A Bio-Informational Theory of Emotion: Motion and Image Size Effects on Viewers

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The human brain is not specialized to deal with 20th-century media. There is no neural function or anatomical region designed to help humans differentiate mediated and unmediated experience and to change mental processing accordingly. People are certainly capable of telling the difference between a picture and real life, but this is a thoughtful response, and it is preceded and constrained by responses that are automatic and not unique to media. When we see a gory television news clip, for example, we may thoughtfully judge that it is not real and that it requires no immediate action (e.g., we don't need to run from the room or render assistance to victims), but all such thoughtful judgments can be influenced by primitive reactions to the pictures as reality. In the news example, we are repulsed by gore, whether pictorial or real, and this response will influence how we assign meaning to the message.

A significant primitive response for which the brain is specialized is emotion, the focus of the present experiment. From a biological perspective, emotions are neurophysiological circuits in the brain that regulate approach and avoidance by engaging neural pathways associated with each (Lang, 1995). The influence of emotions, however, is not confined to primitive circuits in the brain. Emotions play an important role in a range of behaviors, including attention, memory, perception, and physical action, and they can be expressed behaviorally, linguistically, and physiologically.

Most research about mediated communication and emotion has concentrated on the effects of media content. This research includes effects of pornography, erotica, violence, and negative information in news, political ads, and public service announcements. The similarity between mediated and unmediated experience is the basis for the successful application of psychological theories about emotion to the pictures and words that can only represent experiences and phenomena not actually present. If mediated presentations of real-world

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stimuli are to render experiences unique, then an entirely new theory of emotion would probably be needed to account for human responses to media, and this does not appear necessary.

Different forms of media, however, do suggest questions about the uniqueness of media and the need for additions to more general psychological theory. It is possible to do things with pictures that have no counterpart in natural experience, and these special properties of pictures could potentially change emotional response. This experiment has examined two such qualities of media form as predictors of emotional response to pictures: (a) the ability to significantly change the physical size of stimuli (by changing the size of media displays), and (b) the ability to represent an image as either a stationary or moving picture. Each of these formal features is important in media, especially for newer forms of display and representation.

Bio-Informational Theory of Emotion

One recent theory of emotion that has received considerable empirical support is the bio-informational theory (Lang, 1995). In this theory, emotions are seen as action dispositions. The biological systems that regulate emotion reflect central activation and preparation for action and happen when highly motivated actions are delayed or inhibited. The bio-informational theory regards emotions as motivationally tuned states of readiness that are products of Darwinian development.

Despite an apparent range of human emotional expressions, the bio-informational theory of emotion suggests that two primary motive systems underlie all affective responses—the appetitive system (consummatory, sexual, and nurturant) and aversive system (protective, withdrawing, and defensive). These two motive systems are best understood by the behavioral responses they engender, namely, approach and avoidance. Each system has its own set of neural pathways and a distinct repertoire of responses that are activated by various stimuli (Lang, 1995).

The bio-informational theory posits a network model of emotion. The action dispositions and their physiological manifestations are linked to nodes in the brain that represent attributes of the emotion-eliciting stimuli. In this way, fundamental attributes of the stimulus (e.g., its size, color, and motion) can influence emotional responses. For example, the fear many people feel when encountering a snake is activated by writhing or the *s*-shaped pattern of its movement. Support for this view comes from ethological research that indicates fear can be induced in rodents by rudimentary representations of predators (Plutchik, 1980).[1] By emphasizing a network of affective responses the bio-in-

[1] The same silhouette of a bird can elicit different emotional responses in field mice, depending on its orientation. If the figure is moved overhead "tail first," it resembles a goose and elicits no physiological effects or fear in the mouse, but if the figure is turned around, it resembles a long-tailed hawk and elicits a flight response in the mouse.

formational theory encourages emotion researchers to investigate the specific attributes of stimuli, namely those characteristics that become nodes in the emotion network. It was the belief that motion and size constitute such attributes that led to their selection as independent variables in this study.

As with a number of other theoretical approaches to emotion (Mandler, 1984; Osgood, 1969; Osgood, Suci, & Tannenbaum, 1957; Russell, 1980; Russell & Mehrabian, 1977), the bio-informational theory regards affect as a dimensional construct. The two most commonly cited dimensions are hedonic valence and arousal. The third dimension, less frequently used, is dominance. The valence or evaluative dimension is a continuous affective response ranging from pleasant or positive valence, to unpleasant or negative valence. The dimension of autonomic arousal or emotional intensity is characterized by a continuous response ranging from energized, excited, and alert to calm, drowsy, or peaceful. Dominance is defined as a continuous scale whose endpoints are in control and out of control (Lang, Dhillon, & Dong, 1995). The dominance-submissiveness dimension can also be thought of as freedom to enact a full range of behavior (Shapiro & Biggers, 1987).

Emotion manifests itself verbally, viscerally, and behaviorally (Lang, 1995), and each manifestation suggests different measures. Among the measurement techniques commonly used are evaluation (self-report), assessment of facial expressions, and physiological measurements, such as heart rate and skin conductance. Each of these measures yields information about a different aspect of emotional experience, but the measures are correlated. For example, Greenwald, Cook, and Lang (1989) found that facial electromyographic (EMG) activity (a measurement of muscle movement and, in this study, an indication of smiling and frowning) was highly correlated with self-report ratings of the pleasantness of pictorial stimuli (r = .88).

In the experiment presented here, emotional responses were measured by self-reports. The Self-Assessment Mannequin (SAM), consisting of the three 9-point picture scales that represent the three dimensions of emotion, was used in this experiment. The scales are valence (ranging from very pleasant to very unpleasant), arousal (calm to excited), and dominance (not in control to in control). Lang et al. (1993) found high correlations between SAM and a number of physiological measures and viewers' evaluations of their emotional responses. Each of the three dimensions in the SAM ratings was assessed in relation to two qualities of message form, size and motion.

Image Size

Size is important to humans in a variety of ways. Infants show a preference for larger objects in a presentation (Fantz, Fagan, & Miranda, 1975); height in men is related to physical attractiveness, income, and occupational status (Jackson, 1992); and estimates of productivity are influenced by physical size (Josephs, Giesler, & Silvera, 1994). In many instances, quantity or size is a primitive heuristic that influences a range of judgments, including estimates of potency (Pelham, Sumarta, & Myaskovsky, 1994).

In communication research, size effects are only beginning to be investigated empirically, but possible effects have been discussed for a long time. Image size has been a critical feature of film presentations ever since the transition from the Kinescope and Mutoscope peep shows to projected images (Belton, 1992). The power of the film experience can be attributed, at least in part, to the size of the projected image. The film industry recognized this and promoted the new technology as being superior to live stage performances because it made things "larger than life" (Vardac, 1968). Wide-screen systems such as Cinerama and Cinemascope gave cinema a competitive edge over the upstart technology of television in the 1950s and 1960s because they provided a more compelling experience and made the audience feel as if they were really there (Belton, 1992).

The same can be said for television—there has been very little scientific research on display size, but growing interest. One of the most important characteristics of emerging video-display technologies is the size of the screen. The overall size, as well as the variability of size, of video-display systems has been increasing at a rapid pace (Reeves, Detenber, & Steuer, 1993). Although organizational and industrial psychologists have conducted ergonomic studies on the nature of video-display terminals (VDTs) in the workplace, not much attention has been paid to the physical characteristics of video displays in the home. Virtually everything that we know about the effects of television is based on research that uses, or assumes, that people are watching on standard 19" sets.

Only a handful of studies have investigated empirically the effects of screen size, and, with one exception, all of these studies have assessed effects other than emotional response. A technical report on big-screen televisions that appeared in the Society of Motion Picture and Television Engineers (SMPTE) journal found that increasing visual angle (through larger image sizes and nearer viewing distances) leads to a greater subjective evaluation of the sensation of reality (Hatada, Sakata, & Kusaka, 1980). In a study about faces presented on different screens, Reeves, Lombard, and Melwani (1992) found that screen size affected viewer's attention: Viewers paid more attention to large screens. Evaluative judgments of picture content also are influenced by screen size. Lombard (1992) found that viewers evaluated people on a large screen more positively than those seen on a smaller screen. Two studies measured memory differences; however, neither provided clear evidence of how screen size affects memory. Reeves et al. (1992) did not find a significant main effect for screen size on recognition memory, but recognition memory for sounds was significantly poorer in the large-screen presentation condition than in the small-screen condition.

In 1986, Shapiro conducted the only investigation of the effects of screen size on autonomic arousal and mood. The author based his prediction that arousal would increase with screen size on a classical stimulus-response model. He argued that the larger screen constituted a stronger stimulus and would, therefore, elicit a stronger response (i.e., greater arousal). The results of Shapiro's research indicate that arousal, as measured by galvanic skin response (GSR), does indeed increase when identical content is viewed on a 72" screen as opposed to a 19" or 5" television (Shapiro, 1986). This study, however, is unpublished, perhaps because of problems with the experimental design.[2]

The best summary of prior research is that larger image sizes indeed can intensify viewers' evaluations of content. The explanation for this effect, however, is unknown. One explanation for the effects could be that a larger screen creates a better opportunity for people to respond to the images as natural experience by making the images more vivid. This may be a case of what Frijda (1988) calls apparent reality: Events appraised as real elicit emotions, and their intensity corresponds to the degree to which they appear real. Further, we think that image size should affect sensory processing more than semantic processing (Reeves & Thorson, 1986). It seems reasonable that evaluations of pleasantness or unpleasantness are based more on what is depicted than how it is depicted. Consequently, image size should affect arousal ratings, but may not change evaluations of valence.

Motion

Motion, especially the difference between moving and still pictures, also has been manipulated. Movement constitutes a fundamental attribute of the physical world. The fact that the brain has specialized nerve cells to process motion supports the idea that motion perception is critical to understanding the world (Goldstein, 1989). Not only does visual processing emphasize the coding of movement, but there is evidence that motion perception is innate (Ball & Tronick, 1971; Barten, Birns, & Ronch, 1971). J. J. Gibson (1966, 1979) developed an ecological approach to visual perception based on the notion that changes in the optic array, due to movement of the perceiver or the world around the person, provide all of the information necessary to perceive size, distance, velocity, and relative positions. Gibson's approach, and its emphasis on motion perception, still holds considerable currency in psychology (Goldstein, 1989).

Motion also plays an important role in aesthetic analyses and theories of film and television form (Arnheim, 1933/1958; Belton, 1992; Bordwell & Thompson, 1993; Zettl, 1973). The repertory of motions possible within the frame of a film or television presentation sets them apart from other artistic forms of representation (Sparshott, 1982). Zettl (1973) describes three types of motion in filmic presentations: primary, secondary, and tertiary. Primary motion is event motion in front of the camera, that is, the movement of objects within the frame (e.g., a flag waving in the breeze). Secondary motion is camera motion, movement of the frame relative to objects within it (e.g., pans, dollies, and zooms). Tertiary motion is the sense of motion induced by a sequence of shots (i.e., editing). Among film and television practitioners such as Zettl, it is well known that these

[2] Unequal cell sizes contributed to a lack of homogeneity of variances, so the results of the ANOVA ($F = 3.18$, $p < .05$) may be called into question. Another weakness of the study was the absence of message replications.

different types of motion affect the viewers' subjective experience of the presentation. In general, film theorists believe that movement on the screen is engaging for the viewer.

Despite the psychological and aesthetic significance of movement, only a handful of studies have examined its effect on the cognitive processing of film or television. Most often motion is conceptualized as a basic attribute that influences attention or cortical arousal to film and television presentations (Huston & Wright, 1983; Reeves et al., 1985; Singer, 1980). Most studies have operationalized attention as the amount of time eyes are on the screen. Reeves et al. (1985), however, used alpha blocking (an on-line EEG measure) as an indicator of attentional increases and decreases. They found that motion in 30-second commercials was associated with higher attention or cortical arousal (a decrease in alpha). This correlation and previous research led them to conclude that people respond to movement on the screen in much the same way they do to real-life motion (Reeves et al., 1985). To a large extent, the results of this study help to substantiate the claim made by film theorists that motion captures attention, and, whereas it is important to bear in mind the distinction between cortical and autonomic arousal,[3] the two forms of arousal are related (Zillmann, 1991). Therefore, it seems reasonable to suggest that the cortical arousal generated by movement in the image may be incorporated into emotional evaluations.

The effects of motion versus still images on memory have been investigated in two different studies. In an experiment on learning from a multimedia presentation, Meshot (1991) found no effects of motion (moving versus still pictures) on knowledge gain. On the other hand, Kipper (1986) did find that people better remembered the physical properties (the layout) of a videotaped scene when it was shot with a moving rather than with a fixed camera. It seems likely that the different results were due to the fact that Kipper (1986) measured the changes that the motion manipulation produced, namely improved knowledge of the setting, more precisely than Meshot. If this were the case, then it might be that memory is improved only for certain kinds of information and by certain kinds of motion.

Motion is not a presentation variable in the same sense that image size or picture resolution is, yet it is nonetheless an important attribute of pictures. Although one may think the worlds of still photography and video are distinct and separate, such new technologies as multimedia are bringing them closer together. It is now common to see both still and moving images in CD-ROM programs. The digital revolution will present people with the choice of seeing some pictures as moving images or stills. The psychological impact of this difference seems worthy of investigation.

Another reason for studying the effects of motion is that there exists a fairly substantial body of research that examines emotional responses to still images

[3] Autonomic arousal manifests itself in the form of such physiological changes as increased heart rate and perspiration, and it is constituted by affective or emotional reactions, while cortical arousal is associated with attention, alertness, and information processing (Zillmann, 1991).

(Bradley et al., 1992; Burke, Heuer, & Reisberg, 1992; Christianson, 1984; Greenwald, Cook, & Lang, 1989; Heuer & Reisberg, 1990; P. J. Lang et al., 1993; Reisberg, Heuer, McLean, & O'Shaughnessy, 1988). These studies provide a methodological and theoretical foundation on which to build. By manipulating motion as an independent variable, this experiment can extend the parameters of these psychological research programs.

No previous research has addressed the issue of motion effects on emotional responses to images. However, based on the theory and research discussed above, motion appears to be a fundamental attribute of stimuli, both mediated and naturally occurring, that has psychological significance for people. Therefore, its potential effect on emotional responses, and particularly autonomic arousal, is being investigated.

In this experiment, motion is operationalized by having still and moving versions of identical content. This is done by selecting moving images (short clips from film and television) from which a single representative frame may be selected. To avoid possible confounds, it was decided that the only type of motion depicted in the stimuli should be object motion; camera movement such as pans and zooms were not part of the shots selected.

Measuring Effects of Image Size and Motion

Conducting the study required two primary procedural phases, development of the stimulus material and running the actual experiment. The experiment involved presenting images to small groups of viewers in a special screening room. Each picture was projected onto a screen for 6 seconds, and participants rated their emotional responses to the images immediately after viewing. In a between-subjects design, we made two experimental manipulations of how the images were presented. Participants saw either small (22" diagonally) or large (90") images and either moving or still images.

We used a 2 (motion) x 2 (image size) within-picture design in this experiment. All 60 pictures were presented in every condition, so that each picture could serve as its own control. The basic design required that small groups of participants view 60 pictures in one of four conditions and rate their emotional responses following each one.

One hundred thirty-two people participated in the experiment, with roughly equal numbers of men and women balanced across all conditions. All participants were students recruited from communication or other social science classes at a West Coast university. Participants were compensated with course credit or $6 for participating in the study.[4] Data reported here come from 125 participants in the pool, 64 of them men. The ethnic distribution was 55% Caucasian, 25% Asian-American, 12% African- American, 5% Hispanic, and 3% other. The median age was 20 years.

[4] An analysis of the two groups, those paid cash versus those given credit, revealed no significant differences across the dependent measures.

Stimulus Selection

Numerous criteria, including length, the nature of the motion in the shot, and the content depicted, guided the selection of the clips used in the study. First, in order to maintain high quality in the stimulus material, we decided that all the clips should come from laser discs. The digital format of video laser discs provides superb resolution and signal quality. Because we anticipated some degradation of the video quality from the necessary editing of the stimulus material, we decided to start with the highest quality video available. A wide range of content—feature films, documentaries, interactive programs, television specials—exists on laser disc, and we sampled all types of content in this study.

Selection criteria required that all the clips be 6 seconds long and contain only a single shot. The purpose of the single shot criterion was to eliminate the possibility that a transition (edit) would affect viewers' arousal. The length was chosen for two reasons. First, most shots in contemporary film and television tend to be rather brief, and those that are longer tend to depict only certain kinds of content, for example, panoramic landscapes. Therefore, 6 seconds proved to be a practical length for selecting single shots of a wide variety of content. The second reason is that we deemed it a sufficient duration for prompting emotional reactions. As Lang (1990) notes, emotional manipulations need not be long nor intense to elicit an affective response in people. Furthermore, numerous psychological studies that have examined emotional responses to still pictures have used 6-second exposures (Bradley et al., 1992; Burke et al., 1992; Heuer & Reisberg, 1990; Lang et al., 1993).

The type of motion depicted in the clips further constrained their selection. We manipulated object motion, rather than camera motion, and eliminated shots in which the motion radically altered the content or the meaning of the image. For example, a shot of a candle being blown out was not considered appropriate. We also eliminated clips in which objects entered or left the frame during the shot. In this way, the beginning of each clip was very similar to the end. The goal was for the still version of the image to be essentially the same as the motion version. Examples include a shot of a flag waving in the breeze, a sailboat cutting through whitecaps, the face of a girl crying, and a snake slithering across a sand dune.

We also chose clips to elicit a wide range of emotional responses. Thus, images could be rated as pleasant, unpleasant, arousing, or unarousing. The goal was for responses to the stimuli to be fairly evenly distributed over the range of a two-dimensional (valence x intensity) emotional space. To this end, the slides in the International Affective Picture System (IAPS) developed by Lang, Öhman, and Vaitl (1988) served as a guide. Previous researchers have shown the images in the IAPS to reliably elicit a range of affective responses (Greenwald, Cook, & Lang, 1989; Lang et al., 1993), and have categorized their content systematically, for example, as erotica, mutilations, wildlife, faces, and so forth. We chose many of the images in this study to correspond with slides in the IAPS, but also included other types of content not found in the IAPS. Altogether, we collected and transferred 258 images onto a video laser disc.

Pretesting of the full set of images produced ratings distributions, and plots indicated that we had obtained a good sample of messages. Therefore, the 60 images needed for the actual study could be drawn randomly from the larger set. Once we had done this, we made small changes in the set of 60 to optimize the battery of images for the study. First, we deleted ambiguous images from the stimulus set to reduce variance in the ratings because of confusion over image content, then chose pictures that had similar mean valence and intensity ratings to replace ambiguous images. Second, because we planned a free recall test as part of another study, each of the 60 images had to have unique and discrete content. Therefore, we replaced redundant images or images that could not be easily distinguished from one another with images that had similar ratings. Third, we replaced images that had a great deal of variance in their ratings (standard deviations greater than 2.5) with comparable images with more stable ratings. These changes yielded a set of 60 pictures that had the same basic distribution as the larger set.

Preparation and Procedures

Guided by the criteria described above, we culled clips from laser discs, then transferred selected shots and several seconds preceding and following them from laser disc onto an S-VHS tape. We then trimmed the shots to 6 seconds by editing them onto another S-VHS tape (in component mode to preserve quality) and inserted four to five frames of video black between clips. We created titles and instruction slides on a computer and transferred them onto the videotape. We then dubbed the S-VHS edited master onto a BETA-SP videotape (again in component) and sent the BETA-SP dub master to a video production facility, where it was used to press a special laser disc called a CAV optical check disc.

To control the laser disc player, a Macintosh Hypercard program was written using the Videodisk Toolkit from Apple Computer. The program enabled the research assistant to catalogue the frame numbers of the starting and ending points of each of the clips, as well as the single frame to be used as the still version of the clip. From these logs, we created four random presentation orders. Each sequence, with the warning and instruction slides inserted between the 60 images, lasted 25 minutes.

Images from the laser disc were presented using two different video projectors: an Eiki LC-150 for the small (22" diagonally) image size and an NEC GP-5000 for the large (90") image. The different sizes correspond to a horizontal visual angle of roughly 10.3° for the small image and 41° for the large image.[5] Both image sizes were rear-projected onto a 6' x 9' screen in a special screening room with two rows of four chairs each on the viewing side at distances of 8' and 10'8" from the screen. The lights were dimmed to one fourth of their brightness during the viewing sessions.

We used the Self-Assessment Manikin (SAM) picture scales (Bradley et al.,

[5] These visual angles are calculated for the front row of seats. For the back row the angles are 8° and 31.4°, respectively. The smaller visual angles are typical of television viewing in the home, whereas the larger angles compare to those experienced in movie theaters.

1992; Hodes, Cook, & Lang, 1985; Lang, 1980; Lang et al., 1993) to measure emotional reactions. These self-report measures represent emotion along three bipolar dimensions: valence (positive-negative), intensity (arousing-not arousing), and control (dominance-submissiveness). Participants are given explicit instructions on how to use each of the 9-point scales properly. Numerous earlier studies have established the validity of the measures and the reliability of the scales (Bradley et al., 1992; Hodes, Cook, & Lang, 1985; Lang et al., 1993).

For the pretesting and the actual experiment, we decided that the presentation scenario and procedure should match the one used in previous IAPS studies as closely as possible. Following the paradigm developed by Lang, Öhman, and Vaitl (1988), we presented sets of 60 images to small, mixed-gender groups of up to eight viewers.

We randomly assigned participants to one of four conditions: large, moving pictures; large, still pictures; small, moving pictures; or small, still pictures. Participants filled out short demographic questionnaires. Before the actual study began, they practiced viewing and rating their emotional responses to four different images. All participants viewed the same four images (a frog, a woman smiling, a building on fire, and a farmhouse in the snow). After the practice session, the experimenter answered participants' questions before leaving the viewing area so the study could begin. The experimenter presented each of the 60 images on screen for 6 seconds, preceded by a 5-second warning slide and followed by a 15-second slide that instructed participants to complete their SAM ratings. At the end of the rating session, the experimenter returned to the viewing area and asked participants to complete another questionnaire and a recall memory test for another study. After students completed these brief tasks, the experimenter debriefed and thanked them for their participation.

Emotional responses to the stimuli were assessed using a pencil-and-paper version of the Self Assessment Manikin (SAM), the validity and reliability of which has been tested and verified in numerous studies (Bradley et al., 1992; Hodes, Cook, & Lang, 1985; Lang, 1980; Lang et al., 1993; Lang, Newhagen, & Reeves, 1996). The SAM ratings data were reduced by collapsing across people, within condition, which yielded 240 average ratings, one for each of the 60 images in each condition. Since pictures, not people, were the units of analysis, within-picture ANOVA models were run for each dimension of emotion (valence, arousal, and dominance).

Arousal, Size, and Motion

In analyzing the data, we ran factorial within-picture analysis of variance (ANOVA) procedures for each of the five dependent variables. The analyses yielded five significant main effects and one significant interaction. A summary of the results can be found in Table 1.

The within-picture ANOVA produced a significant interaction and significant main effects of size and motion on ratings of affective intensity (see Figure 1). The interaction reflects the fact that participants rated the large, still versions of

Table 1. Summary of Results: Image Size and Motion Effects

	Independent Variables		
	Image Size	Motion	Interaction
Dependent Variables			
Arousal	Large > Small***	Still > Moving***	LS > SS> LM > SM**
Valence	Large > Small	Still > Moving	LS > SM > LS > LM
Dominance	Large > Small*	Moving > Still***	LM > SM > LS > SS

Note: LS = large still, LM = large moving, SS = small still, SM = small moving
*$p < .05$ **$p < .01$ *** $p < .001$

the images considerably more arousing (M = 5.57) than the small, still versions (M = 5.18), the large, motion versions (M = 5.1), or the small, motion versions of the same images (M = 4.99), $F(1, 59) = 9.23$, $p < .01$.

Although significant interactions often preclude the interpretation of main effects, in this case the main effects are significant in and of themselves, and therefore interpretable. Participants rated pictures presented as large images as more arousing (M = 5.34) than the same pictures presented as smaller images (M = 5.08), $F(1, 59) = 34.9$, $p < .001$. For motion, they rated the still versions of the pictures as more arousing (M = 5.37) than the moving pictures (M = 5.05), $F(1, 59) = 23.7$, $p < .001$. These differences were significant at each level of the second independent variable. That is, the still versions of the images were rated more arousing for both the large image size, $F(1, 59) = 36.3$, $p < .001$, and the small image size, $F(1, 59) = 5.17$, $p < .05$. Likewise, the larger images were rated more arousing for the still versions, $F(1, 59) = 46.6$, $p < .001$, as well as for the moving versions, $F(1, 59) = 3.07$, $p < .1$.

We found no significant effects of motion or image size for the valence dimension of emotional responses. For the dominance dependent variable there were significant main effects, but not a significant interaction. The moving versions of the images received higher dominance ratings (M = 4.77) than did the still versions (M = 4.5), $F(1, 59) = 31.2$, $p < .001$. In other words, the moving versions of the images elicited more "in control" responses than did the still pictures. For image size, the large versions of the pictures had higher ratings on the dominance scale (M = 4.69) than did the small versions (M = 4.69), $F(1, 59) = 5.23$, $p < .05$.

Presentation Attributes and Emotional Responses

The question guiding this experiment was whether certain presentation attributes, image size and motion, would affect how people responded to the pictures they saw. The concise answer provided by these data is yes, presentation attributes do affect viewers' emotional responses. Results of this study have intriguing implications from both a technological and psychological perspective.

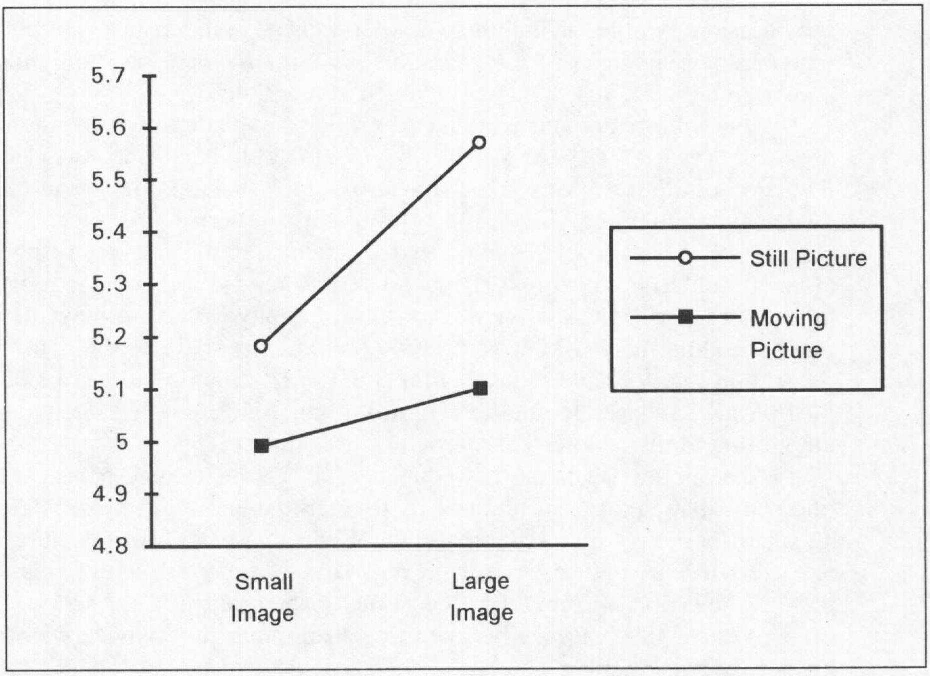

Figure 1. Arousal rating by image size and motion

The results of the experiment indicate that image size positively affects the arousal and dominance dimensions of emotional responses, but has no significant effect on valence evaluations. Specifically, pictures seen as large images elicit stronger feelings of arousal than the same pictures seen as small images. Because arousal is widely regarded as a primitive and automatic response to stimuli in one's environment, a plausible explanation for the effect is that the larger images constitute more compelling and significant stimuli.

Big pictures are not just larger images or representations, they are also bigger things. Images certainly have symbolic significance, but at a more primitive level people respond to their nonrepresentational aspects as well. In terms of Lang's bio-informational theory, the increased arousal was an adaptive response to stimuli that are close enough to real-world counterparts, that is, big things, to be consequential to the organism.

These results challenge the assumption that the words and pictures in media are merely symbolic. When information is mediated, we often assume that people think about who sent it and why, and, most importantly, what it means. People do not think about what to do, because, after all, these are only pictures. They do not deserve the same consideration as other real experiences.

On occasion, people willingly may suspend disbelief in exchange for an entertaining experience, but it is assumed that this suspension is a mindful act and voluntary, and that it can be revoked at any time.

The bio-informational theory, however, helps explain why these discretionary responses to media are not the only ones people have, and especially why they are not the responses that characterize emotional experiences in relation to media. Within the network of information that constitutes a response to any stimulus, there is action. When people see mediated images, they respond automatically to the pictures. Their bodies and minds prepare for a range of behaviors that they may or may not act out. People evolved to have these responses, and there is no switch in the brain that deactivates them just because the stimulus is mediated rather than real. From a bio-informational perspective, pictures are similar to natural experience in that they are able to generate both emotions and the actions that are part of the emotions.

It is also noteworthy that these effects occur across a range of content. Often one hears that a particular film is a "big screen movie," typically in reference to an action or adventure film. Somehow it seems that films with dynamic content, like *Top Gun*, are better appreciated on a large screen. This intuition guided, in part, the selection of stimuli for one of the image size studies described above (Reeves et al., 1993). It may be that there is an interaction between content and image size such that large screens generate more arousal for dynamic messages than for static ones, but it has not been assessed in this experiment. What is clear is that the arousing effect of a large image happens irrespective of the content.

The study provides empirical evidence for what film theorists have suggested for some time—that screen size will have an impact on one's movie-watching experience. There is certainly a host of differences between watching a movie in a theater and on television, but one of the most important may be that the big screens provide a more arousing experience, and it does not take a theater-size screen to make an appreciable difference. The difference in the levels of the screen size factor in this study is dramatic, but the large image size is fairly typical of a private screening room or home theater. With the advent of HDTV, it will become even more common to see image sizes like the one used here.

The findings of the study indicate that a large image size tends to make people feel more in control than does the smaller image size. This result is surprising, especially given that typically arousal and dominance are negatively correlated (Lang, 1988). The correlation suggests that people feel less in control when they are aroused than when they are calm. Why then would people report that they felt both more aroused and more dominant when confronted with a large-screen presentation? One possible explanation is that social desirability influenced the participants' ratings. There seems to be strong social pressure to be in control in most situations, and, given that the viewing and rating sessions took place in small groups, it may be that the self-reports were not accurate reflections of the true emotional response. Another explanation may be that the dominance scale was not a good measure. Of the three scales, the dominance measure has the most questionable construct validity. It may have been measuring something like how much the participants liked the presentation (dominance and valence were positively correlated). The third possibility is that this was a spurious result (a Type I error). Although none of these explanations is very compelling, there does not seem to be a clear and convincing alternative.

Motion Effects

One of the more intriguing results of the experiment is that still pictures generate more arousal than moving pictures. It was expected that motion would have some effect on arousal, but not in the direction the data indicate. How could something static be more arousing than the same thing moving? The result may seem counterintuitive until one considers more carefully the nature of the manipulation.

The still versions of the images were *stilled* moving pictures. Although the stimuli were selected to avoid drastic or dynamic motion, there was motion in each of the initial 6-second clips. So, when the still versions were created by freezing one frame, there was often a sense of implied motion. For example, in the still version of a rocket launch, it was quite clear that the rocket was taking off. We suggest that the still versions of the images invited interpretation, and speculation and elaboration of the meaning or significance of the picture led to greater arousal.

Another example to illustrate how this might work: A still shot of a sailboat racing through whitecaps might lead the viewer to think about how fast it was going, but with the moving version, the viewer knows how fast because it is there on the screen.[6] As moments frozen in time, the still images beg for speculation on what has immediately preceded and what is likely to follow the event depicted. An image of a gun pointed at someone with the muzzle flash clearly visible invites the viewer to consider a number of things: What led up to the shooting, how many shots were fired, whether the shooting is fatal, and what the consequences might be. In the moving version, these kinds of questions are less likely to arise for two reasons: First, even with clips as short as 6 seconds, the questions are mostly answered. The moving version provides more information, so there is less of a search for it. Second, as an ongoing stream of information, the moving version constitutes a fairly demanding cognitive task, and viewers may not have the mental resources available to speculate (Lang, Dhillon, & Dong, 1995).

To some degree, the explanation is that still pictures leave more to the imagination than moving pictures do. It is fairly well established that in certain situations people fill in missing information. It could be that the rumination and augmentation lead to a kind of internally generated arousal. This scenario is fairly analogous to emotional responses being generated by mental imagery (Lang, 1995). Compared to moving pictures, still images are more clearly repre-

[6] A phenomenon known as representational momentum provides support for the idea that implied motion is cognitively engaging. Research has shown that short-term memory for photographs is distorted slightly forward in the direction of the motion (Finke & Freyd, 1985; Freyd, 1987).

sentations, and therefore much less likely to be treated as natural experience. As representations, people assume that still pictures have some communicative intention associated with them. Still pictures afford greater aesthetic distance, so people look for their symbolic significance. The search for meaning may be the source of the stronger emotional responses elicited by the still images in this study.

The data indicate that the moving versions of the images evoked greater control responses than did the still versions. An extension of the explanation offered for motion's effect on arousal could account for the effect of motion on dominance as well. It is clear from the data that still images generate more arousal than moving ones, and, if still images invite interpretation as suggested, or put more strongly, if they demand interpretation, then it is possible that they induce a mild form of anxiety in the viewers. Viewing the still images in this experiment might be analogous to confronting a striking piece of abstract art. Both are understood to be symbolic, so there must be some communicative intent. If the meaning of the representation is unclear or ambiguous, it can be an unsettling experience that may produce anxiety (Lazarus, 1991).

Given that laboratory settings often create demand characteristics, there may have been even more pressure on the participants in this study to figure out what the images might mean. Even though the images were all quite literal, and their meaning was simply what they depicted (a sailboat, a snake, and so on), a number of the participants had been in communication and psychological studies before, and they may have been trying hard to second-guess the study or to deconstruct the stimuli. The explanation offered here should be evaluated cautiously, for it is largely speculative. More evidence is needed before any solid conclusions can be drawn.

Implications of the Study

If the results from this study are robust and reflect true relationships, then there are a number of implications for communication researchers as well as for the general public. For example, a great deal of communication research suggests that the key to understanding media effects is in revealing the nature of the semantic processing of content. However, the results of this study suggest that emotional responses are affected by the form a message takes, as well as by its content. This means that mediated presentations, such as film and television, should not be regarded as solely symbolic communication. In terms of the bioinformational theory of emotion, the significance of media messages to an individual resides not only in their content, but also in the nature of their presentation. Based on the results reported here, it would be extreme to say that the medium is the message, but clearly form of presentation matters. Additional research is needed to assess the relative contribution of both message form and content to the creation of meaning, and the conditions and consequences of their interaction.

The results of this study may cause some concern among those interested in the deleterious effects of television. Cantor (1991) speculates that the intensity of fright reactions to mass-mediated presentations might be intensified if the depiction of fear-evoking stimuli were combined with factors within the presentation, such as sound effects or music, that tend to produce arousal. The arousal produced by increased screen size can also intensify fright. To date, only anecdotal evidence has supported this notion, but the data reported here lend more credibility to the claim. Indeed, increased arousal due to a large image size may compound a whole range of content-based effects. Aggressive behavior prompted by exposure to television violence might be exacerbated, for example, if the antisocial acts were to be splashed across a big screen.

These possibilities point to the need for further inquiry into the psychological effects of home theaters. The trend for larger and larger television screens in the home may be altering the viewing experience. The marketing strategy for these new sets certainly implies that they revolutionize televiewing; television manufacturers tout the big screens as providing a vastly more exciting and compelling entertainment experience. In the words of the advertisers, the new home theater televisions create a sense of being there. An important component in this experience seems to be increased arousal levels in viewers. As the results of the present study suggest, viewers may feel more arousal across the entire range of content and not just in response to exciting action-adventure or suspenseful programs. What this means in terms of such effects as cultivation, agenda setting, and social learning is not known, but the impact of these new big-screen televisions certainly seems worthy of further investigation.

As for the motion effects in this study, there are conceptual as well as practical implications. First, it appears that the effects of motion in pictures on cortical and autonomic arousal are distinctly different. Although Reeves et al. (1985) found that cortical arousal increased when there was motion in a television message, the present study indicates that absence of motion leads to greater autonomic arousal or emotional intensity. The disparity of these findings may be due to a fundamental difference in the two kinds of arousal, or it may be attributable to the types of measures used. The EEG measures used in the Reeves et al. (1985) study assessed psychological changes that were inaccessible to introspection, whereas the SAM measures are based on individuals' ability to reflect on and accurately evaluate their emotional state. Whether the greater arousal reported in response to the still images corresponds to a truly visceral reaction or is primarily generated by cognitive evaluation needs to be determined in subsequent studies. Physiological measurement of arousal (e.g., via skin conductance), in addition to the use of the SAM, should help to clarify the issue.

To a certain extent, the theoretical perspective of the study challenges a long-standing assumption in media research, namely, that media messages are uniquely human creations that represent social realities. From the bio-informational perspective, the representations may not be significantly different from their referents in terms of the emotions they elicit. The adaptive response to a media message is to respond to it as if it were real. Support for this view comes not only from the field of evolutionary psychology, but from communication research, too. For example, Messaris (1994) presents considerable evidence that picture perception is an extension of innate cognitive abilities, rather than some specialized function. This suggests that media researchers should investigate not only how mediated messages differ from natural experience, but also the ways in which they are similar.

The results of this study support the claim that the form a picture takes can affect the emotional and cognitive responses it elicits independent of its content. The findings underscore the need to investigate the psychological impact of different modes of presentation, especially for new communication technologies that are changing the ways messages are displayed. A great deal of public attention has centered on the engineering achievements and economic ramifications of new message delivery systems, like direct broadcast satellites, (DBS) and of advanced presentation devices, like high-definition television (HDTV). The importance of these issues notwithstanding, the concern of social scientists should be the psychological and social impact of the new technologies.

The study also indicates that the bio-informational perspective provides a useful theoretical framework for investigating emotional responses to media. The theory provides an explanation for emotional responses to media messages, and it points to important attributes of media that will elicit emotions.

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