Fear, Message Processing, and Memory: The Role of Emotional State and Production Pacing

THESIS

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Abstract

This study examined the interaction of the emotional state of the individual with television’s structural features. Specifically, we examined the affects of fear and production pacing on participant’s memory of visual and audio content of televised public service announcements. Participants were randomly assigned to one of two emotional context conditions. Immediately after viewing the context stimuli, they viewed a sequence of three PSAs, with one at each of three production pacing levels: slow, medium, and fast. Results were mixed. As predicted, memory sensitivity declined and criterion bias became more liberal as production pacing increased. However, emotional context neither affected memory sensitivity, nor judgment criterion. There was also a significant interaction between emotional state and memory sensitivity, though. Limitations and future research considerations are discussed.
Dedication

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Chapter 1: Literature Review

Memory provides the architecture on which we link prior experience with situational nuance in order to reap the adaptive benefits of learning, and research shows that audio-visual content and structure are inextricably linked to memory and learning (e.g. Lang, Bolls, Potter, & Kawahara, 1999). However, the interaction of these message components and the individual’s emotional state has not been specifically examined. This is an important context to explore because one’s emotional state may exert significant influence on the motivation to attend to, and ability to remember the content of a given message. For example, an individual in a calm emotional state may pay scant attention to a given public health message; whereas an individual in a state of distress triggered by a family health crisis may pay rapt attention to that message due to an abrupt sense of personal relevance. The purpose of this study is to contribute to that understanding by building on the work of LC4MP (Lang 2000, 2006).

Specifically, we will examine the influence of fear on the acquisition of information from televised public service announcements warning against the abuse of drugs and alcohol.

Content, formal features and memory

The limited capacity model of mediated message processing (LC3MP, Lang, 2000) examined these dynamics. The model was predicated on the assumption that people are information processors with a limited pool of cognitive resources with which to encode, store, and retrieve information. Lang and others have demonstrated that these sub-processes operate continuously and simultaneously and therefore often “compete” for these limited cognitive
resources. In effect, the pacing, complexity, and emotional intensity of content affect overall processing efficiency. The original model did address the individual’s input, asserting that the viewer partly controls the allocation of processing resources based on goals and personal relevance. However, it mostly focused on the automatic allocation of processing resources through the elicitation of the reflexive *orienting responses* triggered by structural features such as edits, cuts, effects, production pacing, as well as emotional content (Lang et al, 1999). The orienting response is an automatic physiological and behavioral response that occurs when triggered by novel or signal stimuli (e.g. hearing one’s name). Orienting responses include vasodilatation of the blood vessels to the head, decrease of the alpha frequency of the EEG, slowing of the heart, increases in skin conductance and temperature of the skin, and general vasoconstriction of the blood vessels to the major muscle groups. Each response is brief. Lang suggests that this physiological response set is associated with attention (quieting of the body and an increase of blood flow to the brain) and facilitating stimulus intake. In the context of television, change is interpreted within the message (valence and arousal) or structural features. When an orienting response occurs, the viewer orients their sensory receptors toward the stimulus that caused the response, and an organized set of physiological responses accompanies this behavioral response (Lynn, 1966). For example heart rate drops for 4-6 seconds (Campbell, Wood, And McBride, 1997). Skin conductance increases for 1-2 seconds (Kimmel, Van Olst, & Orlebeke, 1979). Automatic allocation of processing resources occurs when the viewer engages stimuli which are novel, unexpected, or signal a change in the environment. Emotional content also elicits the automatic allocation of resources (e.g. Newhagen & Reeves, 1992). Memory of content was found to be optimal between 3-5 seconds after each orienting response. The competition for resources is critical. Each orienting response summons cognitive resources to
the encoding process. Storage entails the linking of incoming information to prior memories. There are limits to an individual’s capacity to store incoming information; therefore resources allocated to encoding may divert them away from storage. Ultimately, the degree to which a message is processed is determined by the level of resources allocated to and required by these sub processes. Therefore, effective health messages must account for the interaction of emotional content and arousal-inducing formal features of television, as they can enhance or inhibit memory of important content. Yet what type of content is best remembered? This requires a theory of emotional processing.

*Motivation, attention, and memory*

Long before the advent of electronic media, our ancestors evolved emotional programs which were activated by images or cues gathered by our sensory organs. Emotions serve to orchestrate human behavior systems, activating some and deactivating others in a harmonious and efficacious manner based on recurrent situations across thousands of generations (Tooby & Cosmides, 2001). Emotions are essential tools allowing us to prosperously interact with our environment. There are two main theoretical approaches to emotion, the dimensional approach and the categorical/discrete approach. Many public health messages related to substance abuse implicitly advocate the discrete approach: labeled “fear appeals,” they contain graphic content intended to enhance persuasion. But a dimensional approach may be more appropriate. Although numerous researchers focus on discrete emotions when talking about aversive emotions (e.g. Epstein 1972; Nabi 2002; Curtis and Biran 2001, other scholars have concluded these emotions overlap, and consider it unproductive and confounding to parse them out (Ohman, 2008). In the context of a public health message, we must decide whether we can claim with confidence which specific emotions these tactics elicit? Does graphic content elicit
fear, anxiety, disgust, or a combination of the three? This study adopts the LC4MP perspective, which incorporates the dimensional approach and a dual system theory of emotion, and adopts the term “fear” in deference to the established fear appeal literature. Lang (2006a, 2006b) added the motivational/emotional component to the model by introducing the concept of motivated processing, creating the current model (LC4MP). Emotional content activates two fundamental motivational systems termed appetitive and aversive (Cacioppo & Bernston, 1999). The appetitive system facilitates information intake and exploratory/approach behavior, while the aversive system functions to withdraw from dangers. Under conditions of low or moderate arousal, the appetitive system is more active than the aversive system. This is termed the positivity offset, and functions to encourage the individual to explore the environment. If stimuli become more negative and arousing, aversive activation increases. Importantly, this occurs more rapidly than appetitive activation, and is termed the negativity bias, which serves to protect the individual from harmful or threatening stimuli (Cacioppo, Bernston, & Gardner, 1999). In the context of this study, aversive activation will occur as a function of the individual’s emotional state. Specifically, individuals experiencing higher degrees of fear will have higher aversive activation, more rapid onset of negativity bias and increased motivation to attend to the messages. Unlike traditional conceptualizations of emotional valence used in mediated message processing research, appetitive and aversive activation are not mutually exclusive. Cacioppo et al. assert that activation may be independent, reciprocal, or co-active. Coactive processing occurs when activation of both systems are high, and is most likely to occur under conditions of moderate arousal and during exposure to complex, multi-faceted stimuli (M.M. Bradley, 2000). When an individual encounters negative stimuli, resources allocated to encoding new information increase up to a threshold, beyond which the individual ceases to
allocate cognitive resources to encoding and instead allocates them to storage and retrieval. In other words, for survival purposes negative stimuli have motivational relevance and elicit the automatic allocation of resources to process new information. However, beyond a certain point, priorities change. Fight or flight decisions are made and motivation shifts away from encoding and toward storage and retrieval of information. This progression is interconnected with a series of physiological responses termed the defense cascade (M.M. Bradley, P.J. Lang, & Cuthbert, 1997).

Specific to this discussion, effective health appeals may include content which is either positive, negative, or both. However, negative content which elicits aversive activation must not be overly graphic, because it may not be accurately remembered. It is especially critical that producers of these important messages account for the interaction of graphic negative content and production pacing. In addition, we propose that the emotional state of the individual is expected to magnify this interaction. Those experiencing higher states of fear are expected to have less tolerance for graphic content and fast production pacing. The enhanced LC4MP has been used to examine structural complexity, emotional content, motivated processing and personality traits such as sensation-seeking and risk-aversion (Lang, Shin & Lee, 2005), yet Lang and her colleagues have not yet measured these interactions with specific emotional states. This is an important consideration relative to motivation and processing capacity when determining how best to create memorable public health messages.

**Dimensions of memory performance**

Since one’s emotional state exerts an effect on both motivation to seek, and ability to recall information, it is important to account for both when assessing memory. This study will conceptualize memory sensitivity, judgment, and motivation in terms of signal detection theory
as outlined by Shapiro (1994). Historically, various forms of true-false procedures have been used to record the percentage of correct items detected within a message, a technique which assumes that a memory is either available or not available. However, researchers have long recognized that judgment and motivation in memory varies between individuals and situations (Pastore & Scheirer, 1974, Zechmeister & Nyberg, 1982). In a signal detection analysis, the researcher conceptualizes signal (actual memories) and noise (false memories) as distributed along a familiarity continuum. An individual must decide whether the presented material is old (has been seen before), or new. There are four possible outcomes to this decision (two correct, two incorrect). If the state of the test item is true (that is, it was shown before), and the individual responds true (meaning they remember seeing it before), that is called a hit. If the individual responds false, that is called a miss. If the state of the test item is false (was not shown before) and the individual responds true, that is termed a false alarm. If the individual correctly identifies the information as false, that is termed a correct rejection. The mean familiarity of actual memories (hits) is generally higher than false memories (false alarms), but in most situations the distributions overlap. The difference between the means of the two distributions, measured in standard deviation units is termed sensitivity.

However, measuring just hits and false alarms give us an incomplete picture in that it fails to account for the interaction of memory and judgment. A person trying to remember must decide how strong a memory must be before deciding that the memory truly is old as opposed to a false memory. In short, the individual must decide on a threshold of memory: if an item exceeds this threshold, individuals conclude that they have seen it before. Below that level, the item is not sufficiently familiar, and individuals decide they have not seen it. This dividing line is referred to as criterion, its location the criterion bias. This accounts for the fact
that, relative to information recall, there are often rewards for being correct and consequences for being wrong, which vary among individuals and situations. If the rewards for a hit are greater than the consequences of a false alarm, the individual is likely to select a liberal criterion. In this instance, the individual will more often correctly detect real memories (hits), yet will pay a price by increasing the number of false alarms. Conversely, if the rewards for a hit are less than the consequences of a false alarm, the individual will select a conservative criterion. In this instance, the individual will seldom record false alarms, yet pay a price my missing some weak real memories (misses). Sensitivity and criterion bias are algebraically-related, as both are based on the relationship between the individual’s proportion of hits and false alarms, but they are independent measures. In short, the familiarity distributions of two individuals may be identical (sensitivity), yet their confidence in that familiarity may differ and will be reflected in their propensity to answer yes or no (criterion bias).

*Emotion, sensitivity, and criterion bias*

Both message content and the individual’s emotional state interact to affect information processing, shaping both sensitivity and criterion bias. This can have important consequences. In an effort to warn against the adverse effects of drugs or alcohol, producers often integrate graphic, fear induction content intended to enhance message effectiveness. However, theory suggests that it could inhibit the memory of message content in some circumstances. When an individual encounters negative stimuli, resources allocated to encoding new information increase up to a threshold, beyond which the individual ceases to allocate cognitive resources to encoding and instead allocates them to storage and retrieval (M.M. Bradley, P.J. Lang, & Cuthbert, 1997). In terms of signal detection, once this threshold is reached, sensitivity (recognition) is impaired as priorities shift away from encoding new information. In addition,
criterion bias may also be affected. There is preliminary evidence that just prior to cognitive overload, criterion bias becomes more liberal (Fox, Park, and Lang, 2007). In short, the individual may choose to de-emphasize information intake, or unconsciously shift away from information intake due to cognitive overload. These trends are particularly evident when aversive activation is high. Leshner, Bolls, and Thomas (2009) examined the effects of fear and disgust on participants’ visual recognition of content of anti-smoking PSAs. They found that sensitivity was higher (better recognition) for messages with higher levels of either fear or disgust, but lower for those which contained high levels of both. In addition, criterion bias was more liberal for those high in disgust, meaning participants were more willing to guess yes. MacLeod, Matthews, & Tata (1986) found that anxious participants directed their attention towards threatening words, while non-anxious participants directed their attention away from them. This dynamic can be seen interacting with memory relative to terrorism and face recognition. Over the past 40 years, literature pertaining to face recognition has consistently found that individuals are better able to recognize faces of their own race (Horry & Wright, 2008; Malpass & Kravitz, 1969; Wright, Boyd, & Tredoux, 2003). This is termed the own-race bias (ORB), which is characterized by higher sensitivity to own race and a more liberal criterion bias toward other races, at the expense of more false alarms. MacLeod and colleagues measured all (white) participants for state anxiety, and also primed some participants with terrorism-related words, and found a significant interaction between anxiety and priming. Those higher in state anxiety that were primed demonstrated higher sensitivity to Middle Eastern faces than those in the non-priming condition. Importantly, the increased recognition came at a “cost,” as measured by criterion bias. Participants responded more conservatively (i.e. confidently) for white faces and more liberally for Middle Eastern faces. In other words, those
with higher aversive activation required less evidence when asked if they recognized a ‘threatening’ face.

To summarize, emotions, both positive and negative, are sources of arousal. At moderate levels, arousal enhances message processing; in excess, it impedes it. Information processing shapes memory, which in turn exerts a significant influence on attitudes. The medium, message content, and the individual are all sources of arousal. Therefore all must be accounted for when examining how mediated health messages are processed. Ultimately, the specific information which an individual remembers, and how that information is evaluated, affects how attitudes are formed, shaped, and sometimes altered.

**Hypotheses**

Emotions serve to orchestrate human behavior systems, activating some and deactivating others based on situational nuance. Emotions are tools allowing us to prosperously engage our environment. Our well-being is predicated on recognizing beneficial (positive) and harmful (negative) stimuli. Positive stimuli activate the appetitive system, encouraging the individual to explore the environment, while negative stimuli activate the aversive system, alerting the individual to potential threats. Most important to this study, aversive activation is rapid, motivating the individual to attend to and encode new information. Individuals in high fear emotional states are expected to attend to and have greater memory of pertinent information than those in low fear emotional states. We therefore expect a main effect for emotional state such that:

H1a: Recognition, as measured by sensitivity will be lower for those in low fear emotional states than for those in high fear emotional states.
In addition, we expect that those in high fear emotional states are more likely to regard the information as relevant to their well-being than those in low fear emotional states. They will therefore require less evidence of familiarity in deciding an item was old. We therefore predict a main effect for emotional state such that:

H1b: Individuals in a high fear emotional state will have a more liberal criterion bias than those in a low fear emotional state.

The medium itself dictates the automatic allocation of processing resources through the elicitation of the reflexive orienting responses triggered by structural features such as edits, cuts, effects, and production pacing. Automatic allocation of processing resources occurs when the viewer engages stimuli which are novel, unexpected, or signal a change in the environment. In the context of this study, change is conceptualized as production pacing – measured in cuts (i.e. edits in the video sequence) per second. Few cognitive resources are allocated at low pacing levels, yet increased pacing elicits greater allocation as each visual change is encountered. Prior research has demonstrated that production pacing can enhance or inhibit memory sensitivity. For example, Lang et al. (1999) demonstrated that for viewers exposed to non-arousing content, memory sensitivity increased as production pacing increased. Importantly, the study demonstrated that memory peaked at medium pacing levels and declined at high levels. In the current experiment, we controlled for content intensity by using PSAs which had been pretested and found to be low in arousal, and utilized PSAs with pacing levels which were faster than those used by Lang and her colleagues. We therefore predict a main effect for production pacing such that memory sensitivity will be highest for PSAs with low levels of production pacing, after which we would see a noticeable decline.
H2: Memory sensitivity will be higher for PSAs with low levels of production pacing, and decline as pacing levels increase.

Both the individual and the medium are potential sources of arousal. An individual in a high fear emotional state who engages content with rapid production pacing will soon place unquenchable demands on a limited pool of cognitive resources. This may lead to a de-emphasis on information intake and a shift toward storage and retrieval, or cognitive overload. Those in the high fear condition should have less tolerance for rapid production pacing. Given the expected decline in memory sensitivity due to increased pacing, there will be an interaction between emotional state and production pacing such that:

H3a: Memory sensitivity will decline more rapidly for those in the high fear condition than for those in the low fear condition as pacing increases.

When arousal from both sources causes information intake priorities to shift or cognitive overload to occur – memory judgment will also change. The individual may experience reduced confidence in memory judgment. There is no definitive way to predict an individual’s reaction to reduced confidence. Perhaps faced with rapid pacing and a high fear state, people will simply guess, demonstrating no propensity to answer yes or no. On the other hand, there is a potential for cognitive overload. Prior research indicates that just prior to cognitive overload, criterion bias becomes more liberal. That is the prediction here. There will be an interaction between condition and production pacing such that:

H3b: Criterion bias will become liberal more rapidly in the high fear condition than in the low fear condition as production pacing increases.
Chapter 2: Method

In order to examine the interaction of emotional state and production pacing on memory sensitivity and criterion bias, a two (emotional state: low fear, high fear) x three (production pacing: slow, medium, fast) completely randomized design was used.

**Independent variables: emotional state and production pacing**

**Emotional state:** We do not attend to and remember arbitrary information simply because we are in a state of distress; instead we focus on information relevant to the stressor. Therefore the fear inducement stimulus had to be topic-specific. For that reason two text-based anti-drug stimuli (PSAs) were created in order to induce high and low fear emotional states. The logic was to focus participants’ attention on the issue of drug abuse, but do so with a two distinct degrees of fear intensity. As mentioned, we chose fear in deference to the established *fear appeal* literature, with the full understanding that graphic content may well induce fear, anxiety, or disgust. To manipulate the emotional intensity, the tactic was to exaggerate or violate various components of effective fear appeals based on extensive research by Witte (1992, 1993). One appeal took a low fear, high efficacy approach. The other took a high fear, low efficacy approach. Both warned of the health consequences of addiction to methamphetamines, and contained similar content. However, the high fear appeal had several distinct variations: graphic pictures of meth addicts, more intense language detailing negative consequences, heavy use of second person pronouns, and muted response and self efficacy components. The low fear appeal was negative in its own right, but contained no pictures, utilized muted language and
third person pronouns, and placed more emphasis on response and self efficacy. We conducted a pretest on the two fear appeals to measure for significant differences in self-reported fear. Results indicated that the two appeals did not produce significantly different fear states, leading to several adjustments to each appeal. We speculated that participants were not motivated to read the appeals closely and were therefore unaffected by their quite distinct characteristics. Given time constraints we were committed to a text-based appeal, but we did make several changes to these appeals. Both appeals were reduced from 1,200 to 900 words. Language in the low fear appeal was made more emotionally neutral, and language in the high fear appeal was made more emotionally charged. Finally, additional photographs of meth addicts were included. The effectiveness of these modifications was not tested, a limitation we discuss below.

**Production pacing:** Structural complexity is multi-faceted but was conceptualized here only in terms of production pacing. Specifically, it was operationalized as the rate of camera changes (cuts) per second. PSAs with slow production pacing had 0.16 cuts per second; PSAs with medium pacing levels had 0.33 cuts per second; and PSAs with fast levels ranged between 0.5 and 0.67 cuts per second.

**Dependent variables:** Memory sensitivity and criterion bias

Sensitivity is a measurement which tests the individual’s recognition of previously encountered information. In this experiment, we showed participants a series of three 30 second audio-visual PSAs warning of the dangers of alcohol and marijuana use. We then tested their memory of this content. We presented them with still shots taken directly from the video portion of the messages, as well as sentences taken directly from the audio portion of the messages. We also altered these same images and sentences and presented all of them to participants in random order and asked them to answer yes or no (‘did you see or hear this
exact image or sentence, or not?). Half of the visual and audio content presented were targets (content actually seen or heard). Half of the images were foils (content altered and not seen or heard). Participants made a total of 36 yes or no decisions based on the degree to which the content seemed familiar. Many researchers assume that if participants made yes or no decisions and also ranked each decision in terms of the degree to which they seemed familiar, the two distributions would be normally distributed. In other words, each yes and no decision would be made with varying degrees of confidence. If normality is assumed, sensitivity is then measured by computing the difference between the proportion of false alarms, \( p(FA) \) (e.g. instances a participant reports seeing a video segment that was not included in the video); and hits, \( p(h) \) (e.g. instances a participant reports seeing a video segment that was included in the video). Assumptions of normality should be checked. There is an advantage in using non-parametric measures, particularly for instances when an individual answers all true items correctly \([p(h) = 1]\), or answers all false items correctly \([p(FA) = 0]\). The greatest concern is ceiling effects (i.e. the memory test is too difficult and all participants perform poorly), or floor effects (i.e. the memory test is too easy and all participants perform extremely well). Such cases present measurement problems for parametric measures but not non-parametric measures (Shapiro, 1994). This did occur for a few participants, and since we did not pretest the stimuli due to time constraints, we chose 1) not to discard this data so that we had sufficient data points; 2) to utilize non-parametric measures developed by Hodos (1970) for sensitivity and criterion bias, as recommended by Shapiro (1994).

\[
Sensitivity: \quad A' = 1 - \frac{1}{4} \left[ \frac{p(FA)}{p(h)} + [1 - p(FA)] \right]
\]

where \( p(h) \) = the proportion of hits, and \( p(FA) \) = the proportion of false alarms. Higher memory sensitivity is reflected by a larger \( A' \) mean value.
Criterion Bias:

\[ B'' = p(h)[1 - p(h)] - \frac{p(FA)[1 - p(FA)]}{p(h)[1 - p(h)]} + p(FA)[1 - p(FA)] \]

A neutral criterion bias indicates no propensity to answer yes or no, and has a \( B'' \) mean value of zero. A liberal criterion bias is reflected by a \( B'' \) mean value of less than zero, with criterion bias becoming more liberal as \( B'' \) mean values decrease. Conversely, a conservative criterion bias is reflected by a \( B'' \) mean value greater than zero, with criterion bias becoming more conservative as \( B'' \) mean values increase.

Participants

A convenience sample of 106 O.S.U. undergraduates (27 male, 79 female) from the School of Communication participated in the experiment in exchange for extra credit in their respective courses. Participants’ ages ranged from 18 – 36, with a mean of 20.6. They were greeted and presented with consent forms, and given the opportunity to ask questions regarding the procedure.

Procedure

The study was administered using MediaLab (Jarvis, 2007). Participants were greeted and presented with consent forms and sign-up sheets for their respective classes to ensure they received extra credit. They were given a verbal outline of what they would be presented with in the experiment and offered the chance to ask questions. They were then randomly assigned to either the low or high fear condition. Once seated at individual desktop computers, they were asked to put on headphones and begin the experiment by reading one of two fear appeals warning of the dangers of methamphetamine use. The purpose of this step was to induce distinctly different emotional states among the participants. They were instructed to read these appeals closely, as they would be tested for memory of their content. Immediately following
the text-based appeals, the stimulus continued with the presentation of three 30 second audio-visual PSAs directed at a youth audience warning against the abuse of alcohol and marijuana – one for each of three production paces: slow, medium, and fast. In order to verify that any observed difference was due to pacing and not the content of a particular PSA (single stimulus effect), three separate PSAs were selected for each production pacing level. The production pacing sequences were also randomized in order to account for potential fatigue effects. After viewing the PSAs, participants were engaged in a distraction task designed to clear their short term memory and avoid recency effects. This involved answering questions about basic demographic information and evaluating the text-based fear appeals. The visual and audio memory tests followed. Test order was also randomized. To measure visual memory, participants were presented with six still shots taken from each of three PSAs they watched (18 total). Nine of the images were targets – actual images contained in the messages. Nine were foils – images that appeared similar to audio-visual content but which were not contained therein – (see Figure 1.) We established a criteria for all foils such that alterations had to be made to central information in the middle third of the still shot. Photo-editing software (Adobe Photoshop) was used to alter the frames. Alterations ranged from changing the color of clothing, or adding or removing a central object from the image.
Participants were asked to decide if they had seen the image by clicking a yes or no key or computer mouse as quickly as they could. They were instructed to make these decisions within three seconds. A parallel process was used to measure audio memory. Participants were presented with six sentences (in print on the screen) from each of the three PSAs they watched (18 total). Nine of these were targets – actual phrases contained in the audio-visual messages; nine were foils. We established criteria for all audio foils such that at least three words from the original phrase had to be changed, as well as the meaning of the phrase. Two examples of audio targets and their respective foils are: (Target) ‘Sometimes just hanging out with your friends is all it takes to have a great time.’ (Foil) ‘Sometimes listening to your friends is a terrible influence.’ (Target) ‘You have to have a quick mind so you can surf harder.’ (Foil) ‘You have to
slow things down so you can think clearer.’ Participants were asked to decide if they had heard that exact quote, and required to make their decision within 5 seconds. In sum, each participant was asked to make recognition decisions on 36 items (18 visual, 18 audio evenly split between targets and foils). After the memory test was completed, each PSA was presented again for a manipulation check. Participants were asked to rate each for production pacing level, valence, and the degree to which the message was persuasive to them and their friends. This was the final phase of the experiment. At this point, participants were given a final opportunity to ask questions about the experiment, debriefed, thanked for their participation, and dismissed.
Chapter 3: Results

Manipulation check

To check for production pacing differences, a series of independent t-tests were conducted based on participant’s ratings of each PSA on a 9 point scale. Participants noticed a difference between fast ($M = 5.62$), medium ($M = 5.33$), and slow ($M = 4.13$) conditions. All comparisons were significant ($p < .01$).  

A two-factor fixed-effect ANOVA was conducted in order to test for main and interaction effects of emotional state and production pacing on memory sensitivity and criterion bias. In addition, Bonferroni planned comparisons and trend analyses were conducted to test for significant within-group differences.

Hypothesis 1a addressed the primary assumption that participants in the low and high fear conditions would have different motivations to attend to the anti-drug messages which followed. We expected that those in the low fear condition would be less motivated to attend than those in the high fear condition. We predicted a main effect for condition such that memory sensitivity would be lower for those in the low fear condition than for those in the high fear condition. There was a difference in the predicted direction but it was not significant for video $F(1, 103) = .99, p = .32$; but approached significance for audio $F(1, 103) = 3.57, p = .06$). Memory sensitivity for  

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1 We also included a manipulation check on the two fear appeals. Participants were asked to indicate (on a 9-point Likert scale) how frightened, uncomfortable, nervous, or tense they were after reading the appeals. However, due to a coding error, only participants in some conditions were exposed to these questions and the manipulation check had to be discarded.
audio content was lower for participants in the low fear condition ($A'$ mean = .72, $SE = .03$) than for those in the high fear condition ($A'$ mean = .80, $SE = .03$).

Hypothesis 1a is not supported (see Figure 2).

Figure 2. Memory Sensitivity by Condition

Note: Metric of the vertical axis ranges from .5 to 1, larger, more sensitive. Standard error bars: dotted, black (low fear); solid, gray (high fear)
Hypothesis 1b addressed the judgment aspect of participants’ memory. It predicted a main effect for condition such that criterion bias would be more liberal for those in the high fear condition than those in the low fear condition. A liberal criterion bias indicates that an individual has a propensity to answer “yes” when presented with a recognition task. This leads to a lower value for B’ mean. In other words, our prediction is that individuals in the high fear condition will be more likely to say they recognize content (even if it had not been presented before) than those in the low fear condition. Again, results were in the predicted direction, but were not significant for either video content $F(1, 103) = .953, p = .33$, or audio content $F(1, 103) = .359, p = .55$). Hypothesis 1b is not supported (see Figure 3). There are two plausible explanations for these results, to be discussed.
Note. $B^*$ ranges: (-1, +1). 0 is neutral +/larger, more conservative. Standard error bars: gray, solid (low fear); black, dotted (high fear)

Figure 3. Criterion Bias by Condition
Hypotheses 2 addressed the arousal-inducing effects of production pacing. Prior research has demonstrated that production pacing can enhance or inhibit memory sensitivity. We predicted a main effect for production pacing such that memory sensitivity would be highest for PSAs with slow production pacing and then decline as pacing levels increased. There was a main effect as predicted for video content $F(1, 103) = 15.22, p < .001$, and audio content $F(1, 103) = 26.17, p < .001$. Memory sensitivity was higher for video content from PSAs with slow production pacing ($A'$ mean = .84, $SE$ = .02), than medium levels ($A'$ mean = .79, $SE$ = .03), or fast levels ($A'$ mean = .66, $SE$ = .03). Memory sensitivity was higher for audio content from PSAs with slow production pacing ($A'$ mean = .89, $SE$ = .02), than medium levels ($A'$ mean = .85, $SE$ = .02), and fast levels ($A'$ mean = .72, $SE$ = .02). Hypothesis 2 is supported.

Hypothesis 3a addressed the interaction of emotional state and production pacing. Specifically, we expected that shifting priorities relative to information intake or possible cognitive overload would affect memory sensitivity. An individual in a high fear emotional state will have less tolerance for fast production pacing, and may well place excessive demands on a limited pool of cognitive resources. We predicted an interaction such that memory sensitivity would decline more rapidly in the high fear condition than the low fear condition as production pacing increased. The data support this prediction. There was a significant interaction between emotional state and production pacing for visual content $F(2, 103) = 3.23, p = .04$. Overall, memory sensitivity declined in both conditions as production pacing increased. However the only significant within-group decline, as indicated by a comparison of respective confidence intervals, occurred between the high fear, medium pace condition ($A'$ mean = .86, $SE$ = .05) and the high fear, fast pace condition ($A'$ mean = .69, $SE$ = .05), indicating that the combined effects of high fear and fast pacing had the most detrimental effect on memory sensitivity (see figure
For audio information, there was not a significant interaction between emotional state and production pacing $F(2, 103) = 1.90, p = .15$, although memory sensitivity was lowest in the high fear, fast paced condition. Hypothesis 3a is partially supported.

Hypothesis 3b addressed the interaction between emotional state and production pacing relative to memory judgment. Prior research has demonstrated that criterion bias becomes more liberal just prior to cognitive overload, indicating that the individual is simply guessing that they have seen or heard an item presented on the screen. Even in the absence of cognitive overload, we expected a decrease in recognition confidence (i.e. more liberal). We therefore predicted an interaction effect between emotional state and production pacing such that criterion bias would become more liberal in the high fear condition than in the low fear condition as production pacing increased. There was not a significant interaction between emotional state and production pacing for either video $F(2, 103) = .07, p = .93$), or audio information $F(2, 103) = 2.22, p = .12)$. Criterion bias was most liberal for video content with slow production pacing levels for both high and low fear conditions (see Figure 3). Since memory sensitivity was particularly high for those in these conditions, there is no evidence that this liberal shift is related to impending cognitive overload. Interestingly, there was a condition-by-pacing quadratic shift in criterion bias $F(1, 104) = 4.32, p = .04$. As reflected by comparing their respective confidence intervals, there was a significant conservative-to-liberal shift between slow and medium pacing in the low fear condition; then a significant shift back toward conservative criterion bias between medium and fast pacing. In other words, participants appear to have been relatively uncertain at slow pacing levels, gained significant confidence at medium levels, and then become uncertain again as pacing became fast. Hypothesis 3b is not supported.
Chapter 4: Discussion and Conclusion

This study attempted to build on the principles of Lang’s LC4MP (2000, 2006). Lang and others have demonstrated that production pacing, information complexity, and emotional intensity interact to affect overall processing efficiency. We sought to build on portions of this research by examining the interaction between specific emotional states (high versus low fear) and production pacing levels. We predicted a main effect for emotional state such that those in the high fear condition would be more motivated to attend to each message and therefore demonstrate higher memory for video and audio content. Similarly we predicted that those in the high fear condition would require less evidence of having seen and heard items, resulting in a more liberal criterion bias. Results were in the predicted direction but not significant. There are several plausible explanations for our failure to find significant effects having to do with the experimental design. First, it is difficult to manipulate fear in a laboratory environment. While the two appeal stimuli differed in language intensity and visual graphics, the effect appears to have been minimal, or may have decayed rapidly such that their effect on memory sensitivity was only marginal. As discussed, this was a concern going in. The original pretest was insignificant. We reduced the length of the appeals, altered the language intensity of each, and added more graphic photographs to the high fear appeal. It is possible that participants are simply not motivated to scrutinize the stimuli content, thus negating the potential effects of their quite distinct characteristics. It is also plausible that, despite the more intense, personalized language and use of graphic pictures in the high fear appeal, the low fear appeal
was interpreted as bleak in its own right. This may well have evoked negative affect sufficient enough to neutralize the difference between the two appeals. The experiment may have been better served by including a control group which viewed no stimulus at all. In addition, since it would be more difficult to avoid or gloss over, a graphic, audio-visual high fear appeal would likely have had a greater effect.

Nonetheless, we did see some very tentative evidence suggesting that emotional state might influence memory sensitivity. While not significant, effects were in the predicted direction and approached significance for audio content. If these patterns held up in subsequent testing, this would suggest that participants in the high fear condition are exhibiting higher memory sensitivity. We also saw hints of a possible effect for emotional state on memory judgment. While not significant, effects were in the predicted direction. Again, if these trends were borne out by further testing, this would suggest that those in the high fear condition require less evidence to claim they had indeed seen or heard an item before.

This study did, however, provide further confirmation of the influence of production pacing on memory. Given that the production pacing levels of the PSAs used here were considerably higher than those used by Lang et al. (1999), we predicted that memory sensitivity would be highest at low production pacing levels and then decline as pacing increased. This is precisely what occurred. As discussed, the PSAs utilized in this experiment had been pretested and found to be of low to moderate intensity. We were therefore confident that there would be no confound related to content. Perhaps the most interesting, albeit unexpected finding emerging from this study concerns the effect of production pacing on the memory sensitivity of audio content. Memory sensitivity for audio information was highest for those in the low production pacing condition and lowest for those in the high production pacing condition. This difference
was statistically different and appears to indicate that video production pacing had a noticeable effect on audio memory sensitivity. This is an interesting finding, which challenges an assumption of the field. We expect production pacing to effect encoding of visual information, but not necessarily audio content. Much scholarship posits separate cognitive “pools” which encode audio and visual information (e.g. Pavio, 1971, 1986, 1991, Sadoski & Pavio, 2001). The PSAs were coded for audio information introduced – a measure of audio structural complexity developed by Potter (2006). Audio complexity was similar across all nine PSAs utilized in the current experiment (ranging from 4-7). There is therefore no confound among the PSAs in terms of audio complexity. Fast production pacing appears to have inhibited audio memory sensitivity. Given prior research proposing separate processing of audio and visual information, this warrants future examination.

Limitations

This study examined the interaction of emotional state and structural complexity in the form of production pacing. However there are important components of video and audio structural complexity which were not examined. As mentioned, in an effort to avoid a confound involving audio complexity, we pre-screened all nine PSAs for audio complexity utilizing measurements developed by Potter (2005). However we did not utilize a similar measurement developed by Lang and her colleagues (2006) which measures aspect of video complexity above and beyond production pacing. In other words, information which follows each camera change varies in terms of cognitive demand, and should be accounted for. It is therefore possible that despite uniformity within production pacing categories, the video complexity within pacing categories was not uniform. We anticipated a liberal shift in criterion bias in the high fear, fast production pacing condition. This did not occur, likely as a result of an insufficient fear appeal. Regardless,
we would only be able to infer cognitive overload without using physiological measures – specifically secondary task reaction time (STRT). Prior research has demonstrated that STRT is a reliable indicator of cognitive resources available for the encoding process (Lang et al., 2006). In addition, Fox, Park, & Lang (2008) demonstrated that when signal detection measures are used in combination with STRT, the point at which cognitive overload occurs may be more accurately identified.

Given that sensitivity and criterion bias are calculated by measuring relative proportions between hits and false alarms, an ideal recognition test should include a large number of items since proportions are sensitive to change at lower levels (Murdock, 1982). We were limited because of our interest in comparing memory sensitivity and criterion bias between conditions. We used 36 total items across nine randomized PSAs, differentiated by production pacing levels (i.e. 3 each slow, medium, fast). In order to avoid the single stimulus effect and still achieve a high number of items (close to 100 would be ideal), we would have been compelled to acquire as many as 27 PSAs which were both low in arousal and at different production pacing levels. In sum, ideal experimental design would have included materials coded for audio and video complexity, as well as STRT and signal detection measures, as well as a larger number of items. Although we were unable to induce demonstrably different emotional states using the text and photo-based fear appeals, there is preliminary evidence that the experimental design was sound. Specifically, the emotional state of the individual is a crucial component in the engagement of mediated health messages, and should be accounted for. Lang improved her model in 2006 by integrating the motivational components proposed by Cacioppo & Gardner. However, these components only account for the valence of the content, and not the emotional state and motivation of the individual. Is there external validity in such experimentation? The
defense cascade (Lang, Bradley, & Cuthbert, 1997) provides a useful model depicting the stages of physiological response to aversive perception, yet it leaves some questions unanswered. For example, there are instances when an individual is compelled to engage aversive stimuli, such as consultation with a physician regarding a stricken family member. The individual may be forced to engage aversive stimuli such as medical reports, seek disquieting information relative to long term treatment, or look at actual wounds. Could such situations provide (within limits) a temporarily higher tolerance for aversive stimuli? Some of these answers may be attainable by parsing results obtained from a variety of typologies. Some may remain purely theoretical.

**Future considerations**

A comprehensive understanding of motivated message processing must go still further. Positive and negative emotions do not manifest themselves the same across all individuals. Lang and colleagues have developed activation measures which have identified four main typologies: risk takers, risk avoiders, inactives, and coactives. Activation of the appetitive and aversive motivation systems likely vary among these individuals. For example, individuals who are risk-averse have a high positivity offset and a low negativity bias. They are more easily frightened, and thus more likely to dislike negative stimuli such as risky behavior or graphic anti-drug messages. The wrong message might create unintended boomerang effects (Sherif, 1965). On the other hand individuals who are risk-takers have a high positivity offset and a low negativity bias. They are driven to explore and may be attracted to negative stimuli, which may in fact generate a positive mood state. It is conceivable that graphic messages might attract these individuals to risky behavior. Interestingly, such a positive mood state could be advantageous if it was linked to an attractive normative influence. For example a graphic message depicting aversive consequences to a valued peer may produce a stimulating yet
memorable message with lasting impact. In short, the effectiveness of a given message is contingent on the emotional state and individual differences in the activation (perhaps co-activation) of the appetitive and aversive systems, as well as the structural complexity of the message. In addition, how does audio and video complexity interact with these typologies? There may be stimulating components which are unique to visual content. If so, perhaps audio-only messages would have greater effects on risk-takers. In addition, if a given message has high amounts of both positive and negative, how do these co-activating stimuli affect message processing? In other words, do they have cumulative effects leading to cognitive overload? This is not clear in the message processing literature. If there are cumulative effects, do they differ among typologies? In sum, all aspects of the emotional state, individual differences, message content, and production features must be explored if we are to gain a comprehensive understanding of motivated message processing.

Conclusion

There is a wealth of communication literature which explains the effects of content and formal features on memory, yet the moderating role of the individual’s emotional state has not been specifically measured against features such as production pacing. We know that content and features are sources of arousal. In moderate amounts, arousal enhances memory; in excess it inhibits it. Because health crises may be sudden, individuals in calm emotional states may be jolted into states of anxiety or fear – a third source of arousal which motivates individuals to attend to messages they may have previously ignored. We argue that all sources of arousal must be accounted for in order to craft public health messages which the audience remembers in detail. This study offers tentative evidence that the emotional state of the individual may
affect both memory and judgment of content encountered in public health messages, but more research is required.
References


Appendix

**Phase I** (Instructions): “Please read carefully the following article. After reading it, you will be asked to answer some questions about what you read.”

**Phase II** (Distracter Task) Demographics
Age: How old are you?
Gender: You are: 1-male; 2 - female
Race: Would you mind telling us your race? 1- Asian; 2- Black; 3- Hispanic; 4- White; 5- Other; 6: Please skip this question
Persuasion: How persuasive is this message to you? 1- Not persuasive at all; 5- Somewhat persuasive; 9 – Very persuasive
Perf: How persuasive will this message be to your friends? 1- Not very persuasive; 5 – Somewhat persuasive; 9 – Very persuasive

**Phase III** (Instructions): “Next you will see some still images. Some of these images are from the PSAs you just watched and some are not. If you recognize an image as an exact image from the PSAs, please click yes; otherwise click no. Each image will be presented for only 3 seconds. Please make your judgment within 3 seconds.”

“Next you are going to see some sentences. If you think you heard the exact sentence from the PSAs that you just watched, please click yes: otherwise please click no. You have up to 5 seconds to make the response.” All PSAs had been previously pretested and judged to be low in arousal.

**Targets and Foils: response categories (1 = yes; 2 = no)**

<table>
<thead>
<tr>
<th>Target</th>
<th>Foil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow</td>
<td>sa1t/sv1t, sa2t/sv2t, sa3t/sv3t</td>
</tr>
<tr>
<td>Medium</td>
<td>ma1t/mv1t, ma2t/mv2t, ma3t/mv3t</td>
</tr>
<tr>
<td>Fast</td>
<td>fa1t/fv1t, fa2t/fv2t, fa3t/fv3t</td>
</tr>
</tbody>
</table>

**Note:** Cell indicates variable name for audio/video responses.

**Phase IV:** (pacing manipulation check and PSA reaction)
“Now in this last part, please tell us how the 3 PSAs made you feel.”
pace: The pacing of this clip is (1-very slow – 9 very fast).
a: Please rate overall how aroused the movie clip made you feel (1- not at all – 9 extremely aroused, excited, awake).
v: Please rate overall how you feel positive or negative about this message (1- very positive – 9 very negative)
n: Please rate overall how negative the movie clip made you feel (1- very negative – 9 not at all negative)
p_: Please rate overall how positive the movie clip made you feel (1-very positive – 9 not at all positive)
l_: How much do you like this message? (1- don’t like at all – 9- like it very much).
ef_: How persuasive will this message be to your friends? (1- very persuasive – 9 not at all persuasive)
e_: How persuasive is this message to you? (1- very persuasive – not at all persuasive)
wat_: Have you seen this message somewhere before? (1- never, 2- once, 3- more than once)

Dependent variables:
Asv: A’ slow video = memory sensitivity for video content (slow paced condition)
Bsv: B” slow video = criterion bias for video content (slow pace condition)
Amv: A’ medium video = memory sensitivity for video content (medium pace condition)
Bmv: B’ medium video = criterion bias for video content (medium pace condition)
Afv: A’ fast video = memory sensitivity for video content (fast pace condition)
Bfv: B” fast video = criterion bias for video content (fast pace condition)
Asa: A’ slow audio = memory sensitivity for audio content (slow pace condition)
Bsa: B” slow audio: = criterion bias for audio content (slow pace condition)
Ama: A’ medium audio = memory sensitivity for audio content (medium pace condition)
Bma: B’ medium audio = criterion bias for audio content (medium pace condition)
Afa: A’ fast audio: memory sensitivity for audio content (fast pace condition)
Bfa: B’ fast audio: criterion bias for audio content (fast pace condition)

Stimulus Order and Condition (H = High Fear; L = Low Fear; 1 = order one; 2 = order two; 3 = order three; s = slow, m = medium, f = fast pacing)
H1 Dear Richard s1_c1; GirlBall m2_p2; Surfing f2_p6
H2 FistinMouth s2_c2; GirlOutside m3_p3; Director f3_p1
H3 Boring s3_n1; Yard m1_p8
L1 Dear Richard s1_c1; GirlBall m2_p2; Surfing f2_p6
L2 FistinMouth s2_c2; GirlOutside m3_p3; Director f3_p1
L3 Boring s3_n1; Yard m1_p8; 4Cigarettes f1_n6