding is indexed by recognition, storage is indexed by cued recall, and, as mentioned previously, available resources are indexed by STRTs. Available resources are equal to resources allocated minus resources required. However, if the level of resources required is controlled across messages and at the point where the STRT probe occurs, then variation in STRT will reflect only the change in resources allocated (Lang et al. 2006, 2007c). As a result, faster STRTs will mean greater resource allocation. Hence, because coactivation should lead to greater resource allocation:

H1 STRTs will be faster (indicating greater resource allocation) during coactive compared to positive or negative messages.

H2 Recognition and cued recall will be better for coactive compared to positive or negative messages.

In addition, as a result of the positivity offset and negativity bias:

H3 During the initial time period, STRTs should be faster for coactive and positive messages than for negative messages due to the dual activation in coactive messages and the positivity offset.

H4 STRTs should get faster from the first to the second time period for all messages (due to increasing motivational activation), but the increase should be greater for negative compared to positive messages due to the negativity bias.

H5 During the first time period, recognition and cued recall should be better for positive compared to negative messages and there should be no difference or negative should be better during the second time period.

Method

Design

The experiment uses a 3 (Message Type) × 3 (Time) × 4 (Messages) X 4 (Order of presentation) mixed design. Message type, time, and messages are within subjects factors. Message type has three levels: increasingly positive, increasingly negative, and increasingly coactive. Time has three levels: the first, middle, and last 10 s in each 30-second message. The message factor represents the four messages presented in each message type (Reeves and Geiger 1994). Order of presentation was a between subjects factor and is made up of four different purposive presentation orders designed so that each message appeared in each third of the stimulus presentation across orders and was preceded and followed by different messages in each order.

Stimulus selection and manipulation check

The messages used in this study were chosen from a data base of over 300 PSAs on drug prevention, anti-smoking, safe sex, etc. The PSAs in this data base were already preliminarily coded for a variety of structural and content features, including positive and negative appeals and amount of new information introduced (an indicator of resources required). An initial group of 36 messages were selected based on the researchers' judgment of the trajectory of emotional content (increasingly positive, negative, or coactive). Positive messages were defined as those which contained positive and pleasant locations, people displaying positive emotions, and positive activities. Negative messages were defined as those which showed unpleasant locations, people displaying negative emotions, and negative activities. Coactive messages were defined as those that contained both positive and negative elements (including locations, display of emotions, and activities).

A pretest was conducted on the selected messages using continuous response measures (Biocca et al. 1994). In groups of two to five, 80 participants continuously rated their emotional responses while viewing the 36 PSAs on laptop computers with headphones. There were two orders of the 36 messages. Each participant rated half of the messages while responding to the prompt "how positive do you feel" and half the messages while responding to the prompt "how negative do you feel." Thus, each message was continuously rated for negative emotional experience by half the subjects and for positive emotional experience by half the subjects. Online ratings were sampled 10 times per second, averaged over one second, and stored using MediaLab software (Jarvis 2006). The rating scales ranged from 0 to 10, anchored by "not at all negative" or "not at all positive" and "extremely negative" or "extremely positive".

Following data collection, for each message, positivity and negativity ratings were averaged across participants over each second and plotted across time. Visual inspection of the graphs was used to select the final four messages in each Message Type condition (positive, negative, and

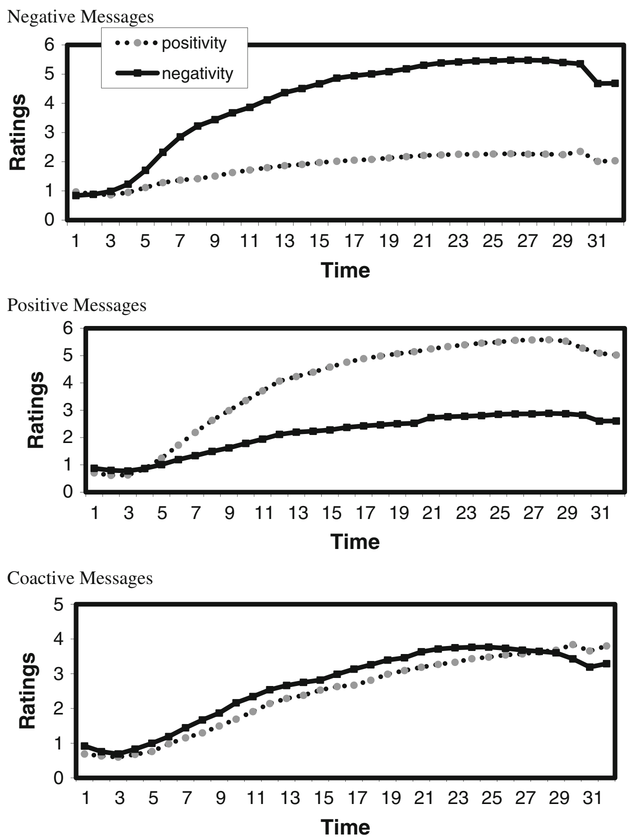

Fig. 1 Average negativity and positivity ratings for the three types of emotional messages over time

coactive) which best exemplified the desired dynamic pattern of emotion, that is, increasing positivity, increasing negativity, and simultaneously increasing positivity and negativity across the course of the message. The continuous ratings by second averaged across the four final messages per message type are shown in Fig. 1.

Participants in the final experiment gave summative positivity, negativity, and arousal ratings following each message, which served as a manipulation check. There was a main effect of message type on both self-reported negativity, $F(2,166) = 353.01$, $p < .001$, $\eta_p^2 = .800$, and positivity, $F(2,166) = 270.75$, $p < .001$, $\eta_p^2 = .770$. The means and standard errors are presented in Table 1. Negative PSAs were rated the most negative, followed by the coactive and then the positive PSAs; all three means differ significantly from one another. Positive PSAs were rated the most positive followed by the coactive PSAs and the negative PSAs; all three means differ significantly from one another. In addition, there was a main effect of message type on arousal ratings. The 36 messages in the pretest were initially selected, on the basis of a priori coding, to be moderately arousing. While all the messages are in the moderate arousal range, planned *t* tests reveal that the summative ratings of the coactive PSAs are significantly lower than the negative and positive PSAs, which did not differ significantly from one another. All, however, are in the moderate range of the scale.

Dependent variables

Resource allocation

STRTs were measured as an indicator of resource allocation. In order to control momentary increases in both resources allocated as a result of an OR and resources required as a result of the introduction of new information, STRT probes were placed so as not to be within 1.5 s of an orienting eliciting structural feature (e.g., camera changes, music onsets; Lang et al. 2007c). To further control resources required the messages used in the study were all selected to have moderate levels of resources required as indicated by the global information introduced measure (Lang et al. 2006). Three tones were embedded in each message—one tone in every 10-second period of the message. The time between tone onset and when participants pressed a button in response (as they were instructed to do as a secondary task) was collected. Because resources required was controlled, slower STRTs indicate less resource allocation while faster STRTs indicate more resources allocated to process the message. The STRT tones were controlled and data were collected using

Table 1 M(SE) for three message types

Message type			
Dependent variable	Positive	Negative	Coactive
Positivity rating	5.89 (.17)^{a}	1.90 (.11)^{b}	3.32 (.13)^{c}
Negativity rating	2.11 (.13)^{a}	6.61 (.17)^{b}	4.59 (.16)^{c}
Arousal rating	4.62 (.18)^{a}	5.00 (.27)^{a}	3.69 (.17)^{b}
Recognition (% correct)	.747 (.018)^{a}	.747 (.02)^{a}	.806 (.01)^{b}
Cued recall (% correct)	.293 (.02)^{a}	.470 (.02)^{b}	.577 (.02)^{c}
STRT (ms)	376.13 (11.66)^{a}	413.68 (13.30)^{b}	385.85 (11.47)^{a}

Means which do not share a superscript differ significantly from one another ($p < .05$). Planned comparisons were computed using *t* tests

MediaLab software. Because outliers can have a disproportionate influence on STRT means and variance, values greater than two times the interquartile range were replaced with the top value of the intern quartile range (Basil 1994). A total of 3.7 % (93 of 2448) of the data points were replaced.

Encoding

Accuracy of audio recognition was used as an indicator of encoding. Recognition tests are frequently thought to be a good indicator of encoding because they do not require the participant to retrieve information. The audio recognition test was created by selecting one sentence from each 10-second period of each PSA as the target sentence, resulting in three targets per message. Foils were created for each target by changing three words in the sentence without changing the meaning of the sentence. Both the target and the foil sentences were then digitally recorded by the same speaker. In the experiment, participants heard each sentence over headphones and were told to click a "yes" at the bottom of the screen if they had heard that exact sentence in the message, or a "no" if they had not. They were instructed to respond as quickly as possible. The items were presented randomly using MediaLab software. Response accuracy was scored and is reported as percent correct of audio targets.

Storage

Cued recall tests are often used as an indicator of storage because they require participants to retrieve a specific piece of information. For each message, a fill-in-the-blank question was created about the major action or the main point in each 10 s of the message. The questions were presented on a computer screen and participants typed in their answers. The three questions for each message were presented randomly, following a sentence designed to cue participants to the specific message being asked about ("you saw a message about…"). The order in which messages were cued was also randomized across subjects. Participants' answers were scored as correct or incorrect and recorded as percent correct per message.

Participants

Eighty-four undergraduate students at a large Midwestern university participated in the experiment for course or extra credit. Their average age was 21.05 ($SD = 1.34$) and 58 % were female. Due to a data collection error, $N = 68$ for all STRT analyses.

Procedure

After giving informed consent, participants were seated at individual laptop stations in a room with up to five others separated by dividers. All messages and questions were delivered via laptop and headphones. Participants first viewed the 12 randomly presented negative, positive, and coactive PSAs. While viewing each PSA, participants were instructed that their primary task was to concentrate on watching and remembering the television messages as they would be given a memory test at the end of the experiment (i.e., the primary task); however, they were also told that whenever they heard a tone they were to push a button as fast as possible (i.e., the secondary task). Immediately after viewing each PSA, they rated how positive, negative, and aroused they had felt while viewing on 9-point scales. Next, participants completed an image viewing and rating task as a 15 min distractor before memory measures were administered. They then completed the cued recall followed by the audio recognition tests. Lastly, they completed several demographic items, and were thanked and dismissed.

Results

H1 and H2 tested hypotheses about the impact of dual versus single motivational activation. H1 predicted that STRTs would be faster (indicating greater resource allocation) during coactive compared to positive or negative messages. The main effect of message type on the STRT data was significant, $F(2, 134) = 14.09$, $p = .001$, $\eta_p^2 = .174$ (see Table 1 for the means). Planned comparisons were tested using pairwise t tests. STRTs during coactive messages were significantly faster than during negative messages, but did not differ from positive messages.

H2 predicted that recognition and cued recall would be better for coactive compared to positive or negative messages. The message type main effect was significant for both recognition, $F(2,166) = 6.12$, $p < .001$, $\eta_p^2 = .069$, and cued recall, $F(2,166) = 132.06$, $p < .001$, $\eta_p^2 = .614$ (see Table 1 for the means). As expected, coactive messages were recognized and recalled significantly better than positive and negative messages. There was no significant difference in recognition for positive and negative messages, but negative messages were recalled significantly better than positive messages.

The next three hypotheses tested predictions related to positivity offset and negativity bias. H3 predicted that STRTs should be faster for coactive and positive messages during the first time period. The motivation type main effect tested on the data from the first time period was

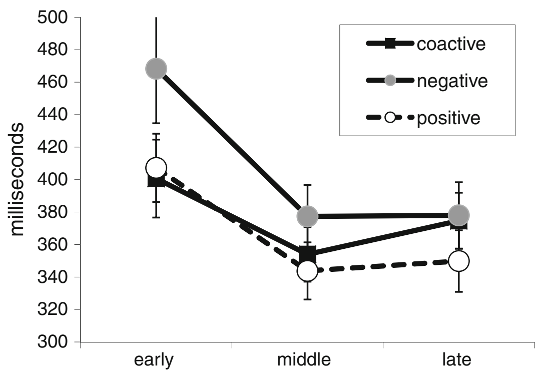

Fig. 2 Message Type × Time interaction on the STRTs

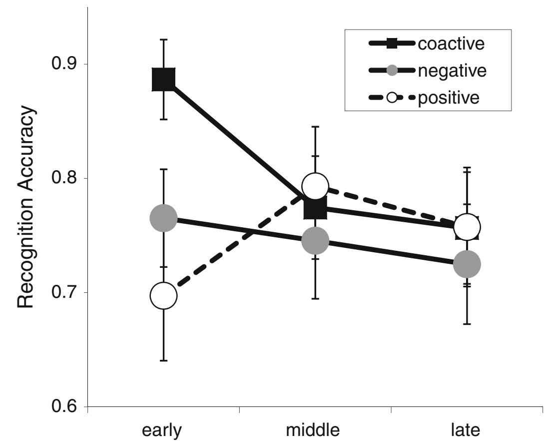

Fig. 3 Message Type × Time interaction on recognition

significant, $F(2,134) = 10.26$, $p = .000$, $\eta_p^2 = .133$. During the first time period, both coactive ($M = 419.01$, $SE = 13.75$) and positive ($M = 416.93$, $SE = 17.41$) messages have faster STRTs than negative messages ($M = 477.36$, $SE = 20.13$), and they do not differ from one another.

H4 predicted that STRTs should get faster from the first to the second time period for all messages, but that the increase should be greater for negative compared to positive and coactive messages. There is a significant Message Type × Time interaction, $F(2,134) = 2.71$, $p < .001$, $\eta_p^2 = .13$. The interaction is shown in Fig. 2 and the means are reported in Table 2. All three message types have significantly faster STRTs during the second time period; but the change is greatest for negative messages (96.637 ms), followed by positive (72.441 ms) and coactive (59.022 ms) messages. In the second time period, STRTs during negative messages remain significantly slower than during positive or coactive messages. In the third time period, however, there are no longer significant differences among the three message types.

H5 predicted that during the first time period, recognition and cued recall should be better for positive compared to negative messages, but during the second time period, there should be either no difference between the two, or negative should be better. The message type × time interactions were significant for both recognition, $F(4,332) = 6.211$, $p < .001$, $\eta_p^2 = .070$, and cued recall, $F(4,332) = 54.864$, $p < .010$, $\eta_p^2 = .398$. The interaction effects are shown in Figs. 3 and 4, and the means are reported in Table 2. During the first time period, contrary to the prediction, negative messages were recognized better than positive messages (and coactive better than either of them). As predicted, during the second time period, there are no significant differences between positive and negative messages, indeed there are no significant differences in recognition among the message types during the second and third time periods. On the other hand, cued recall results are exactly as predicted. Cued recall is significantly better for positive compared to negative messages during the first time period and significantly better for negative

Table 2 M(SE) for each of the three message types at each of the three time periods

	10-Second time period		
	1	2	3
STRT			
Positive	419.930 (13.750)$^{a\ a}$	346.570 (10.350)$^{a\ b}$	362.798 (14.829)$^{a\ b}$
Negative	477.357 (20.130)$^{b\ a}$	380.721 (12.541)$^{b\ b}$	382.967 (11.436)$^{a\ b}$
Coactive	416.930 (17.411)$^{a\ a}$	357.721 (8.758)$^{a\ b}$	382.908 (11.682)$^{a\ c}$
Recognition			
Positive	.697 (.028)$^{c\ a}$	.793 (.026)$^{a\ b}$	.757 (.026)$^{a\ b}$
Negative	.765 (.021)$^{b\ a}$	.745 (.025)$^{a\ a}$	.725 (.026)$^{a\ a}$
Coactive	.887 (.017)$^{a\ a}$	.774 (.023)$^{a\ b}$	.757 (.024)$^{a\ b}$
Cued Recall			
Positive	.438 (.023)$^{c\ a}$	.152 (.021)$^{b\ b}$	.289 (.025)$^{c\ c}$
Negative	.271 (.025)$^{b\ a}$	.562 (.027)$^{a\ b}$	.577 (.034)$^{b\ b}$
Coactive	.696 (.028)$^{a\ a}$	.558 (.026)$^{a\ b}$	.476 (.023)$^{a\ c}$

Means which do not share a superscript differ significantly from one another ($p < .05$). The first superscript is for comparisons between message types (across rows); the second superscript is for comparisons across time (across columns). Planned comparisons were computed using t tests

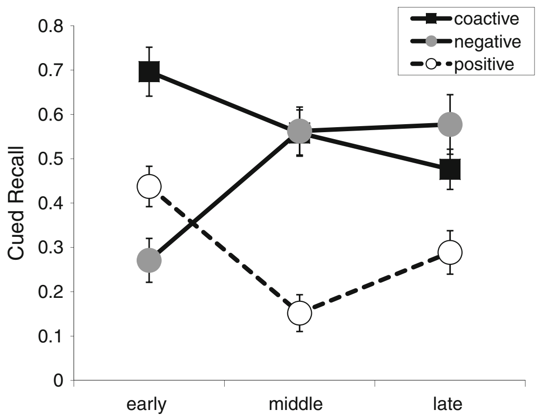

Fig. 4 Message Type × Time interaction on cued recall

compared to positive messages during the second time period.

Discussion

This study had two major goals, to test and extend theoretical hypotheses derived from the LC4MP about how motivational activation elicited by emotional messages would alter resource allocation and message processing and to begin the process of understanding the real time interaction between different patterns of emotional message content and viewer's concurrent motivated cognitive processing.

Overall, the motivated cognition hypotheses fared well in this experiment. First, coactive messages were predicted to result in more resource allocation, replicating previous work by Wang et al. (in press) and overall better encoding and storage as a result of the dual activation of the motivation systems. Coactive messages had faster STRTs and this was particularly true early in messages. These early resources gave coactive messages the best recognition and cued recall in the first time period and kept processing at a high level throughout the message.

The second set of predictions was related to the functional characteristics of the motivational systems: negativity bias and positivity offset. It was expected that as a result of the positivity offset, positive messages would be processed better early when motivational activation was low. Results did show faster STRTs and better cued recall for positive compared to negative messages as expected. However, recognition was better for negative messages during the first time period. Thus, the hypothesis concerning the first time period was only partially supported. As a result of the negativity bias, it was expected that during the second time period, processing of negative messages would get better more quickly and achieve equal or higher levels of encoding and storage than positive

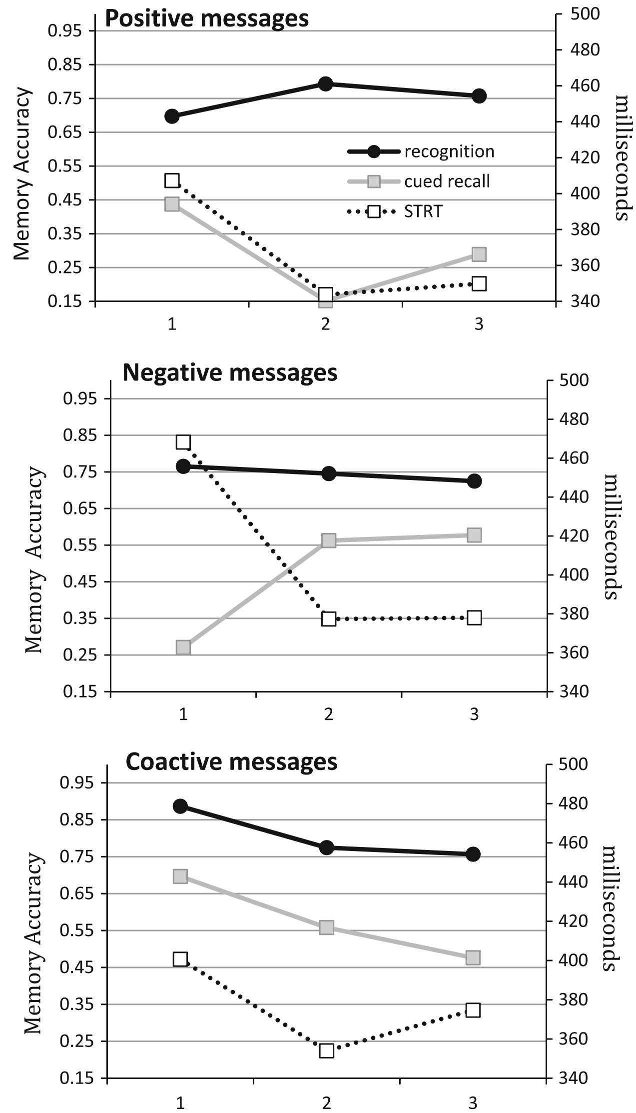

Fig. 5 Patterns of change by message type

messages. Here, as predicted, negative messages had equal recognition, better cued recall, and a larger decrease in STRT compared to positive messages—though positive message still had slightly faster STRTs.

In addition to these specific predictions, the other primary goal of this study is to expand our understanding of how specific trajectories of emotional change in television can influence how resources are allocated overall and across the cognitive processes involved in message viewing. To illustrate these patterns, Fig. 5 was created graphing the three dependent variables together by message type. From the top to the bottom, the three graphs show the data for positive, negative and coactive messages. As shown, positive messages have high and stable levels of recognition as is predicted for appetitive activation; however, surprisingly, cued recall starts out low and gets worse despite fast STRTs indicating plenty of available resources.

On the other hand, negative messages have poor cued recall initially which then gets better quickly and stays good. The LC4MP prediction that greater motivational activation leads to better storage was based upon the motivated cognition perspective that motivationally relevant things should be remembered to increase survival probabilities. Findings in the currents study suggest that while both appetitive and aversive activation (at least at moderate levels) support encoding motivationally relevant stimuli, storing negative stimuli is still relatively more automatic than storing positive stimuli. This would certainly be in line with myriads of research findings suggesting that people are more sensitive to and better remember negative compared to positive information (e.g., Bradley et al. 2001; Lang et al. 1993).

In summary, these data suggest that the LC4MP serves as a useful theoretical framework for studying the overtime interactions of dynamic emotional content and motivated cognitive processing. In addition, these data support the contention that the change in emotional content over messages alters how messages are processed in understandable and predictable ways. Future research should continue to probe how changes in arousal and valence over time alter how concurrently and subsequently presented information contained in messages is encoded, stored, and later retrieved. In addition, there are various typical emotional trajectories in message production. Their influence on processing should be further identified. For example, many messages start positive and end negative or start negative and end positive. Future research should test LC4MP's predictions about these and other patterns of emotional change.

While motivational activation is a relatively fast and automatic response to emotional message content, little is known about the speed of deactivation of the motivational systems or about how messages are processed when the systems are deactivating. Similarly, nothing is known about how messages are processed at times when one system is activating and the other is deactivating. A thorough theoretical understanding of these processes could enable message producers to locate crucial information advantageously with respect to ongoing emotional content. This should result in more effective message design and production. Dynamic time series models have proven to be useful to systematically examine real-time message processing (e.g., Wang et al. 2011, 2012, in press) and should facilitate this theoretical inquiry. Of particularly interest is to develop these dynamic models to formally connect real-time resource allocation data to post-exposure memory outcomes to examine their relationships.

It is worth noting that message type resulted in very large effect sizes for cued recall. This suggests that if one is concerned with how well information is stored, it is not just whether a message is emotional or whether it is positive or negative that matters. Rather, the dynamic pattern of the emotional content makes a large difference. Indeed, the main effect of message type explained 61.4 % of the variance in the cued recall data and 40 % of the variance in the overtime interaction. Thus, the time course of emotion may be particularly influential when it comes to how people store information from a message.

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