Psychophysiological Responses to Still vs. Animated Pictures With Different Levels of Emotional Valence

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ABSTRACT

With the rapid development of multimedia and Internet technologies, understanding what visual contexts are well-received among viewers is important for message designers and visual practitioners. This study investigated the effects of valence (positive vs. negative), picture type (animated vs. still), and their interaction effect on attention, motivational intensity (sympathetic arousal), memory sensitivity and judgment. Eighty-seven participants in a mixed factorial design experiment were exposed to six pictures that were either animated or still. Results indicated that animated pictures led to greater attention and motivational intensity than still ones. Negative pictures also elicited greater motivational intensity but were less remembered than positive ones. Additionally, people exhibited greater sympathetic arousal when processing negative animated pictures than other types of pictures. Implications are also discussed.

KEYWORDS

animation
attention
motivational intensity
ad recognition
psychology of technology

INTRODUCTION

Media contents serve as an essential information source. They sometimes offer the same information but are presented in different formats (e.g., still and animated visuals). Animations are generally preferred as they are believed to be more communicative via presenting more information of a particular scenario. It has been found that Twitter posts with animated images are twice as likely to be retweeted than still pictures (Farkas, 2016). Thus, animation has been widely used in digital strategy and marketing to provide positive user experiences and smooth interactions. This raises an interesting research question: Will the same mediated contents (either positive or negative) presented in different formats produce different effects on attention, arousal, and memory? The current study examined the main and interaction effects of picture type (animated vs. still) and valence (positive vs. negative) on attention, sympathetic arousal, and memory in affective picture processing.

The Animate-Inanimate Distinction

Reeves and Nass (1996) introduced the idea of "the media equation" from a series of experiments. Findings from these experiments suggest that people often treat media and media contents as though they were real. In other words, humans perceive and respond to mediated cues and contexts as though they offered both opportunities and threats. From an affordance perspective (Gibson, 1977), both real and mediated environments present us with opportunities and threats. Humans tend to adapt to and alter their environments and the stimuli within them in order to make affordances better suit their needs. In general, animated pictures of objects and animals present a greater variety of affordances than still ones. A number of research studies have indicated that animated stimuli are more likely to elicit attention, sympathetic arousal, and emotional responses (e.g., Bayles & Chaparro, 2001; Heo & Sundar, 2000; Hong et al., 2004; Lang et al., 2002; Pratt et al., 2010). For example, viewers demonstrated greater sympathetic arousal and attention for animated banner ads than still ones (Heo & Sundar, 2000; Lang et al., 2002). Hong et al. (2004) found that flashes elicited greater attention and facilitated quicker location of the flashed target item in tightly packed screen displays. However, empirical findings have been inconsistent as some studies showed that still pictures elicit greater negative emotional feelings than animated mediated messages (i.e., videos, Fan et al., 2020). As for the effects on memory, some studies suggest that animated contents are better memorized than still ones (Hamborg et al., 2012; Yoo et al., 2004), while some others draw the opposite conclusions (Diao & Sundar, 2004; Hong et al., 2004; Kuisma et al., 2010). However, there is a lack of empirical data on the effect of

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picture type on cognitive and emotional responses when individuals are exposed to either still or animated versions of the same information which varies in valence.

Message Valence and Motivational Activation

Exposure to mediated emotional stimuli (e.g., pictures) will automatically activate two independent motivational drive systems – the appetitive and the aversive motivational systems (Cacioppo & Berntson, 1994, 1999; Cacioppo et al., 1997, 1999). When the appetitive system is activated, human beings exhibit an increasing approach motivation. The activation of the appetitive system energizes the dynamic eagerness for beneficial outcomes, such as seeking opportunities, obtaining rewards, and so forth. Activation of the aversive system urges avoidance of threats, such as attacks, diseases, noxious objects, and so forth. Message valence affects which motivational drive system gets activated during information processing. In particular, viewing positive pictures activates the appetitive system, while viewing negative pictures activates the aversive system. Much work has been done to study how attention, arousal, and emotional responses can be influenced in still picture processing (e.g., Bradley et al., 2001a, 2001b; Schupp et al., 2012). For example, a study conducted by Schupp et al. (2012) demonstrated that emotional pictures (positive and negative) generated greater directed attention than neutral ones. In addition, Bradley et al. (2001a, 2001b) found that people exhibited greater sympathetic arousal and attention for negative pictures depicting threat, violence, and death compared to positive pictures depicting foods, families, and nature. This may be due to a negativity bias. Negativity bias is the tendency for individuals to pay more attention to negative stimuli (e.g., dangers and threats) over positive stimuli (Cacioppo & Berntson, 1994). However, the attention span does not last long, as withdrawal motivation (withdrawal from the threat) occurs. In other words, people allocate more attention in threatening situations. However, they may not memorize the negative information well because they are deliberately trying not to encode it. Studies of the negativity bias have demonstrated that positive messages are often better remembered than negative ones (Lang et al., 1995; Lang & Friestad, 1993; Newhagen & Reeves, 1992). They showed that individuals were deliberately trying not to encode negative information as dangers became more imminent and arousing (Bailey et al., 2018; Leshner et al., 2018; Liu & Bailey, 2019). For example, studies indicated that individuals exhibit more signs of defensive processing, indexed via poor attention and memory (poor recognition sensitivity and a more liberal criterion bias), when they are exposed to substance-abuse prevention public service announcements that contain disgust messages and fear appeals (Leshner et al., 2018; Liu & Bailey, 2019).

On the basis of previous findings, the current study examined the main and interaction effect of picture type (animated vs. still) and valence (positive vs. negative) on attention, motivational intensity, visual recognition sensitivity, and criteria for decision-making. Thus, the following hypotheses were proposed:

- H1a: Animated pictures would elicit greater attention and motivational intensity than still ones.
- H1b: Animated pictures would generate greater visual encoding sensitivity and more conservative criterion bias compared to still ones.
- H2a: Negative pictures would elicit greater attention and motivational intensity than positive ones.
- H2b: Negative pictures would generate poorer visual encoding sensitivity and more conservative criterion bias compared to positive ones.
- H3a: Negative animated pictures would elicit the greatest attention and motivational intensity than other types of pictures.
- H3b: Negative animated pictures would generate poorer visual encoding sensitivity and more conservative criterion bias than other types of pictures.

METHOD

Participants

Eighty-seven undergraduate students (60.4% female, 76.8% white, M_{age} = 20.48, SD_{age} = 2.08) were recruited from a large Northwestern state university to participate in a psychophysiological experiment. They received extra credits for their participation in this study. Specifying a standard small effect size (0.20) and an a of 0.05 in the G*Power program (Faul et al., 2007), the proposed repeated measures design required at least 32 participants to have a 0.95 power estimate.

Experimental Design

A 2 (Picture type [animated, still]) × 2 (Valence [positive, negative]) × 3 (Repetition) × 8 (Time [halfsecond]) mixed factorial design experiment was used. Picture type was a between-subject variable. All others were within-subject variables.

Stimuli

Twelve pictures (six were still pictures, while the other six were animated pictures) with a resolution of 720 × 576 pixels were used as stimuli. The pictures were selected from the emotional movie database (EMDB; Carvalho et al., 2012). The selected raw EMDB stimuli were edited to 4 s animated pictures that did not include scene changes or camera edits. The peak-end rule suggests that the peak and end moments of an individual's affective experience have a decisive influence on their overall retrospective evaluations (Kahneman et al., 1993). Accordingly, each selected static picture was a screenshot depicting the intense (peak) point (e.g., the presence of positive or negative emotions like joy, love, sadness, or anger) in the corresponding animated picture. For example, one of the animated pictures showed a young man entering a church for his mom's funeral and starting to cry when he sees the coffin. The corresponding static picture shows a young man crying at the funeral of his mother. Picture stimuli were pretested to make sure they did not vary in elicited experience to add additional control. Thirty-five undergraduate students viewed and rated the stimuli to assess affective valence, which was indexed via self-report ratings on the scale from 1 (*not positive/negative at all*) to 7 (*extremely positive/negative*). Based on the pretest results, positive pictures (including both animated and static ones) were rated as significantly more positive (*M* = 4.303, *SD* = 1.093) and less negative (*M* = 1.7333, *SD* = .983) than negative pictures (positivity rating: *M* = 2.167, *SD* = 1.387; negativity rating: *M* = 4.581, *SD* = 1.373). There were no significant differences between pictures within each category in terms of positivity and negativity ratings (Positive pictures: $F_{positivity}[1, 20] < 1, p = .537$; $F_{negativity}[1, 42] = 1.079, p = .305$; Negative pictures: $F_{positivity}[1, 42] = 2.08, p = .157$; $F_{negativity}[1, 33] < 1, p = .879$).

Manipulated Independent Variables

PICTURE TYPE

This factor had two levels: animated and still. Animated pictures were selected from the EMDB and edited to 4 s stimuli. Still pictures were screenshots taken from the animated pictures. The intense (peak) points of the animated pictures were kept in the corresponding still pictures as explained above.

VALENCE

This factor had two levels: positive and negative. Social positive contents selected from the EMDB were categorized as positive stimuli, while social negative contents were categorized as negative stimulus.

TIME OF EXPOSURE

Each picture was presented on the screen for 4 seconds (or 8 half seconds).

REPETITION

Three pictures from each category were used in order to generalize to the type of picture rather than any specific scene or scenario.

Dependent Variables

HEART RATE (HR)

HR data were collected as an indicator of attentional resource allocation across exposure to the pictures (Lang, 1994; Potter & Bolls, 2012). Heart rate deceleration over time is indicative of greater attention paid to an external stimulus. Raw HR data were collected by placing two standard 8 mm Ag–AgCl electrodes placed on the right and left forearms. A third ground 8 mm electrode was placed on the nondominant forearm. Following the procedures recommended by the Society of Psychophysiological Research on heart rate measurement (SPR Ad Hoc Committee on Electrodermal Measures, 2012), raw data were collected as milliseconds between beats and converted to a weighted average beats per minute (BMP) per second. Change scores were calculated using the first second of the identified segment as a reference point. The pulse signal was recorded with Biopac Acqknowledge software and analyzed off-line with Biopac Acqknowledge software. Recording artifacts were identified and corrected using interpolation.

SKIN CONDUCTANCE LEVEL (SCL)

Thr SCL was used as an indicator of sympathetic nervous system arousal or intensity of motivational activation evoked by stimuli (Bailey, 2017; Potter & Bolls, 2012). Skin conductivity is a measure of sympathetic nervous system response, which is active in response to both emotionally and bodily arousing contexts (Bailey, 2017; Potter & Bolls, 2012), with more arousing contexts eliciting greater SCL. Following the procedures recommended by the Society of Psychophysiological Research on skin conductance measurement (SPR Ad Hoc Committee on Electrodermal Measures, 2012), SCL was collected by placing a pair of standard 8mm Beckman Ag/AgCl disposable electrodes on the palm of the subject's nondominant hand. The raw SCL signal was recorded using a Biopac MP150 wireless bio-amplifier that passed a constant measurement voltage of .5v.

SIGNAL DETECTION MEASURES

A forced-choice (yes-no) video recognition test was conducted after picture viewing. In particular, two target screenshots (selected from picture stimuli) and two foils (selected from similar content that was not seen by the participants to match the targets in terms of topic and imagery/soundscape) were presented in the recognition test. Participants were asked to respond positively as quickly as possible if they thought they had seen screenshots from those previously viewed pictures, or negatively if they thought the screenshots were not from those previously viewed pictures. All screenshots were presented randomly for 50 ms using Direct RT software (Jarvis, 2014). Encoding sensitivity and criterion bias were computed by using the hit and false alarm rates to reflect memory sensitivity and judgment (Macmillan & Creelman, 1991; Shapiro, 1994). In particular, encoding sensitivity (d') was calculated by subtracting the standardized false alarms rates from the standardized hit rates (Macmillan & Creelman, 1991). Greater encoding sensitivity (d') indicated the viewer's ability to accurately recognize something as having been seen before. Criterion bias (c) was calculated by multiplying the sum of the standardized hit rates and false alarm rates by −0.5 (Macmillan & Creelman, 1991). Criterion bias (c) measures how liberal or conservative a viewer is in deciding if a stimulus matches a memory (Shapiro, 1994). A neutral criterion bias (c value of zero) indicates the viewer has no greater tendency to say yes than no. When c is negative, the viewer is more liberal, with a tendency to answer yes, which maximizes hits at the possible cost of additional false alarms (Macmillan & Creelman, 1991).

Procedure

Upon arrival at the lab, participants' informed consent was obtained. All participants were given access to a keyboard and a computer mouse on a movable desk above the participants' laps. MediaLab software (Jarvis, 2014) was used to deliver the questionnaire. Participants viewed a total of 12 of either still or animated pictures. Psychophysiological data were recorded continuously during the exposure to pictures. After the completion of the picture viewing session, the researcher removed the HR and SCL sensors. Participants then answered some demographic questions. After these questions, which served to clear short-term memory of pictures, the participants were asked to finish a visual recognition test. They were thanked, debriefed, and dismissed. The entire procedure lasted approximately 45 minutes.

Data Analysis

Data obtained were submitted to 2 (Picture type [animated, still]) × 2 (Valence [positive, negative]) × 3 (Repetition) × 8 (Time: [halfsecond]) between-subjects repeated measures analyses of variance (ANOVAs). The α level was set at .05 and Tukey's HSD post-hoc tests were used to test for significant differences between individual means where necessary. For visual recognition data, 14 participants were not included in the analysis because they did not follow proper procedures and did not vary their answers. The remaining data were submitted to a 2 (Picture type [animated, still]) × 2 (Valence [positive, negative]) between-subjects repeated measures ANOVA.

RESULTS

Animated Versus Still Pictures

H1a predicted that animated pictures would elicit greater attention and motivational intensity than still ones. This hypothesis would call for the two-way interaction effects on HR (greater attention) and SCL (greater motivational intensity). The predicted interaction effects of picture type and time were found on HR, $F(7, 616) = 4.845$, $p < .05$, $\eta_p^2 = .052$. As predicted, participants demonstrated stronger HR deceleration when viewing animated pictures compared to still ones, meaning that people paid more attention to process animated pictures than still ones. Pairwise comparison results indicated that animated pictures elicited significantly greater HR deceleration from 6 to 8 halfseconds (see Figure 1) than still pictures. However, the interaction effect of picture type and time on SCL were not found, $F < 1$, $p = .75$. Thus, H1a was partially supported.

H1b predicted that animated pictures would generate greater visual recognition sensitivity and more conservative criterion bias compared to still ones. However, the between-subject effects of picture types on encoding sensitivity ($F < 1$, $p = .596$) and criterion bias ($F < 1$, $p = .421$) were found to be not statistically significant. Thus, H1b was not supported.

Positive Versus Negative Pictures

H2 predicted that negative pictures would elicit greater attention and motivational intensity than positive pictures. This hypothesis would call for the two-way interaction effects on HR (greater attention) and SCL (greater motivational intensity). Based on our results, the predicted interaction effects of valence and time were found on SCL, $F(7, 595) = 5.094$, $p < .01$, $\eta_p^2 = .057$. Pairwise comparison results indicated that negative pictures elicited significantly greater motivational intensity than positive pictures from 4–8 halfseconds (see Figure 2). However, the interaction effect of valence and time on HR was found to be insignificant, $F(7, 616) = 1.045$, $p = .368$. Overall, the presence of negative pictures elicited greater attention and motivational intensity than positive ones. Thus, H2a was partially supported.

The main effects of valence on encoding sensitivity, $F(1, 70) = 9.303$, $p < .01$, $\eta_p^2 = .117$, and criterion bias, $F(1, 70) = 14.592$, $p < .001$, $\eta_p^2 = .173$, were also found to be significant. Results indicated visual sensitivity was significantly poorer for negative pictures ($M = -1.455$, $SD = .209$) than positive ones ($M = -.618$, SD = .185, $p < .01$). In addition, participants were liberal (i.e., c less than zero) across all conditions, but they were less liberal when making decisions about negative pictures ($M = -.203$, $SD = .011$) than positive ones ($M = -.251$, $SD = .01$, $p < .001$). Thus, H2b was supported.

The Interaction Effect of Valence and Picture Type

H3a predicted that negative animated pictures would elicit the greatest attention and motivational intensity than other types of pictures. The predicted three-way interaction effect of picture type, valence, and time was found to be significant for SCL activation, $F(7, 595) = 3.978$, $p < .05$, $\eta_p^2 = .045$. Pairwise comparison results indicated that negative animated pictures elicited significantly greater motivational intensity than positive animated pictures during the entire 8 half-seconds (see Figure 3). However, the interaction effect on HR was not found, $F < 1$, $p = .572$. Thus, H3a was partially significant.

H3b predicted that negative animated pictures would generate poorer visual encoding sensitivity and more conservative decision-making than other types of pictures. The predicted interaction effects of picture type and valence on encoding sensitivity, $F(1, 70) = 1.157$, $p = .286$, and criterion bias, $F < 1$, $p = .933$ were not found. Thus, H3b was not supported.

DISCUSSION

The dual motivational system theories suggest that emotional stimuli (e.g., pictures) could automatically activate either one or both of two motivational systems, which have been called the appetitive and the aversive systems (Cacioppo & Berntson, 1994, 1999; Cacioppo et al., 1997, 1999). In particular, the appetitive system is primarily activated in positive contexts (e.g., exposure to food or sex rewards). Conversely, the aversive system is primarily activated in negative contexts (e.g., exposure to threats, dangers, or hazards). The current study tested the interaction effect of valence and time during animated versus still picture viewing on cognitive resources to encoding, visual encoding sensitivity, and criterion bias. As expected, participants exhibited greater motivational intensity for negative pictures compared to positive ones. Though encoding sensitivity was generally poor, participants showed poorer visual recognition and more conservative criteria bias when making decisions about negative pictures than positive ones. One explanation is that the presence of aversive stimuli elicited defensive processing, yielding poor recognition memory sensitivity and a more conservative criterion bias. Thus, consistent with previous research, individuals exhibited poor encoding sensitivity and a more conservative criterion bias due to the activation of defensive processing (Lang et al., 1995; Lang & Friestad, 1993; Newhagen & Reeves, 1992; Liu & Bailey, 2019). Negative marketing has been used as a tactic to increase

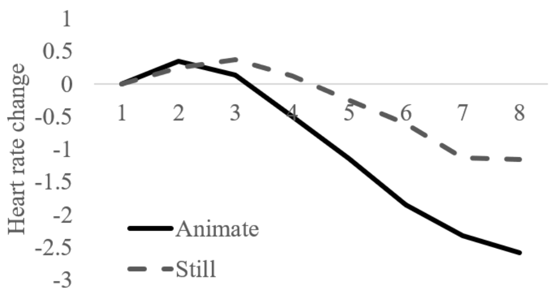

FIGURE 1.

The two-way interaction of picture type and time on heart rate.

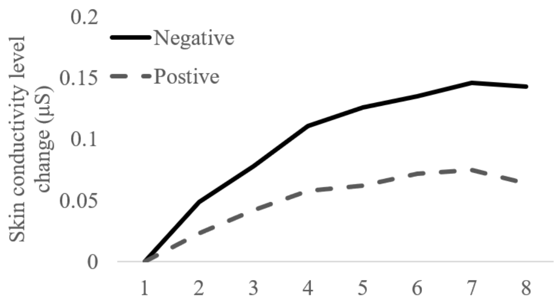

FIGURE 2.

The two-way interaction of valence and time on skin conductivity level.

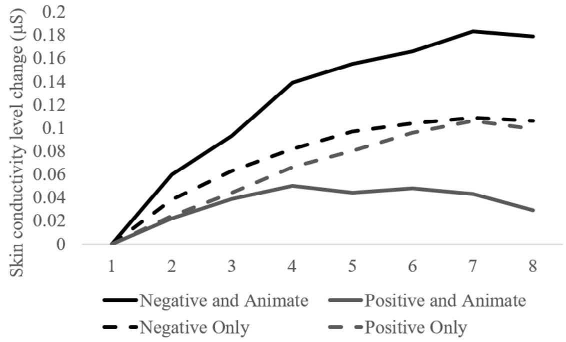

FIGURE 3.

The three-way interaction of picture type, valence, and time on skin conductivity level.

customer engagement. With these findings in mind, message designers and visual practitioners may have to reconsider how to present negative content in a more appropriate way during affective picture viewing to better facilitate information processing.

Gibson's (1977) affordance concept posits that people automatically perceive what different environmental stimuli (i.e., objects, substances, other animals) afford them in terms of behavior. Animated pictures may elicit greater motivational activation than still pictures as animated pictures present a greater variety of affordances than still ones. In this study, our results demonstrated that people paid greater attention to animated pictures than still ones. The results are consistent with previous research (Heo & Sundar, 2000; Lang et al., 2002; Pratt et al., 2010; Hong et al., 2004). This suggests that animated pictures have a privileged cognitive processing status over still pictures. From an ecological perspective, animated stimuli may offer more information about affordances that contribute to survival and reproduction than inanimate (or still) stimuli. In other words, animated pictures are a more engaging medium that can grab the attention of the users faster than still ones. Thus, message designers and visual practitioners are suggested to use animated pictures to increase content reach. For example, in the context of online advertising (e.g., banner ads), embedding animated ads is likely to better capture viewers' attention than still ones. However, the expected main effects of picture type on encoding sensitivity and criterion bias were not found. Media researchers need to make concerted efforts to further investigate the effect of picture type on picture recognition.

This study also examined the interaction effect of picture type and emotional valence during affective picture viewing. Overall, participants demonstrated the most sympathetic arousal for negative animated pictures. In other words, people showed greater motivational reactivity toward negative animated pictures over positive animated and still pictures. Though this study did not find a significant effect of picture type and valence on encoding performance, the presence of aversive cues in animated media messages may elicit defensive processing. It is likely that animated stimuli that present threats will, as they become more vivid and imminent, activate the aversive motivational system resulting in defensive processing. Further research is needed to explore the effect of this interaction on encoding performance. Thus, message designers and visual practitioners may have to consider how to appropriately use visual information to encourage desired cognitive and emotional responding instead of message rejection, denial, or minimization.

The current study is not without limitations. First, it employed an experimental setting to control for extraneous factors that may influence affective picture processing. However, affective picture processing might yield different patterns in more natural circumstances. In addition, this study used a college-aged adult sample, meaning that the results may not be generalizable to other individuals. The college-aged sample may access visual context via the Internet more frequently than other populations. Future research is needed to see if there might be any differences between populations.

Overall, the current study adds important insights to the extant literature focused on understanding how the presence of still versus animated pictures with different levels of emotional valence influences cognitive and emotional responses and how these pictures are later remembered. The results of this study indicated that negative pictures generally elicited greater motivational intensity but were less remembered than positive ones. Animated pictures also led to greater attention and motivational intensity than still ones. Additionally, participants exhibited stronger sympathetic arousal during exposure to negative animated pictures than other types of pictures. Practically, findings from this study provide recommendations for message designers and visual practitioners who may be interested in facilitating information processing more effectively.

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DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

REFERENCES

Bailey, R. L. (2017). Electrodermal activity. In: J. Matthes (Ed.), *The international encyclopedia of communication research methods* (pp. 1–15). Wiley.

Bailey, R. L., Wang, T., & Kaiser, C. K. (2018). Clash of the primary motivations: Motivated processing of emotionally experienced content in fear appeals about obesity prevention. *Health Communication, 33*, 111–121. doi: 10.1080/10410236.2016.1250186

Bayles, M. E., & Chaparro, B. (2001). Recall and recognition of static vs. animated banner advertisements. *Proceedings of the Human Factors and Ergonomics Society 45th Annual Meeting, 45,* 1201–1204. doi: 10.1177/154193120104501510

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001a). Emotion and motivation I: defensive and appetitive reactions in picture processing. *Emotion, 1*, 276–298. doi: 10.1037/1528-3542.1.3.276

Bradley, M. M., Codispoti, M., Sabatinelli, D., & Lang, P. J. (2001b). Emotion and motivation II: sex differences in picture processing. *Emotion, 1*, 300–319. doi: 10.1037/1528-3542.1.3.300

Cacioppo, J. T., & Berntson, G. G. (1994). Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin, 115*, 401–423. doi: 10.1037/0033-2909.115.3.401

Cacioppo, J. T., & Berntson, G. G. (1999). The affect system architecture and operating characteristics. *Current Directions in Psychological Science, 8*, 133–137. doi: 10.1111/1467-8721.00031

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1997). Beyond bipolar conceptualizations and measures: The case of attitudes and evaluative space. *Personality and Social Psychology Review, 1*, 3–25. doi: 10.1207/s15327957pspr0101_2

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1999). The affect system has parallel and integrative processing components: Form follows function. *Journal of Personality and Social Psychology, 76*, 839–. doi: 10.1037/0022-3514.76.5.839

Carvalho, S., Leite, J., Galdo-Álvarez, S., & Gonçalves, O. F. (2012). The emotional movie database (EMDB): A self-report and psychophysiological study. *Applied Psychophysiology and Biofeedback, 37*, 279–294. doi: 10.1007/s10484-012-9201-6

Diao, F., & Sundar, S. S. (2004). Orienting response and memory for web advertisements: Exploring effects of pop-up window and animation. *Communication Research, 31*, 537–567. doi: 10.1177/0093650204267932

Fan, S., Shen, Z., Koenig, B. L., Ng, T. T., & Kankanhalli, M. S. (2020). When and why static images are more effective than videos. *IEEE Transactions on Affective Computing, 1*, 1–1. doi: 10.1109/TAFFC.2020.3040399

Farkas, E. (2016, September 12). *Campaigns with branded emojis can supercharge video ads and drive earned media. See how it works.* Retrieved from https://marketing.twitter.com/en/insights/best-practices-for-supercharging-campaigns-with-branded-emojis

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175–191. doi: 10.3758/BF03193146

Gibson, J. J. (1977). The theory of affordances. In: R. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing: Toward an ecological psychology* (pp. 67–82). Lawrence Erlbaum Associates.

Hamborg, K. C., Bruns, M., Ollermann, F., & Kaspar, K. (2012). The effect of banner animation on fixation behavior and recall performance in search tasks. *Computers in Human Behavior, 28*, 576–582. doi: 10.1016/j.chb.2011.11.003

Heo, N., & Sundar, S. S. (2000, August). *Emotional responses to Web advertising: The effects of animation, position, and product involvement on physiological arousal* [Conference presentation]. Annual convention of the Association for Education in Journalism and Mass Communication, Phoenix, AZ.

Hong, W., Thong, J. Y., & Tam, K. Y. (2004). Does animation attract online users' attention? The effects of flash on information search performance and perceptions. *Information Systems Research, 15*, 60–86. doi: 10.1287/isre.1040.0017

Jarvis, B. G. (2014). *MediaLab research software (version 2014)* [Software]. Empirisoft.

Kahneman, D., Fredrickson, B. L., Schreiber, C. A., & Redelmeier, D. A. (1993). When more pain is preferred to less: Adding a better end. *Psychological Science, 4*, 401–405. doi: 10.1111/j.1467-9280.1993.tb00589.x

Kuisma, J., Simola, J., Uusitalo, L., & Öörni, A. (2010). The effects of animation and format on the perception and memory of online advertising. *Journal of Interactive Marketing, 24*, 269–282. doi: 10.1016/j.intmar.2010.07.002

Lang, A. (1994). What can the heart tell us about thinking? In: A. Lang (Ed.), *Measuring physiological responses to media messages* (pp. 99–112). Lawrence Erlbaum Associates.

Lang, A., Borse, J., Wise, K., & David, P. (2002). Captured by the World Wide Web: Orienting to structural and content features of computer-presented information. *Communication Research, 29*, 215–245. doi: 10.1177/0093650202029003001

Lang, A., Dhillon, K., & Dong, Q. (1995). The effects of emotional arousal and valence on television viewers' cognitive capacity and memory. *Journal of Broadcasting & Electronic Media, 39*, 313–327. doi: 10.1080/08838159509364309

Lang, A., & Friestad, M. (1993). Emotion, hemispheric specialization, and visual and verbal memory for television messages. *Communication Research, 20*, 647–670. doi: 10.1177/009365093020005002

Leshner, G., Clayton, R. B., Bolls, P. D., & Bhandari, M. (2018). Deceived, disgusted, and defensive: Motivated processing of anti-tobacco advertisements. *Health Communication, 33*, 1223–1232. doi: 10.1080/10410236.2017.1350908

Liu, J., & Bailey, R. L. (2019). Effects of substance cues in negative public service announcements on cognitive processing. *Health Communication, 34*, 964–974.

Macmillan, N. A., & Creelman, C. D. (1991). *Detection theory: A user's guide*. Cambridge University Press.

Newhagen, J. E., & Reeves, B. (1992). The evening's bad news: Effects of compelling negative television news images on memory. *Journal of Communication, 42*, 25–41. doi: 10.1111/j.1460-2466.1992.tb00776.x

Potter, R. F., & Bolls, P. D. (2012). *Psychophysiological measurement and meaning: Cognitive and emotional processing of media*. Routledge/Taylor & Francis.

Pratt, J., Radulescu, P. V., Guo, R. M., & Abrams, R. A. (2010). It's alive! Animate motion captures visual attention. *Psychological Science, 21*, 1724–1730. doi: 10.1177/0956797610387440

Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places.* Center for the Study of Language and Information Publications & Cambridge University Press.

Schupp, H. T., Schmälzle, R., Flaisch, T., Weike, A. I., & Hamm, A. O. (2012). Affective picture processing as a function of preceding picture valence: An ERP analysis. *Biological Psychology, 91*, 81–87. doi: 10.1016/j.biopsycho.2012.04.006

Shapiro, M. A. (1994). Signal detection measures of recognition memory. In A. Lang (Ed.), *Measuring psychological responses to media messages* (pp. 1–14). Lawrence Erlbaum.

SPR Ad Hoc Committee on Electrodermal Measures. (2012). Publication recommendations for electrodermal measurements. *Psychophysiology, 49*, 1017–1034. doi: 10.1111/j.1469-8986.2012.01384.x

Yoo, C. Y., Kim, K., & Stout, P. A. (2004). Assessing the effects of animation in online banner advertising: Hierarchy of effects model. *Journal of Interactive Advertising, 4*, 49–60. doi:10.1080/15252019.2004.10722087

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