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ORIGINAL ARTICLE

Using the Limited Capacity Model of Motivated Mediated Message Processing to Design Effective Cancer Communication Messages

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This paper applies the limited capacity model of motivated mediated messages (LC4MP) to the problem of creating effective messages about cancer. A general description of the model is presented and then applied specifically to the task of creating effective cancer communication messages by asking the following questions about cancer communication: (a) What is the goal of the message? (b) Who is in the target market? (c) What medium will carry the message? and (d) What is the motivational and personal relevance of the main information in the message for the majority of people in the target market? The paper concludes that cancer is a motivationally relevant topic that will elicit aversive activation. Target markets for various types of cancer-related messages (e.g., smokers or people of a certain age) will process mediated messages in predictably different ways making certain design decisions better for certain target markets. Both structural and content elements of messages interact with the limited capacity information processing system to impact resource allocation, which in turn determines how well messages are encoded, stored, and retrieved at a decision point. Individual differences in peoples' motivational activation influence both their tendencies to engage in risky behaviors that increase the probabilities of getting cancer and their processing of health-related messages. Future research from this perspective should be done to optimize cancer messages for specific target audiences using specific media.

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Why do we study health communication specifically? Is health communication different from other types of communication? Is health communication about cancer different from health communication about other topics? Obviously, we study health communication because we want to be able to deliver effective messages about health-related information and behaviors to people who would benefit from those messages.

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Health communication shares a great deal with other forms of goal-directed communication (e.g., advertising, political communication, public relations, and educational messages), and we should take advantage of what is known to construct health-related messages that achieve specific goals for designated target audiences. The goals of the message may range from awareness to reinforcement to knowledge gain to persuasion to behavior change. The target market may range from every member of the public, young and old, one to a small well-defined group of people.

In many ways, communication about cancer and cancer control is a restricted subset of health communication. Communications about cancer deal with a topic that is scary, negative, and may impact, in some way, virtually everyone. Communicating about cancer includes all of the goals extant in other forms of health communication: awareness (e.g., of new treatments and findings), reinforcement of behaviors that decrease cancer risk (e.g., NOT smoking), knowledge gain (e.g., creating messages that give people information about cancer, medication, treatment, etc.), persuasion (e.g., changing people's minds about the health risks of common and uncommon behaviors such as getting a tan, drinking a glass of wine, or having yearly mammograms), and behavior change (e.g., getting screened, stopping smoking, eating more vegetables). Communication about cancer may be highly targeted (e.g., teens, women over 55, sufferers of a specific condition) or it may be aimed at the entire population (e.g., messages about healthy eating and lifestyles or the danger of too much sun).

In other words, communication about health in general and cancer in particular is much like any other sort of goal-directed communication. You must determine the audience for your message, the goal of your message, what medium can be used to reach that audience, and then you must build an effective message. This paper is about this final step. How do you build effective messages about cancer? The theory presented here (the limited capacity model of motivated mediated message processing [LC4MP]; A. Lang, 2000, 2005) is a theory about how individuals process mediated messages. The theory is meant to be applicable to all contents, all media, and all goals. The medium, the content of the message, and the goal of the message are variables within the theory. Different media, contents, and goals will lead to different patterns of motivational and cognitive responses in viewers that, interacting with the structure and content of the messages and the individual differences of the media user, determine a great deal about how a message is processed, including which parts of the message are attended to, encoded, and stored and how the message is evaluated and liked. The goal of this paper is to apply LC4MP specifically to the problem of creating effective messages about cancer. To do so, this paper will introduce LC4MP in general and review and apply the findings of research done within the LC4MP framework to this question.

The LC4MP

This model has five major assumptions—the first about the nature of cognition, the second about the nature of motivation, the third about the nature of media, the

fourth about the nature of time, and the fifth about the nature of communication. First, people are assumed to be limited capacity information processors (Basil, 1994; Schneider, Dumais, & Shiffrin, 1984; Shiffrin & Schneider, 1977). They have only a limited number of cognitive resources to expend on the tasks of perceiving, encoding, understanding, and remembering the world they live in. When there are insufficient resources available, processing suffers. Second, people have two underlying motivational systems, the appetitive (or approach) system and the aversive (or avoidance) system (Bradley, 1994; Cacioppo & Gardner, 1999; P. J. Lang, Bradley, & Cuthbert, 1997). These systems activate automatically in response to motivationally relevant stimuli in the environment and influence ongoing cognitive processing. Third, media are made up of variably redundant streams of information presented through multiple sensory channels (eyes, ears, touch) and formats (words, text, still pictures, moving pictures, etc.; Reeves, Thorson, & Schleuder, 1986; Reeves et al., 1985; Thorson, Reeves, & Schleuder, 1986). Fourth, all human behavior occurs over time and is constantly changing from one second to the next. Human behavior, and therefore human cognition, is a dynamic process (Thelen & Smith, 1994). Fifth, communication is the overtime interaction between the human motivated information processing system and the communication message (S. Geiger & Reeves, 1993; A. Lang, 2000; Rafaeli, 1988). This interaction is continuous and truly interactive. Aspects of the message influence the motivational and cognitive systems and aspects of those systems influence how the message is perceived, encoded, stored, and eventually retrieved. In other words, communication is a continuous, interactive, dynamic, embodied process all of which must be taken into account when designing effective messages about anything—including cancer.

According to LC4MP, processing messages involves three major subprocesses: encoding, storage, and retrieval. These subprocesses occur constantly, continuously, and simultaneously. Encoding is the act of creating a mental representation of a stimulus. It is the process of selecting information from the environment for further processing. Encoding is not a veridical process. People do not make exact copies of the world in their heads. Rather, they automatically (and unconsciously) select the important aspects of a message and encode them. Information that is not encoded is lost. A major area of importance in LC4MP is understanding how to design messages to insure that important parts of a message are encoded. Processing resources must be allocated to a piece of information in order for it to be encoded. Resources can be allocated as a result of automatic or controlled processing mechanisms (A. Lang, Potter, & Bolls, 1999; Schneider, Dumais, & Shiffrin, 1984; Wickens, 1984). Controlled allocation is related to a person's ongoing goals and interests. On the other hand, many aspects of the environment automatically elicit the allocation of resources. One way this is done is through the elicitation of an orienting response.

An orienting response is an automatic attention response, sometimes called the "What is it?" response, which is elicited by novel and signal stimuli in the environment (Graham, 1979). Novel stimuli are things that represent a change in the

environment. They are things that are new to this particular environment—not new in general. Therefore, a person walking into a room, a sudden noise, or a sudden change in the light level would all elicit an orienting response. Orienting responses are also elicited by signal stimuli, that is, stimuli that a person has learned signal important information. These include things such as your name. Novel stimuli are the same for all people; signal stimuli differ for different individuals.

Another type of stimulus to which resources are automatically allocated is motivationally relevant stimuli (A. Lang, Bradley, & Sparks, 2004; A. Lang, Newhagen, & Reeves, 1996; A. Lang, Sparks, Bradley, Lee, & Wang, 2004; P. J. Lang, Bradley, & Cuthbert, 1990). These are stimuli that are related to survival. The appetitive motivational system evolved to help the organism get food and mates in order to ensure the survival of both the individual and the species. The aversive motivational system evolved to protect the individual from danger. Primary motivational stimuli include sex, food, and danger. Like novel stimuli, primary motivational stimuli are the same for everyone. However, individuals also learn that certain stimuli signal positive or negative consequences; therefore, stimuli can take on motivational relevance through learning (like Pavlov's dogs salivating to the dinner bell), and these stimuli will often vary from individual to individual.

In sum, elements of the environment or of a media message are encoded when limited cognitive resources are allocated to them. Resources can be allocated as a result of controlled or automatic mechanisms. Stimuli that are novel, signal, or motivationally relevant are encoded automatically. According to LC4MP, encoding can be indexed by measuring audio and video recognition. Audio recognition tends to be a more sensitive measure than video recognition (A. Lang, Bolls, Potter, & Kawahara, 1999).[1]

The second major subprocess in LC4MP is storage. Storage is conceived of as the linking of recently encoded information to previously stored information (Baddeley, 1990; Bradley, 1994; Christianson, 1992; Zechmeister & Nyberg, 1982). New and old information are linked when they are concurrently activated. Thus, once new information is encoded or old information is retrieved, an active mental representation exists. Being active simultaneously forges the link. In general, the more links a new piece of information has to old information, the better it is stored. Thus, in order for information to become part of an individual's long-term memory, it must be encoded and it must be linked to already stored information. Although something must be encoded in order to be stored, many things that are encoded are only poorly stored, because few resources are allocated to storage. Thus, encoding does not necessarily predict storage (A. Lang, Bolls, Potter, & Kawahara, 1999a). LC4MP argues that motivational relevance leads to the automatic allocation of resources to storage. Storage, in LC4MP, is indexed by cued recall techniques.

Finally, the third subprocess is retrieval (Craik & Lockhart, 1972; Zechmeister & Nyberg, 1982). This subprocess involves retrieving previously stored information. Again, resources (allocated through controlled or automatic mechanisms) are

required in order for retrieval to occur. The primary automatic mechanism is some sort of spreading activation. Memory is loosely conceived of as bits of information that are linked to one another. When a bit is active, this activation is thought to spread through the links to activate closely related information. Thus, as information is encoded from a message, activation spreads to related information leading to the ongoing concurrent retrieval of information related to the topic of the message. Again, the amount of ongoing concurrent retrieval will be dependent on the resources allocated to it. LC4MP indexes retrieval using free recall measures.

According to LC4MP, these three processes are simultaneously and continuously active during media use. Aspects of the individual's goals, the message content, and the message structure are continuously resulting in automatic and controlled allocation and reallocation of resources to encoding, storage, and retrieval. Resources are allocated independently to the three subprocesses out of the same fixed pool of limited resources (Basil, 1994; A. Lang et al., 1999a). When the message requirements and the user's goals result in more calls for resources than there are, cognitive overload is said to occur. This means that there are insufficient resources available to perform all three subprocesses to the level required. When this happens, performance on one, two, or all three subprocesses will deteriorate. When there are insufficient resources, some processes will receive sufficient and others will receive insufficient resources. According to LC4MP, where the resources go may depend on the time demands of the message. Thus, if the user cannot control the speed of the message (no stopping, rewinding, or pausing), then time-sensitive subprocesses (like encoding and to some extent concurrent retrieval) will automatically receive more resources and storage will be shorted. When this occurs you end up with a message that was attended to (all resources allocated), encoded (very good recognition memory), but cannot be retrieved (poorly stored; A. Lang & Basil, 1998).

According to LC4MP, the pattern of resource allocation across the subprocesses, in addition to being a function of message structure, content, and viewer goals, is also affected by motivational activation. LC4MP incorporates a view of motivational activation that posits two independent motivational systems. The appetitive and aversive systems are thought to activate in four different ways: reciprocally, that is, one is active and one is inactive; coactively, that is, both are active; inactively, that is, neither is active; or in an uncoupled way, that is, there is no relationship between their activities (Berntson & Cacioppo, 2000; Cacioppo & Gardner, 1999; A. Lang, Shin, & Lee, 2005). Thus, any given set of environmental stimuli (or mediated stimuli) might automatically activate the appetitive system, the aversive system, both systems, or neither system. LC4MP theorizes that the level of activation in the motivational systems impacts how resources are allocated across the subprocesses (A. Lang, 2005). At low levels of activation (i.e., in a neutral environment), the appetitive system is thought to be slightly more active than the aversive system. This has the evolutionary advantage of getting the animal out of the nest to explore the environment. This greater appetitive activation is called the positivity offset.

An increase in negative stimuli in the environment leads to increased activation in the aversive system and an increase in positive stimuli leads to an increase in appetitive system activation. The activation functions of the two systems are thought to differ in shape. The appetitive system is thought to increase in a relatively smooth, monotonic function. Approach can occur slowly and carefully and mistaking a neutral object for a positive object (e.g., not food for food), whereas disappointing is not overly consequential. The aversive system, on the other hand, is thought to activate much more quickly at lower levels of stimulation because it is functioning to protect the organism from danger. Mistaking a dangerous thing for a neutral object might mean death, which is very consequential. Thus, the system ramps up more quickly. This steeper slope is referred to as the negativity bias. Thus, it takes an extremely positive stimulus to achieve a high level of appetitive activation, whereas a moderately negative stimulus achieves an equivalent level of aversive activation.

According to LC4MP a major goal of appetitive activation is information intake, which means as much information as possible about the stimulus being approached, and the surrounding environment, needs to be encoded. In addition, the more motivationally arousing the stimulus is, the more it activates the appetitive motivational system and the more evolutionary advantage there is to encoding and storing the stimulus and the surrounding environment so that it can be found again in the future. Hence, LC4MP argues that appetitive activation increases the automatic allocation of resources to both encoding and storage and that these allocations and the level of appetitive activation increase as the stimulus becomes more arousing (A. Lang, Bradley et al., 2004; A. Lang, Sparks et al., 2004; Yegiyan, Bradley, & Lang, 2005).

The goal of aversive activation, however, is not information intake but rather protection. At low levels of aversive activation, potentially negative stimuli need to be identified; therefore, at low levels of activation, resources are also automatically allocated to encoding. However, as activation increases, the organism needs to turn its mental resources to the task of figuring out what to do (fight, flee, or freeze). This requires the retrieval of relevant already stored information about the environment (escape routes, hidey holes) and the stimulus itself (how fast, how dangerous). Thus, resources are shifted away from encoding—the danger is known—to retrieval. In addition, because the danger needs to be avoided in the future, some resources are automatically shifted to storage in order to remember where this danger is located and hopefully the successful strategy about to be used to avoid it (A. Lang, Bradley et al., 2004; A. Lang, Sparks et al., 2004; Yegiyan et al., 2005).

Thus, according to LC4MP, during mediated message use, controlled and automatic mechanisms allocate processing resources continuously overtime to encoding, storage, and retrieval as a function of the structure, content, and motivational and personal relevance of the mediated message. One can apply this theoretical approach to the task of creating effective messages by answering the following questions for the message being created: (a) What is the message goal? (b) Who is in the target market? (c) What medium will carry the message? and (d) What is the motivational and

personal relevance of the main information in the message for the majority of people in the target audience? The answer to each question tells you something important about how to construct your message.

The first question asks about the goals of the message. If the goal is awareness, then you want to create a message that attracts attention and is well encoded. If the goal is knowledge gain, the message must also be well stored. If the goal is persuasion, then the message should elicit positive evaluations, be perceived as effective, and alter attitudes. If the goal is behavior change, then the behavior to be changed, the reasons to change, and how to change must all be encoded and stored and the appropriate level of motivational activation should be associated with each of these elements (i.e., appetitive activation with how to change and aversive activation with the reasons to change).

The second question asks, to whom is the message directed? This is important because some of the variables that one might use to define a target market also define groups that have demonstrably different patterns of cognitive processing and motivational activation. For example, older people allocate resources somewhat differently than younger people, their orienting responses habituate more slowly, and less arousing stimuli elicit greater motivational activation compared to young people (Kane et al., 1994; Light, Prull, & Kennison, 2000; Madden, 1990; Maki, Zonderman, & Weingartner, 1999; Orchard, 1995; Tipper, 1991). Similarly, health messages about risky behaviors are often targeted at high-sensation seekers. High-sensation seekers allocate more resources to encoding than low-sensation seekers, they tend to have slower responding aversive systems, greater activation overall in their appetitive systems, and they have bigger responses to novelty and smaller responses to arousing content than low-sensation seekers (Brocke, Beauducel, & Tasche, 1999; Greene, Krcmar, Walters, Rubin, & Hale, 2000; A. Lang, Chung, Lee, Shin, & Schwartz, in press; Lukas, 1987). These types of differences should be considered when designing effective messages.

The third question asks, what medium will convey the message? Because the structure of the message plays an extremely important role in the automatic allocation of resources, medium matters (Anderson & Lorch, 1983; S. F. Geiger & Reeves, 1991; A. Lang et al., 1996). Different media have different structural features. Determining, for each medium, what structural features elicit the automatic allocation of resources has been a major focus of LC4MP research (A. Lang, Borse, Wise, & David, 2002). In addition, how different elements of structure interact over time with the presentation of important information is a major determinant of how much information is encoded and stored (A. Lang, Geiger, Strickwerda, & Sumner, 1993). Further, some aspects of structure, in some media, have been shown to affect evaluation of the message arguments, overall attitude toward the message, and intent to engage in the behavior being advocated regardless of the informational content of the message (Bolls, Muehling, & Yoon, 2003; Hitchon, Thorson & Duckler, 1994).

Finally, the fourth question asks, for most people, what is the motivational and personal relevance of the primary information in the message? The answer to this question will partially determine motivational activation, which will affect the

pattern of resource allocation across the subprocesses and the level of controlled resource allocation that the message may expect to receive. The latter is of particular importance because one designs messages quite differently depending on whether you think the receiver is seeking out your message and is interested in its contents or is simply being exposed to your message during a commercial break.

Designing effective cancer communication messages

The remainder of this paper will ask these four questions specifically about cancer communication and review relevant studies that make suggestions about how effective messages can be designed in light of these answers.

Motivational and personal relevance

What is the motivational and personal relevance of the main information in the message for the majority of people in the target audience? We still start with this question because for all cancer communication messages, regardless of goal, target market, or medium, a central feature of the message is that it is about cancer and cancer is to some extent motivationally relevant. Cancer is bad. Cancer is scary. Cancer is life threatening. Cancer almost certainly activates the aversive motivational system. Experience, culture, and society impart motivational relevance to things. Our motivational systems do not respond only to the primary motivators of food, sex, and danger. They also respond automatically to things that we have learned are good and bad. Once this lesson has been learned for a thing, that thing will automatically activate the appropriate motivational system (appetitive for good and aversive for bad). Thus, we have learned that cancer is dangerous and bad, so it should automatically activate the aversive motivational system to some extent, though surely our own sense of risk will influence the level of activation (related to, e.g., age, family history, and experience).

For example, A. Lang, Chung, Lee, and Zhao (2005) have argued that society has defined risky products as motivationally relevant—some in positive ways and some in negative ways. Therefore, when they appear in media messages, they should elicit increased motivational activation (which is measured by increased physiological arousal) and cause resources to be automatically allocated to storage. To test this, A. Lang et al. did a study where participants viewed 30 life-sized pictures of products that were either risky (can of beer, pack of cigarettes, etc.) or not risky (can of pop, box of chalk) while their heart rate (HR) and skin conductance were collected. As predicted, participants had higher skin conductance and greater free recall for risky compared to nonrisky pictures. There were no differences in ratings of positive and negative valence possibly because for some participants, these were positive stimuli and for some they were negative stimuli. A second study repeated the same procedures using risky (marijuana, cocaine, AIDS, etc.) and nonrisky words (Tylenol, antibiotics, asthma), with the same results suggesting that it is the thing—not the representation—that matters.

It seems likely then that simply mentioning cancer will elicit some activation in the aversive motivational system. This is important because at low levels of aversive activation, few resources are allocated to encoding (due to positivity offset). Indeed, recent studies suggest that calm negative messages—that is, messages about negative topics that are not arousing—receive a baseline allocation of resources that is insufficient for thorough processing; therefore, they tend to be very poorly encoded (Park, Sanders-Jackson, Wilson, & Lang, 2005). However, if messages about cancer (like messages about risky products) automatically activate the aversive motivational system, then more resources should be automatically allocated to encoding and storing these messages compared to equivalent messages not about cancer. However, this also means that one must be cautious about adding other motivationally relevant items to the message because you might create a message that is more arousing than you intended, which could result in cognitive overload.

Research examining the online processing of television drug abuse prevention messages suggests that this is a very real possibility. In this research, studies using the LC4MP theoretical framework have found that increasing the structural pacing of television messages increases attention to and memory for the messages up to a point (by increasing the resources allocated to encoding through the elicitation of orienting responses) but that when messages become too fast the encoding subprocess becomes overloaded and memory suffers (A. Lang, Schwartz, Chung, & Lee, 2004; A. Lang et al., in press). In addition, when the message topic is arousing, which causes additional resources to be automatically allocated to storage, cognitive overload occurs at a slower level of structural pacing. Of particular interest here is that this same research shows that when the topic of the message involves a risky activity or product (e.g., drug abuse or alcohol advertising) overload occurs at a lower level of structural pacing for both calm and arousing appeals. The authors argue that this is due to the additional requirement to allocate resources to encoding and storing the risky (motivationally relevant) stimulus, which pushes the system into overload more quickly.

This may mean that when creating messages about cancer, one must remember that the very topic itself will elicit some level of aversive activation that will cause the automatic allocation of resources to encoding and storage. Therefore, one might produce a calm message and be less concerned that it is insufficiently arousing to elicit a reasonable baseline allocation of resources. If the message design calls for complex structure to elicit orienting responses or an emotional appeal to elicit motivational activation, one should be cautious and not overuse those strategies because the system might overload at a lower level than it would with a different topic. On the other hand, for some goals, messages that produce cognitive overload may still achieve the message goals. During cognitive overload, encoding is often quite good, which makes these ads successful at increasing awareness. Storage is usually quite poor, and little information from the messages can be retrieved so overload should be avoided when information gain is a primary goal. On the other hand, messages that result in cognitive overload are often rated as enjoyable

and lead to positive attitude toward the ad and intent to purchase products so some overload may be acceptable if persuasion is a primary goal (Yoon, Bolls, & Lang, 1998).

It is also worth noting that people's personal level of involvement with messages about cancer varies, which also affects motivational activation. For example, if the target market consists of cancer survivors or the families of people with cancer, these people will likely experience greater aversive activation in response to messages about cancer and those messages will be more personally relevant. As a result, both automatic and controlled processes will allocate resources to processing the message. The use of structure and emotion to increase automatic resource allocation, on top of the controlled and motivational resource allocation, would likely be wasted and might indeed backfire because you might overactivate the aversive system and cause actual withdrawal or message avoidance. On the other hand, if your target market is young adults who, *on average*, have a lower level of personal involvement and experience with cancer, there will be less controlled and motivationally related resource allocation; thus, the use of structure and emotional appeals to increase resource allocation may be an excellent strategy.

Finally, despite the fact that all cancer messages are about cancer, which is bad, some messages may be about positive developments, which are good—new treatments, success stories, and so forth. When this is the case, you may very well be creating a message that elicits coactivation of the appetitive and aversive systems. For example, messages about prevention likely elicit the least aversive activation because they are aimed at healthy, often low risk, people and can be produced using positive appeals to increase appetitive activation. In this case, although the mere mention of cancer will elicit some aversive activation, the overall positive tone of the rest of the message should elicit a greater amount of positive activation. Because positive activation and low levels of aversive activation both result in automatic allocation of resources to encoding and storage, these messages will have a memory advantage regardless of how else they are produced. On the other hand, messages about treatments or screening for high-risk groups will have greater aversive activation (associated with the greater risk of getting or the actuality of having cancer). When this is the case, increasing appetitive activation through the use of positive appeals is likely to be very important to combat the tendency to withdraw from negative stimuli. Again, coactivation may improve processing of the message but carries with it the increased possibility of cognitive overload.

What medium?

The next question asks what medium will be used to deliver the message? This is an important question within the framework of the LC4MP. Each medium (the Web, television, radio, print) has its own set of perceptual channels, temporal constraints, learned signals, and orienting eliciting structural features. To design a message that achieves an optimum balance between resources allocated and resources required (i.e., does not cause cognitive overload) but at the same time maximizes resource

allocation to the message (ensuring high levels of attention) requires careful attention to the demands and opportunities of the medium.

For example, television (a medium much studied within the LC4MP framework) has two channels of information (audio and video). The auditory channel can have verbal information, natural sound information, music, or sound effects. The visual channel can contain still pictures, moving pictures, text, live action images, animated images, or a combination of these. The audio and the visual channels can vary in terms of the redundancy of the information in the two channels from identical to completely unrelated. The television message is usually designed to be watched in its entirety—without stopping and starting—and it is temporally demanding so that information not encoded at exposure is lost. New parts of the message are continually demanding to be encoded, whereas the older parts of the message are being stored. Viewed in this way, the cognitive task of encoding and storing the information in a television message is extremely taxing. As a result, only a small subset of the information in a television message is ever encoded, less of it is stored, and even less of it is retrievable at a later date. The goal, when designing television messages, is to use structural features to increase the probability that important parts of the message are encoded and then to ensure that there are periods of time during the message when sufficient resources are allocated to storage and competing message demands for resources are low so that the encoded information can indeed be stored.

Research has shown that many structural features of television elicit orienting responses including scene changes, camera changes, loud noises, sudden movements toward the camera, and the onset of videographics (A. Lang, 2000). Other structural features do not appear to elicit orienting responses like the onset of slow motion, pans, and zooms. This means that some structural features can be used to call resources to encoding. Research shows that the information presented immediately following an orienting eliciting structural feature is encoded better when the resource demands of the informational content are low and worse if the informational demands are high (Fox, Lang, Chung, Lee, & Potter, 2004; Thorson & Lang, 1992). Thus, when the message itself is difficult or unfamiliar—and therefore requires many resources—orienting responses will interfere with that processing and decrease encoding of the message. However, when messages are familiar or easy, the reverse occurs and the additional allocation of resources elicited by the orienting response increases encoding of the information. This means that when designing television messages, one should judge, for your target audience, the difficulty of the information you want them to understand and learn. If it is easy, use judiciously placed structural features to maintain a high level of encoding. If it is difficult, refrain from using structural features as they will interfere with ongoing processing. For example, if your message is simple and familiar (e.g., smoking causes lung cancer, stop smoking) you may want to include graphics (say animations of smoke turning pretty pink lungs black and tumor ridden) to increase resource allocation. On the other hand, if the message is new and complex (the steps needed to carry out

a specific diet regimen), you might want to simplify your presentation and maximize audio/visual redundancy in order to increase storage.

Further, judicious placing is an important part of the use of orienting eliciting structural features. Information placed 1–2 seconds after a structural feature is not encoded as well as information placed 3–5 seconds later (A. Lang, 1991). When designing television messages for maximum ease of processing, it is important to keep the temporal unfolding of events in mind.

Television messages happen over time. When the message begins, the viewer's mind is not necessarily attuned to the topic of the message. The moment the message begins, the images and words begin to activate links to stored information and the automatic retrieval of information needed to understand the message begins. Thus, the choice of what comes first, in a message, will influence the type of related information that is retrieved. When initial information does not elicit appropriate background information, then the processing task becomes much more difficult because newly encoded information must be maintained as an active mental representation without being linked to related content (A. Lang, Sias, Chantrill, & Burek, 1995). Research has shown, for example, that if news stories are presented in chronological order rather than in the traditional broadcast style of what's new, followed by the causes and the consequences, this reduces the need to retrieve already stored information and increases encoding of the news stories by 15% (A. Lang, 1989).

Similarly, if the goal of the message designer is to maximize encoding and storage, it makes sense to design a message that activates the appetitive motivational system. However, it is important to realize that motivational activation also occurs over time. It takes a certain amount of time to build emotion in the message in order to activate the associated motivational system. Although some images are hardwired and may elicit almost immediate activation (babies being born, sexual encounters), others require narrative consequences to gain their emotional punch. Therefore, you may want to begin a message with a measured emotional appeal designed to appropriately activate the motivational system. During this period, one would not want to introduce much information. However, once the emotional story has activated, the motivational system—then the presentation of factual information, which you want to be stored—will be facilitated by the motivational activation.

Similarly, messages might vary in emotional tone in order to activate first one motivational system and then the other. For example, consider a behavior change message where the goal is to encourage women to go in for a yearly mammogram. One might begin the message with strong positive images linked to a positive story followed by the message "it's easy, it's important, here's what you should do." This part of the message, what to do and how, will then be well encoded and stored as a result of the appetitive activation. The next part of the message might tie the lack of action to aversive motivation. Thus, the message might change suddenly from positive to negative (the same people who were happy and cancer free now dying of cancer), followed by the message, "failure to act can kill." This creates a message that functions as a conditioning stimulus. Positive emotions and appetitive activation are linked to

the message of having a mammogram, whereas negative emotions and aversive activation are linked to the message that not having a mammogram is potentially deadly.

Finally, it should also be noted that the use of words is very important in audio and audio/visual messages. Research shows that motivationally relevant words embedded in ongoing audio messages have the ability to elicit orienting responses and are remembered better than nonmotivationally relevant words (Lee & Potter, 2005; Potter et al., 1997). Thus, the use of motivationally relevant and emotional words will increase resources allocated to processing the message and focus those resources on a specific word. Care should be taken to make sure that the word is fundamentally related to the message or else the word will distract from the overall meaning of the message.

Research using the LC4MP framework has also been done on other media to begin identifying the structural features that elicit orienting and the types of information presentation that are maximally effective. To date, both audio-only information (e.g., radio messages) and simple computer- or Web-based messages have been investigated (Borse & Lang, 2000; Chung, Lee, Lang, Borse, & Buchman, 2002; A. Lang, Lee, Chung, & Borse, 2001; A. Lang et al., 2002). Little research has been done on text messages (Wise & Lang, 2001). A brief summary of what this research tells us about these media follows.

Audio-only, or radio, information, like television messages, is temporally constrained. It tends to begin and continue. Generally, these messages are designed to be heard in their entirety. Therefore, they too are subject to cognitive overload if too much information is presented too quickly or if structural elements are placed in such a way as to interfere with rather than aid the processing of verbal information (Angelini, Lee, Schwartz, Sparks, & Lang, 2003; Lee, Angelini, Schwartz, & Lang, 2003). Unlike television, there is only a single channel of information presentation—audio—but there may be several strands of audio contained in that channel. Thus, a message might contain a verbal narrative, a natural sound background, and sound effects punctuating the high points of the message. Thus, one strand of audio could interfere with or compliment a second strand of audio. Many audio structural features have been shown to elicit orienting responses in attentive viewers including motivationally relevant words, sound effects, voice changes (from one speaker to another), and music onsets (Potter et al., 1997). As with television, research has shown that increasing the pacing of audio structural features initially improves memory for the message but eventually overloads the system and decreases memory for messages (Potter, 2000; Potter & Callison, 2000). Research examining audio drug prevention messages strongly suggests that audio messages about arousing topics are processed much more thoroughly at low compared to high levels of audio structural complexity (A. Lang, Schwartz, Lee, & Angelini, 2006 A. Lang, Schwartz, Lee, & Shin, 2003). With audio messages, it is likely that either emotional content or structural complexity improves processing but the combination does not. Similarly, the use of concrete language, chronological presentation of information, and multiple voices are good combinations for increasing encoding of the message.

Research examining computer presentation of information and simple Web stimuli from the LC4MP perspective is still in its early stages. Several early studies demonstrated convincingly and surprisingly that the simple appearance of information on a computer screen does not elicit an orienting response. Instead, research suggests that the content of the information must be either personally or motivationally relevant for an orienting response to occur. This means that a great deal of computer-presented information must rely on controlled resource allocation (i.e., the viewer wants to pay attention to it) in order to be encoded. Of particular interest here is that studies suggest that the element of control may not play a particularly large role in the automatic processing of computer-presented messages. In one study (A. Lang et al., 2002), three different types of text-based messages were presented on a computer screen, a headline, a headline in a box, or a personally relevant warning. Participants clicked to bring up half of the stimuli and the other half were presented by the computer. There was no difference in orienting behavior between the two groups. The headlines and the boxed headlines did not elicit orienting but the personally relevant warnings did, regardless of how onset was initiated.

Several other studies have examined the effects of animation on orienting behavior (Chung, 2005). These studies suggest that initially animation does elicit orienting responses but that the orienting response quickly habituates to repeated use of animation. In addition, the resources allocated as a function of the orienting response appear to be allocated to the object that is moving and not to the rest of the information on the screen. Thus, unless the goal is to have people remember the animated object, animation may interfere with the processing of the central information in a message.

Studies on educational multimedia have also suggested that sound effects elicit orienting in computer users and increase encoding for the sound. For example, in one study, 9- to 13-year-old participants encoded the most information from multimedia presentations that included both animation and sound effects compared to one or the other or none (Schwartz, 2005). Of particular interest here, however, was that the increase in encoding that occurs as a result of the orienting responses is not generalized to the message. Instead, sound effects increase memory for the sound and animations increase memory for the animated object. This conjunction of orienting eliciting feature and encoding specificity appears to be somewhat unique to computer and multimedia messages perhaps because users have control over the time of presentation. In television and radio messages, which continue rather relentlessly onward following an orienting eliciting structural feature, the additional resources allocated seem to be less focused on the feature that elicited them, which has already become history, and more generally used to process the parts of the message that follow.

Target market?

The next question asks, who is in the target market? Obviously this needs to be considered first when considering what medium to use. Is the target market media

savvy? Are they online, connected, or dialed in? Or is the target market more traditional, watching TV, listening to the radio, reading the newspaper. This aspect of targeting will play an important role in determining what medium to use that will then affect message design as discussed in the previous section.

However, the aspect of this question on which this section is focused is whether there is something about the target that will make this group of people process media differently. In general, will this group respond differently to structural or content aspects of the message? Is there something about the before group that makes their cognitive and/or motivational systems function differently from the "norm"? This is an area in need of much research. Much of what is known is new, speculative, or borrowed and not yet tested in the types of mediated environments under consideration here. Yet, it is a critically important when designing messages to teach, persuade, inform, reinforce, and even change behavior.

Research on drug prevention messages provides an excellent example of a target market that is presumed to process mediated messages differently, namely, sensation seekers. Sensation seeking is a personality trait that has been shown to be associated with drug experimentation, drug use, drug abuse, smoking, and a myriad of other risky behaviors like gambling, unsafe sex, and reckless driving, some of which are related to increased cancer risk such as smoking and risky sexual behaviors (Donohew et al., 2000; Greene et al., 2000; Jonah, 1997; Parent & Newman, 1999; Sheer & Cline, 1995; Wood, Cochran, Pfefferbaum, & Arneklev, 1995). Research in this area suggests that high-sensation seekers seek out novel and arousing content and that they require more arousing content to experience the same level of arousal as low-sensation seekers (Aluja Fabregat & Torrubia Beltri, 1998; Donohew, Palmgreen, & Lorch, 1994; Krcmar & Greene, 1999; Lorch, Palmgreen, Donohew, & Helm, 1994; Palmgreen et al., 1991). For these reasons, drug prevention messages targeted at high-sensation seekers, who are at the most risk of using drugs, need to be placed within media that appeal to high-sensation seekers and the messages themselves need to have high sensation value (i.e., they should be complex, fast paced, emotional, etc.).

Within the framework of the LC4MP, individual differences are thought to operate at almost every level of interaction between a mediated message and a media user. Although certain things will elicit orienting responses in all people, there is also a series of idiosyncratic things that will elicit orienting just for a single individual. For some target markets, specific words or images might elicit orienting though they would not for the general population. Similarly, although positive messages should elicit appetitive activation and negative messages should elicit aversive activation, what is positive and what is negative will have both cultural and individual variation. For example, research has shown that pictures of food activate the aversive system in people with eating disorders and the appetitive system in those without eating disorders. Similarly, pictures of people smoking activate the aversive system in nonsmokers and the appetitive system in smokers (Geir, Mucha, & Pauli, 2000). Obviously, this sort of group difference will have an effect on designing messages

to stop people smoking because for one group, smoking-related imagery is positive, whereas for the other it is negative and the resulting motivational activation will affect message processing.

Another area in which individual variation may play a role is related to both sensation seeking and individual differences in motivational activation. As discussed previously, the motivational activation functions are characterized by positivity offset (a greater level of appetitive compared to aversive activation at low levels of activation) and negativity bias (a steeper rate of increase in aversive compared to appetitive activation). Recent research suggests that these two things—positivity offset and negativity bias—also exist as individual difference variables (A. Lang, Shin et al., 2005). Thus, some people have a particularly high positivity offset and are more driven to seek out new activities and new experiences, whereas others have a low positivity offset and are quite cautious about new experiences and activities. Similarly, those with high negativity bias respond very quickly and strongly to stimuli that are only weakly negative, whereas those with a low negativity bias require extremely strong negative stimuli to achieve the same level of aversive activation.

Recent work on the processing of drug prevention messages has demonstrated that sensation seeking is related to positivity offset and negativity bias and that an individual's level of positivity offset and negativity bias influences their online processing of emotional health-related messages (Yegiyan et al., 2005). In one study, participants viewed public service announcements about smoking cessation, drug prevention, and safe sex that were positive or negative and arousing or calm. During viewing, participant's HR, skin conductance, evoked startle response, facial muscle activity (smiling, zygomatic and frowning, corrugator), and self-reported emotional experience were measured. Results showed that individuals with a high positivity offset paid more attention to and felt more positive during all types of messages as was demonstrated by inhibited startles (indicative of appetitive activation), lower HR (indicative of greater attention), higher skin conductance (indicative of more arousal), less corrugator activity (indicative of less negative emotion), and more zygomatic activity (indicative or positive emotion) and greater self-reported positive feelings. However, they did not remember more of everything—despite their evident attention and enjoyment—positivity offset did not have an impact on encoding. Instead, arousing content (positive or negative) was encoded best regardless of positivity offset. As a result, messages aimed at those high in positivity offset (who tend to use and experiment more with drugs) should be arousing because they attend to and enjoy all sorts of messages but learn the most from arousing messages. Further, results showed that participants with a high compared to those with a low negativity bias responded more strongly and more negatively to negative messages. This increase in negative responses to negative messages was demonstrated by increased startle magnitude, greater corrugator activity, higher ratings of experienced negativity, increased skin conductance, and decreased HR indicative of disengagement. Surprisingly, however, despite this dislike and disengagement, they encoded the messages better. Thus, it seems likely that high negativity bias individuals, who

tend to experiment with and use drugs less than other groups, will avoid negative public service announcements, but if they are exposed to them, they will convey information and reinforce their existing tendencies to avoid drug use.

Another way in which target market might influence message design is when target markets are determined by age. Research shows that differences exist in how children, adolescents, adults, and the elderly process mediated messages. For example, research on structural complexity or pacing suggests that younger viewers like fast-paced messages more than older viewers (A. Lang & Schwartz, 2002). However, children and older viewers are overloaded by complex structure at a lower level of complexity than are adolescent and young adult viewers (A. Lang, Schwartz et al., 2004). Similarly, children and adolescents appear to be somewhat more affected by structural and concrete elements of messages; in other words, they are a little bit more closely bound by the stimulus, whereas adults and older adults appear to respond somewhat more to the abstract or emotional elements of messages.

There is also a great deal of research examining the effects of aging on cognitive processing though there is not yet a great deal of research on how these cognitive effects of aging might alter mediated message processing. Quite a bit of research suggests that although the elicitation of orienting responses is not effected by age, the habituation of orienting responses is (Kane et al., 1994; Light et al., 2000; Madden, 1990; Maki et al., 1999). Thus, for example, the research discussed earlier that showed orienting responses to computer animation habituating fairly quickly was done on younger adults. It is possible that orienting responses to animations on the web might habituate more slowly or not at all with older media users. Similarly, research also suggests that arousing messages and negative messages may elicit greater aversive activation in older adults, especially women. In any case, once the target market is determined, care should be taken to understand whether the characteristics that define the target market will also have a generalized effect on some aspect of mediated message processing.

Message goal

The final question asks, what is the goal of the message? Is it to maintain attention, to create awareness of something, to convey complex information, to persuade, to change behavior, to associate an emotional state with a behavior, or something else? In order to apply LC4MP to designing effective messages, one must know what part of processing needs to be optimized because the system's limited capacity will not allow all aspects of processing to be performed equally well. Thus, for example, local broadcast news consultants have devised a news format that maximizes attentional inertia and repeat viewing (Grabe, Lang, & Zhao, 2003; Grabe, Lang, Zhou, & Bolls, 2000; Grabe, Zhou, Lang, & Bolls, 2000; A. Lang, Potter, & Grabe, 2003). To keep people watching, they use repeated automatic calls for attention using both structural and motivational elements. To bring them back, they end happy in order to leave viewers with a good feeling about watching. Thus, fast pacing is the primary tool because people tend to like fast-paced presentation and it results in frequent

orienting eliciting structural features. Similarly, news maxims like "if it bleeds it leads" epitomize the use of motivationally relevant stimuli to gain and maintain attention. However, this same format, which keeps eyeballs on screen, leads to extremely low levels of encoding and storage, which is why so many studies show a negative relationship between watching television news and level of news information holding.

Another broadcast format people are well acquainted with is Sesame Street. Again, one of its goals is to bring eyes to the screen (Anderson & Levin, 1976; Ball, Palmer, & Millward, 1986; Lorch & Castle, 1997). Like broadcast news, it uses short bits and lots of structural features to automatically call wandering attention back to the message. Unlike broadcast news, however, it also has the goal of maximizing learning (i.e., encoding and storage); therefore, despite the somewhat complex structure, the message content is kept simple and is repeated frequently. This is an A, an A, an A, this is the letter A. Thus, the structural features do increase resource allocation to encoding, but there is less information to encode because the message is simple and cognitive overload is less likely to occur.

A great deal of research from the LC4MP perspective has dealt with how to design messages that increase attention and arousal without pushing the system into cognitive overload. The reason for this is that most message designers want their messages to be attended to and many want them to be remembered. The keys to attention are eliciting orienting responses and using motivationally relevant elements in your message. The keys to good memory are controlled resource allocation (e.g., cognitive effort), the automatic allocation of resources to encoding, and the creation of arousal in viewers through the use of either arousing content or fast-paced structure. The correct combination of these things leads to high levels of attention and memory.

Other message goals include persuasion, evaluative responses, and behavior change. Less work using the LC4MP exists in these areas. However, some research with television and radio has looked at attitudes and liking for messages, evaluation of argument effectiveness, and intent to change behavior. This research has generally shown that fast pacing (at least with young adults) leads to positive attitude toward the messages, increased liking for the messages, increased intent to adopt the product/change advocated by the message, and increased evaluation of argument effectiveness (Bolls et al., 2003; Potter & Choi, in press; Yoon et al., 1998). However, evaluation also interacts with the emotional content of the message.

For example, recent research has compared the judged effectiveness of claims appearing in drug prevention PSAs that vary in terms of valence (positive or negative), arousing content (arousing or calm), and structural pacing with that of the same claims separated from the executional elements of the message (i.e., with the claims presented only in text). This research shows that the claims are judged to be most effective when messages are arousing and negative. Claims in calm positive messages are judged to be the least effective. However, if one controls for the effectiveness of the claims (judged as text sentences), an interaction appears. Claims in negative arousing messages that are judged to be effective outside the message

environment are judged as the most effective. On the other hand, negative arousing messages that contain claims judged to be ineffective outside the message environment are judged to be the least effective. Thus, arousing negative emotional appeals only improve the evaluation of PSAs effectiveness if the actual information in the PSA is information that would be judged to be effective outside of the PSA (A. Lang & Yegiyan, 2005).

Conclusions

This paper argues that using the LC4MP perspective to design effective health communication messages, and specifically effective health messages about cancer, can be valuable. The LC4MP would suggest that cancer is a motivationally relevant topic that will elicit some level of aversive activation. Target markets for various types of cancer-related messages (e.g., smokers or people of a certain age) will process mediated messages in predictably different ways making certain design decisions better for certain target markets. Both structural and content elements of messages interact with the limited capacity information processing system to impact the level of resources allocated independently to encoding, storage, and retrieval. This pattern of allocation, in turn, will determine if messages are encoded and stored well and can therefore be retrieved at a later decision point. Finally, individual difference in people's motivational activation may influence both their tendencies to engage in certain risky behaviors that increase the probabilities of getting cancer and their processing of health-related messages. Future research in this perspective should be done to learn how to optimize cancer messages for specific target audiences using specific media to convey that information.

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Note

1 In general, video encoding requires fewer resources than audio encoding. Therefore, changes in message design that impact resource levels impact audio encoding before they impact video encoding. Because most of the actual information in messages is contained in the audio or textual aspects of the message, the impact of resource depletion on audio encoding tells us more about changes in design that are affecting message encoding.

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