Personality as a Modulator for Physiological and Neurological Reactions to Emotional Images

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Author's Note:

Abstract

The current study compared self-reported emotional reactivity to film clips and compared reactivity between obsessive and hysterical personality patterns, and separately measured physiological and neurological responses to emotional images and compared responses between groups labeled Emotionally Expressive and Emotionally Restricted. Results validated the use of the selected film clips in eliciting a self-reported emotional response; however, there were no significant differences between hysterical and obsessive personalities. Results validated the use of emotional images as a tool of emotional elicitation, and significant changes in heart rate (HR) and galvanic skin response (GSR) were shown in response to negative images; however, the GSR response was opposite the predicted direction. Neither physiological data nor self-report valence ratings were significantly different between styles of emotional expressivity.

Abbreviations: GSR – Galvanic skin response; HR – heart rate; EEG – electroencephalogram; LKATS – Lazare-Klerman-Armor Trait Scales

Personality as a Modulator for Physiological and Neurological Reactions to Emotional Images

Emotions allow us to assess our environment subjectively, to appraise potentially dangerous situations, and influence subsequent actions based on feelings (Smith & Lazarus, 1990). According to Smith and Lazarus (1990), human emotion evolved from simpler, more structured automatic responses to stimuli. As humans began to move away from the rigidity of response and became more and more complex, we became less dependent on instinct and more dependent on thought and judgment. We learned how to perpetuate our species and survive not only because of instinct, but also because of our ability to assess and adapt to a multitude of situations (Ekman, 1984; Lazarus, 1968; Smith & Lazarus, 1990). Emotions, in part learned from experience, allow us to bridge the gap between environmental adversity and subsequent actions (Smith & Lazarus, 1990). Thus, modern humans do not always act reflexively; we are able to use emotions as a tool to guide us through our surroundings.

Each person's subjective emotion follows an appraisal of stimuli that is based on personal motivations and environmental constraints and allowances (Lazarus, 1968; Smith & Lazarus, 1990). The actions that follow are expressed in a particular physiological pattern and are relevant to the situation at hand. Considering the "fight or flight" response, an organism's choice to stay and fight or to flee depends on the preceding emotional response, which is based on environmental cues and motivational factors. Emotions, in conjunction with reflexes and basic physical needs (e.g., hunger), motivate a person to behave in ways that enable him or her to survive and to thrive (Smith & Lazarus, 1990). This biological root of emotion has been investigated by Ekman (1992) through his research of 6 basic emotions that exist cross-culturally (happiness, surprise, fear, sadness, anger, and disgust), and is supported with evidence of 6 basic types of facial expressions that every culture recognizes and experiences. Research supporting

cross-cultural emotions gives evidence for the biological nature of emotions. While this does not ignore the cultural or social aspects of emotional expression, it does give reason for exploring the physiological nature of emotion (Ekman, 1992; Ekman, Friesen, & Ellsworth, 1972).

Emotional Expression and Personality

The relationship between emotion and personality has been studied extensively from the point of view of various psychological paradigms (Bono & Vey, 2007; Friedman & Booth-Kewley, 1987; Shapiro, 1965; Temoshok, 1986). Emotions are often the foundation of personality tendencies and relate to a person's style of cognition, stability, and social interaction (Keltner, 1996). Obsessive and hysterical personality patterns described by David Shapiro (1965) are just one example of this type of formulation. Shapiro (1965) described these types of "neurotic" personality styles (along with paranoid and impulsive styles), outlining their general characteristics, including emotional tendencies. The obsessive is rigid with restricted emotionality and does not like to lose control of emotions, and the hysteric is free and inconsistent in emotional expression (Shapiro, 1965). Because Shapiro describes emotionality mainly in obsessive and hysterical patterns, these patterns were chosen for the current study.

Lazare, Klerman, and Armor (1966) developed a factor-derived questionnaire designed to assess these patterns, and the use of their survey has been validated in several studies (Boyce & Mason, 1996; Hirschfield, Klerman, Clayton, Keller, & Andreasen, 1984; Lazare et al., 1966). In 1987, researchers Whitson and Dievendorf tested the validity of clinical descriptions of hysterical and obsessive personality types. Expression of emotion is a trait that clearly differs between obsessive and hysterical patterns, hysterics having uninhibited emotions and obsessives restricting emotional expression (Lazare, et. al., 1966; Shapiro, 1965). Whitson and Dievendorf (1987) hypothesized a significant positive relationship between hysterical personality and the

level of emotionality attributed to characters in the TAT stimulus pictures, and a significant negative relationship between obsessive personality and emotionality level seen in the characters. Results of this study showed a significant positive relationship between hysterical personality and the degree of emotionality attributed to characters in the stories (Whitson & Dievendorf, 1987). Hysterical personality was positively correlated with discomfort, anxiety, irritability, and sadness of the story characters and negatively correlated with relaxation and confidence in handling the situation in the story. Obsessive personality was negatively associated with irritability of the characters, and positively correlated with relaxation. The scale has also been widely tested in relation to clinical disorders such as depression (Boyce & Mason, 1996; Hirschfield, et. al., 1984).

Eliciting Emotions

Because many types of stimuli that humans experience on a daily basis have the potential to elicit an emotional response, there are many potential methods for experimentally eliciting emotions as well (Hagemann et al., 1999). While many of these methods are useful, all come with inevitable flaws. Images are standardized so that each participant views the same stimuli, but they are not very immersive and may rely heavily on the participant's imagination in order to produce an emotional response (Hagemann et al., 1999). If the participant is instructed to imagine an emotional scenario behind a still image, the scenarios that people come up with will vary greatly. Some people may not even engage in the task and thus ignore the stimulus altogether. A participant who is not engaged in the stimuli may have a muted response or no response at all (Hagemann et al., 1999). There is also the issue of demand characteristics; someone who may not have a strong response could feign one so that the experimenter gets results, even though those results are invented (Rottenberg, Ray, & Gross, 2007).

Film clips have been widely used in emotional research over the past few decades and have been shown to be valid tools. Film clips are standardized like pictures, but they are dynamic and engaging so that the participant is immersed in the stimuli enough to respond to it (Hagemann et al., 1999). Considering ethics, there are potential psychological risks involved with viewing frightening, disgusting, or otherwise arousing films similar to those involved with real-life situations. These risks are no more than what a person experiences when he or she views a film privately; nevertheless, all subjects need to be informed of the nature of the experiment before beginning and given the option to withdraw. Because color is a potential confound, to avoid different emotional responses related to the color of the clips, all clips should be either color or black and white for consistent presentation (Hagemann et al., 1999). Film clips were used as a tool of emotional elicitation in Part 1 of the current study.

Despite the usefulness of film clips, images containing emotional content were used for the second part of the current study due to time and analysis constraints. Overall, although clips are effective in eliciting emotions, the onset of emotional content within clips varies, making it difficult to isolate and measure differences at the time of emotional reaction for each clip. With images, the emotional content is presented constantly for the duration of the stimulus, making it easy to define the time range of emotional reaction. For these reasons, images were used to elicit emotion in Part 2 of this study.

Measuring Emotion

Emotion can be operationally defined in many ways, but for the purpose of this study we focused on the intensity of physiological and self-reported response (Rottenberg, et. al., 2007). Response strength can be measured through self-report surveys and skin conductance (Lisetti & Nasoz, 2004). The link between emotional response and physical response is made possible by

the sympathetic nervous system (Brouwer, Van Wouwe, Muehl, Van Erp, & Toet, 2013); the stronger the mental response to emotions, the greater the nervous system will respond and increase sweat production on the skin, which in turn increases skin conductance levels (Brouwer et. al., 2013; Codispoti, et. al., 2008; Gross & Levenson, 1995). There is a positive relationship between emotional response and skin conductance, so theoretically the stronger the response the greater the skin conductance level. Valence (pleasantness) of the emotion is not a factor in the magnitude of the skin conductance level because positive and negative emotions both produce elevated Galvanic skin response (GSR) levels (Brouwer et al., 2013; Codispotti, Surcinelli, & Baldaro, 2008; Khalfa, Isabelle, Jean-Pierre, & Manon, 2002). General emotional expression is indicated with GSR amplitudes greater than baseline. The nuances of negative and positive emotions were not individually examined because the focus was on how response intensity differs for broad emotional valences, in addition to differences between neutral responses and emotional responses.

Although some research has been done on interpreting skin response to determine the specific emotion the participant was feeling, individual differences in physical response may present difficulties in determining exactly which emotions are felt during stimuli presentation (Lisetti & Nasoz, 2004; Nakasone, Prendinger, & Ishizuka, 2005). Because emotions are so subjective, we believe self-report surveys are necessary in addition to physical measures so that interpretation of the emotion felt is left up to the individual, not an outside observer who may misinterpret feelings. Although it is unclear if Galvanic skin response can accurately determine specific emotions felt, it can show the intensity of the response. Self-report fills in which emotions were felt and allows the subjective experience of emotion to remain subjective. This type of response was used in both parts of the current study.

In addition to skin conductance level, the current study (Part 2) used heart rate as a secondary physical response indicator. Research has shown that heart rate decelerates during negative emotions (Codispoti, et. al., 2008; Gross & Levenson, 1995). There has also been research showing a similar decrease during pleasant stimuli presentation (Codispoti, et. al., 2008). The decrease or increase of heart rate does not matter for this study; we will simply be looking for a difference in heart rate response between emotional and neutral images.

Electroencephalogram (EEG) measures brain wave activity over longer epochs and activity of certain waves can be averaged over the duration of the recording (Coles & Rugg, 1995). This ability to record over longer periods of time allows participants to process complex stimuli adequately. Average wave amplitude over time will indicate which brain waves were the most synchronous (therefore most prevalent and at the highest amplitude) during stimulus presentation. Each wave occurs within a specific frequency range that can be used to identify the waves. The specific brain wave type indicates the type of brain activity occurring. Alpha waves (8-13 Hz) are more synchronous in the occipital region of the brain when a person is awake but relaxed, with his or her eyes closed, and are indicative of a relaxed mental state (Sammler, Grigutsch, Fritz, & Koelsch, 2007; Teplan, 2002). Beta waves (13-30 Hz) are more synchronous during general consciousness and indicate a person is attentive, with his or her eyes open (Abdou et al., 2006; Teplan, 2002). Beta waves can be observed in the left temporal lobe during a state of wakefulness (Overman et al., 2003). Both alpha and beta waves are most prominent during wakefulness and have been studied well; therefore, these waves will be examined in the current study (Teplan, 2002). EEG equipment measured differences in brain activity while viewing emotional versus neutral stimuli. The emotional stimuli comprise of negative and positive images taken from the internet and the neutral stimuli comprise of images of everyday objects

that do not ordinarily elicit an emotional response. This study examined EEG responses while subjects viewed emotional images and compared them to responses to neutral images. Alpha and beta waves were be focused on because of their implications in arousal, which is linked to emotional response (Höller et al., 2012; Husain, Thompson, & Schellenberg, 2002). Alpha waves, associated with mental relaxation, are more synchronous (high amplitudes) during non-emotionally arousing stimulation, and beta waves, associated with mental arousal, are stronger during the presentation of emotional stimuli (Lefrancois, 2012).

Current Study

The current study assessed differences in emotional response to film clips and images between personality patterns discussed by Shapiro (1965). Separated into two parts, the first part examined responses to film clips via self-reported emotionality, and the second used images to elicit physiological responses. Both parts measure a personality variable in addition to recording self-report emotional response to the chosen form of stimulus.

Part 1 utilized emotional film clips to produce a self-report response which was compared to LKATS personality patterns. For each clip, participants rated the intensity of 6 emotions (happiness, surprise, fear, sadness, anger, and disgust) on a Likert scale from 1-8 (1 = none at all, 4 = somewhat, 8 = extremely, a great deal). Personality responses were used to group participants based on overall LKATS personality pattern (obsessive or hysteric) in an attempt to correlate this personality variable with self-report intensity of emotional response. The following predictions were tested

1. Emotional clips will produce stronger responses than neutral clips. This will validate their use as a tool for emotional elicitation in future research.

2. The target emotion for each film clip will be the strongest reported emotion out of the 6 total emotions (i.e., a clip targeting disgust will elicit the strongest response in the disgust category). This will show that each clip is targeting the appropriate emotion, and other confounding emotions are not a factor.
3. Participants who score low in the obsessive personality pattern and high in the hysterical pattern will report stronger emotional reactivity to the clips. In addition, those who score high on the obsessive pattern and low on the hysterical pattern will report lower emotional reactivity to the clips. These results will echo Shapiro's (1965) and Whitson and Dievendorf's (1987) research on the emotional expressivity of obsessive and hysterical personality patterns.
4. Lower self-reported response to all emotions would support the emotional restriction that is characteristic of obsessive personality types; response to emotions not targeted by the film clips would support the inconsistent emotional response that is characteristic of hysterical personality type.

Part 2 used emotional images to produce a physiological response measured by GSR, HR, and EEG. Self-reported emotional reaction to each image was also measured through a Likert scale from 1-9 (1 = very negative, 5 = neutral, 9 = very positive). The following predictions were tested:

1. Because of previous research showing increased skin conductance in response to emotional stimuli, GSR response magnitudes will be larger for emotional (positive and negative) images than for neutral images.
2. HR response will differ between neutral images and positive/negative images. Research has shown a deceleration in HR in response to negative stimuli; however, responses to

positive stimuli are more inconsistent. Because of this, the current study looked for bi-directional differences between neutral and emotional responses.

3. Alpha waves are associated with a relaxed mental state; therefore, alpha waves will be higher during neutral image presentation; beta waves are associated with mental arousal (which includes emotional arousal) and, therefore, beta waves will be higher during emotional image presentation.
4. Participants who score low on emotional expression will demonstrate a lower magnitude of response on the self-report ratings and the physiological measures. Conversely, participants who score high on emotional expression will show higher magnitudes of response. These finding will support a biological basis for differences in outward emotional expression.

Method Part 1

Participants

Sixty-one participants (14 male) aged 18-22 were recruited from psychology classes at Roanoke College in Salem, VA. Subjects had normal or corrected to normal vision. Experiments were conducted in accordance with the guidelines of the Roanoke College Institutional Review Board.

Stimuli

Film clip choices can be found in Appendix A. These clips were chosen based on previous research with similar films (Rottenberg, et. al., 2007). If a clip could not be obtained, then a different clip targeting the same emotion was chosen from commercially available films found on YouTube and shortened to 30 second MP4 Video files using Windows Movie Maker. Clips were shown on a projector through Windows Power Point. There were 6 clips for sad,

disgust, happiness, and neutral emotions. Three clips in each category were silent, and three retained their sound. The length of the clips was chosen based on the research of Brouwer et. al. (2013), which showed that skin conductance, our focus measure of physiological emotional response in Part 2, can be determined over a time block of 30s. Films were originally intended to carry over to Part 2; however, this medium was ultimately replaced with images.

Procedure

Groups of participants viewed 18 film clips from each target emotion as well as 6 neutral clips and gave a self-reported emotional intensity of Ekman's 6 cross cultural emotions between each clip (Ekman, 1992). Participants rated clips based on a Likert scale from 1 to 9, 1 meaning they did not feel that emotion at all, 5 meaning they felt the emotion moderately, and 9 meaning they felt the emotion very much. The surveys included a write-in option for rating any emotions not listed. Each of the 6 emotions was assigned a rating for each clip.

The order of the film clips was randomly chosen out of three possible orders that were previously arranged. In the interest of time, each participant viewed each film clip once. After clip presentation, participants completed the LKATS personality measurement. The LKATS is a 145 True/False questionnaire designed to measure Shapiro's personality styles (obsessive and hysterical). Questions cluster together into factors that comprise the broader personality patterns. One such factor is emotional restriction, which includes such questions as "I usually express myself with caution and restraint" (Lazare, et. al., 1966). This added personality variable was intended to give insight into differences in reactions to films with and without sound between personality patterns, and also offer preliminary data for the effect of emotional films on different personalities. The presentation of the films lasted 20-40 minutes, with the personality survey lasting 15-20 minutes.

Results Part 1

First, the film clips were assessed separately to determine their effectiveness in eliciting their target emotion. The target emotion is the emotion intended to be evoked by a certain clip, for instance, the clip from the movie Rats was intended to elicit disgust. Non-target emotions are all other non-intended emotions. Emotional ratings of neutral clips as a whole were compared to the emotional clip ratings. Then, clips were compared in relation to personality pattern using ANOVA.

In order to focus on the emotional aspects of the LKATS personalities, the emotional subscales were isolated and addressed separately. These results were analyzed using a 3-way ANOVA with personality as a between-subjects factor. Factors included emotional content of the clips, target and non-target emotions, and emotionality score. T-tests were used to compare response from groups created by LKATS scoring. The sound/silent variable was not pursued because of methodology limitations that prevented proper counterbalancing of clips and isolations of each independent variable.

Film Clips

A significant main effect of emotion was seen for target emotions, with sad clips eliciting a stronger response than disgust or happy, $F(2,6) = 18.489$, $p < .001$. A main effect for non-target emotions was also significant; disgust clips elicited stronger non-targeted emotional response than happy or sad film clips, $F(2,60) = 7.915$, $p = .001$. The target emotion was the strongest emotion reported for each clip (Table 1).

Table 1: Average ratings across all three types of emotional film clips. T-tests (df = 60) indicate a significant difference between the ratings of the targeted emotion and the ratings of all other surveyed emotions, averaged across all 6 clips for each of the 3 emotions.

All Sad Clips		All Happy Clips		All Disgust Clips	
Sad	4.93	Happy	4.3	Disgust	4.669
Other	0.41	Other	0.3	Other	1.321

P-value	0.00	P-value	0.00	P-value	0.00

Effects of Personality

Median splits were conducted on the sub-scale data and scores were combined to form two groups labeled high and low emotionality. Participants who scored high on obsessive and low on hysterical (low emotionality) were compared to participants who scored high on hysterical and low on obsessive (high emotionality). These groupings reflect the emotional expression or restriction of Shapiro's original personality patterns (Shapiro, 1965). Twenty eight participants who scored average on both types were excluded because these participants do not represent distinct personality patterns. No significant main effects of personality were found (Figures 1 and 2), and there was not a significant interaction between personality and Target/Non-target emotions, contrary to our hypothesis, $F(10,20) = 1.502$, $p = .210$. Personality data were split into upper and lower thirds of emotionality in order to compare the most extreme responses (very high compared to very low). With these data, a significant interaction between personality and emotion was trending toward significance ($F(1,44) = 3.064$, $p = .087$); however, the difference was opposite the intended direction (obsessives displayed higher emotionality).

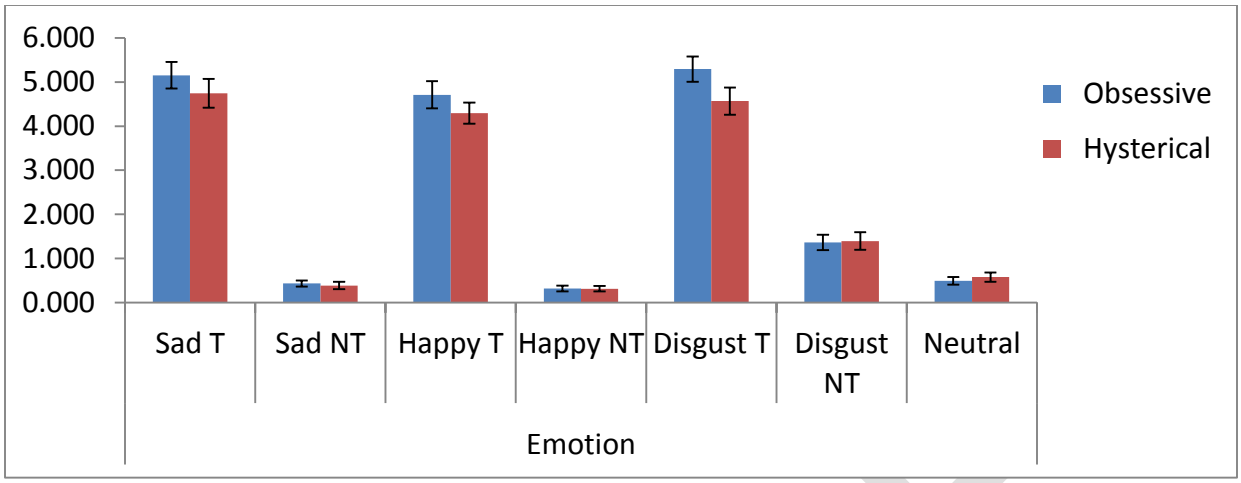


Figure 1: Target Emotion vs. Non-Target Emotion. For each emotion, target emotions were rated significantly stronger in emotion than non-target emotions ($F(2,60) = 117.562$, $p < .001$). No significant differences in response between personality patterns were seen.

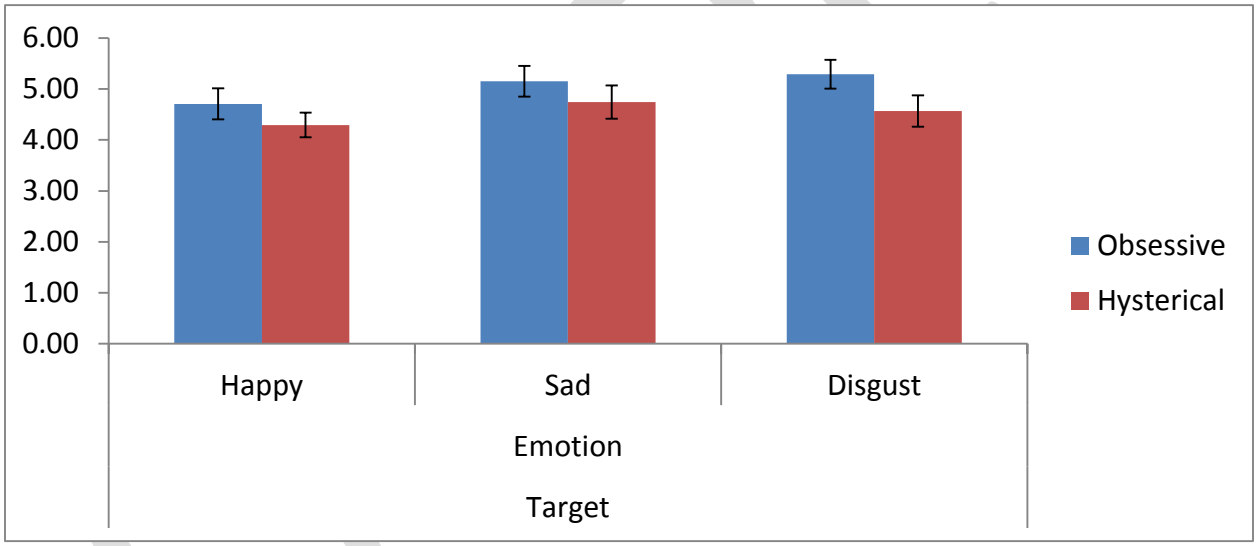


Figure 2: Emotional Ratings per Personality. Emotional ratings were averaged across the variables of emotion and sound content for target emotion. No significant differences between personality patterns were seen.

Emotional clips produced significantly stronger responses than neutral clips, supporting this hypothesis. The target emotion for each film clip was the strongest reported emotion out of the 6 total emotions, which confirmed that each clip targeted the appropriate emotion. Although non-target emotions in the disgust category were significantly higher than in other categories, the non-target emotions in each category were significantly lower than the target emotions.

With regard to the personality hypotheses, neither of them was supported. There were no significant differences between emotional reactivity to the clips and the personality trait of emotionality, $t(35) = .844$, $p = .404$. Finally, high emotional expression (related to hysterical personality) did not display significantly higher responses to non-target emotions, $F(1,11) = .217$, $p = .651$.

Discussion Part 1

Personality data were not significant when using the full LKATS survey. Possible reasons for this lack of significance will be outlined in the General Discussion section. The number of people who scored either high on emotional expression and low on emotional restriction, or low on emotional expression and high on emotional restriction was no more than one would expect due to random chance. This suggests that the personality survey used did not systematically differentiate between patterns of emotional expression. Because the LKATS did not seem to categorize participants into distinct groups, it is questionable whether the scale is a valid tool for assessing these personality types in this population. The sample population comprised of all college students, which may reflect a selection bias; the obsessive personality type is more reflected in this population because traits that correspond to this pattern are preferred over hysterical traits (i.e., attention to detail, orderliness, and ability to focus) (Shapiro, 1965).

Alternatively, the personality variable may have too small an effect size to be visible in a college-age population at a small liberal arts college of mostly females. It can be difficult to make a clear distinction between these styles of emotionality because environmental factors affect how people react, and people may display characteristics of both expression and restriction depending on the situation (Funder, 1997). While the personality variable was not a factor in this

study, the results do validate the use of short film clips in producing differential emotional response. All of our hypotheses involving the emotional nature of the clips were supported, which validates the chosen clips as an emotional stimulus tool.

Because of the lack of significant results drawn from the full LKATS survey, in Part 2 of this study the researchers isolated the emotional reactivity variables in an attempt to be more specific in the target personality variable, rather than assessing a much broader personality pattern as a whole. To create a much shorter and efficient survey examining emotionality style, 14 LKATS emotionality questions were combined with 6 questions unrelated to emotionality.

Method Part 2

Participants

Thirty-one participants aged 18-22 (4 male) were recruited from students in the Psychology Department at Roanoke College in Salem, VA. All subjects had normal or corrected to normal vision. The experiments were conducted in accordance with the guidelines of the Roanoke College Institutional Review Board.

Images

Image choices can be found in Appendix B. These images were chosen based on previous research that validated their efficacy in producing an emotional response (ERP) in a short period of time (Fall 2013 Neuro Seminar). There were 3 categories of clips (positive, neutral, and negative), each with 20 black-and-white images. Images were rated in terms of valence on a Likert scale from 1-9, 1 being very negative, 5 being neutral, and being very positive.

Equipment

Heart rate was measured via AD Instruments Finger Pulse Transducer and recorded through LabChart software. The transducer pad was attached with Velcro® to the participant's

middle finger on the non-dominant hand. The non-dominant hand was used to allow the use of the dominant hand for the number keypad, which would decrease anxiety about using unfamiliar equipment with the non-dominant hand (additional anxiety would confound the emotion reaction to images). Particular settings in the LabChart recording software were applied to the physiological data. For HR, a valid range of 40-140 BPM was chosen.

GSR was also recorded using AD Instruments' skin conductance amplifier and finger electrodes applied to the participant's index and ring fingers on the non-dominant hand. LabChart chose an appropriate recording range of ±20 μSiemens. Conductance level was zeroed for each participant before data collection began. Participants were encouraged to relax so their skin conductance levels would not be elevated when zeroed and would therefore not confound subsequent conductance changes.

Electroencephalography (EEG) signals were recorded using a PowerLab 26T (AD Instruments). Five lead-shielded electrodes transmitted voltage signals from the scalp of the participant to a bio amp specially designed to record signals in the biologically relevant range (±50 μV for EEG) and to minimize artifacts from other electrical devices in the room. Stimulus onset is indicated by a signal sent from an external Cedrus StimTracker device to the same computer, which is also recorded by the LabChart 7 software. Channel 1 electrodes were placed at Fp2 and Oz; Channel 2 electrodes were placed at Cz and A1 (ear for reference). Channel 1 intended to record alpha waves in the occipital region because previous research shows alpha wave synchronization in the occipital region while a person is awake and relaxed. Theoretically, greater alpha waves in this region indicate less response to visual stimulation than lower alpha waves (less relaxation, more attention). Channel 2, in the upper parietal region, intended to

measure beta waves in response to emotional response to stimuli (higher beta waves suggest higher emotional arousal).

Procedure

Despite previous research validating the emotional differences in LKATS personality patterns, the first part of data collection did not produce significant results regarding the LKATS personality survey. Because of this, the survey questions from the LKATS that pertain to emotional reactivity were isolated and intermixed with unrelated questions on a 20-item survey to be used in Part 2. Seven questions pertain to outward emotional expression and 7 pertained to emotional restriction. These traits correspond to hysterical and obsessive personality patterns respectively, but because we isolated just emotionality, we cannot label the emotional styles as part of the LKATS patterns. By isolating emotionality and correlating response with physiological emotionality, we hoped to find a stronger relationship than was found when using the broad obsessive and hysterical patterns.

Participants first completed the shortened personality survey assessing degree of emotional expression (20 True/False questions), which took between 2 and 5 minutes. EEG, GSR, and HR equipment were applied while the researcher debriefed the participant about the procedures. Once all equipment was attached, the researcher visually checked the recording output in LabChart software to ensure the readings were in the appropriate biological ranges (i.e., the EGG reading should not exceed ± 50 μV). After each image was presented, participants used a number keypad to rate the valence of the image (1 = very negative, 5 = neutral, 9 = very positive). Images were on screen for 1 second, followed by a blank screen for 3 seconds, followed by the survey rating prompt. Once the participant pressed a button in response to the survey, the program moved on to the next image. There were 20 images for each type of valence

for a total of 60 images, each presented once per participant. All images were randomized using Cedrus SuperLab 4.5. The study lasted between 35 and 45 minutes.

Results Part 2

To assess differences in response to each type of emotional stimuli, a repeated-measures ANOVA was conducted for EEG, GSR, and HR separately. Examined variables included alpha and beta EEG waves on Channels1 and 2, and 2 separate time ranges chosen from the overall time course for both GSR and HR. Based on the average time course recordings for all participants for the HR and GSR measures, time ranges 2.5-3.5 seconds and 4-5 seconds were chosen for analysis.

Pairwise t-tests confirmed differences between emotions for each dependent variable if the ANOVA was significant. Pearson correlation coefficients (r) were calculated to assess the relationship between physiological emotional responses and self-reported emotional expression.

Heart Rate

Repeated-measures ANOVA confirmed a significant difference between emotional valences at the first time range of analysis (2.5-3.5 seconds: $F(2, 60) = 5.563$, $p = .006$), shown in Figure 3. Pairwise *t*-tests showed that the negative condition was significantly different from the positive and neutral conditions (Neg.vs Pos: $t(30) = -2.559$, $p = .016$; Neg vs Neu: $t(30) = -2.766$, $p = .010$; Pos vs Neu: $t(30) = .109$, $p = .914$). The 4-5 second time range showed no significant differences ($F(2, 60) = .327$, $p = .723$) (Figure 4).

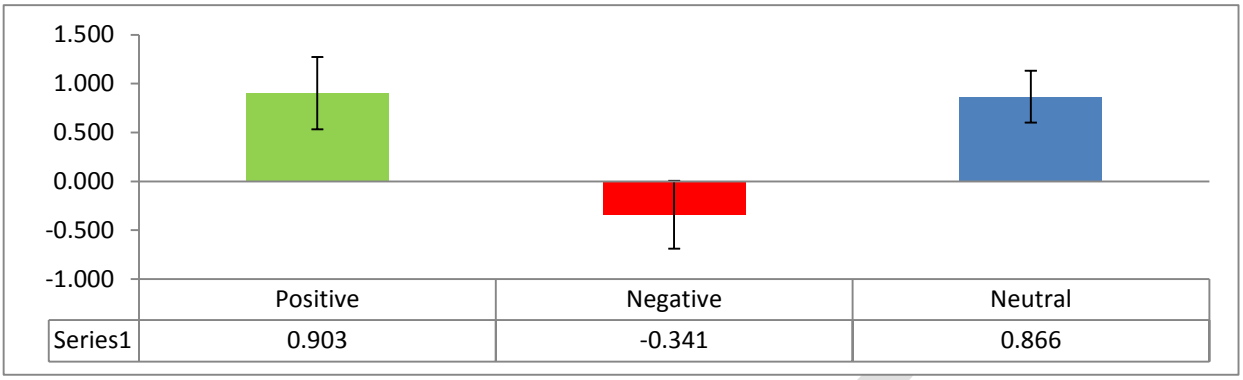


Figure 3: HR Amplitudes 2.5-3.5s Post-Presentation. Negative HR amplitudes were significantly different from the Positive and Neutral conditions. Neutral and Positive were not significantly different.

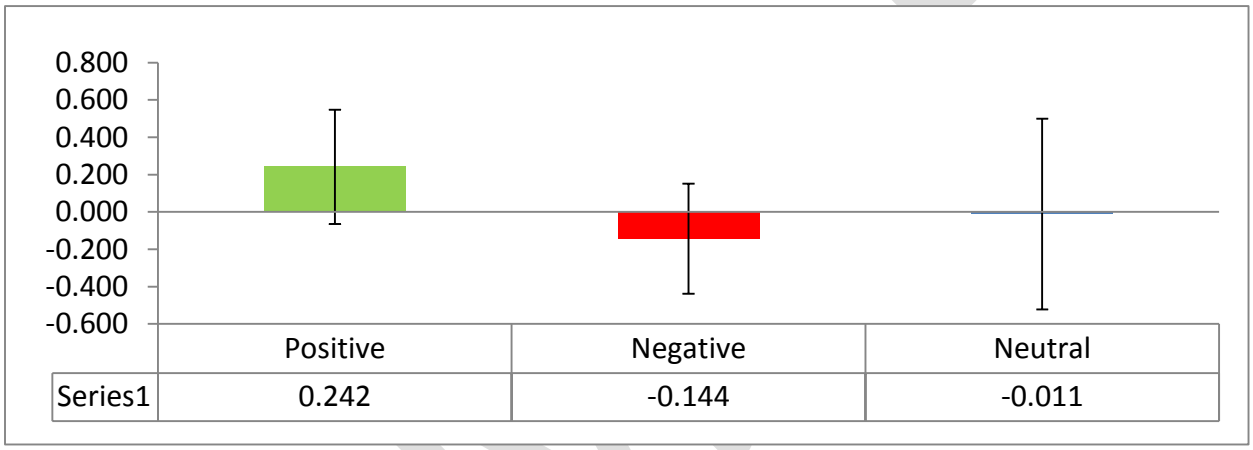


Figure 4: HR Amplitudes 4-5s Post-Presentation. HR amplitudes did not significantly differ between emotional conditions in the second time range, reflecting reaction to rating images using the keypad, $F(2,60) = .327$, $p = .111$.

Galvanic Skin Response

Significant differences were found for GSR amplitudes at the 2.5-3.5s post-presentation range. Amplitudes during the 2.5-3.5 range were significantly different per emotion. When means were compared at this time range, a significant difference was found between the positive/neutral condition and the negative condition (2.5-3.5 range: $F(2, 60) = 3.545$, $p = .035$). ANOVA results for the 4-5 range were not significant, $F(2,60) = 2.285$, $p = .111$.

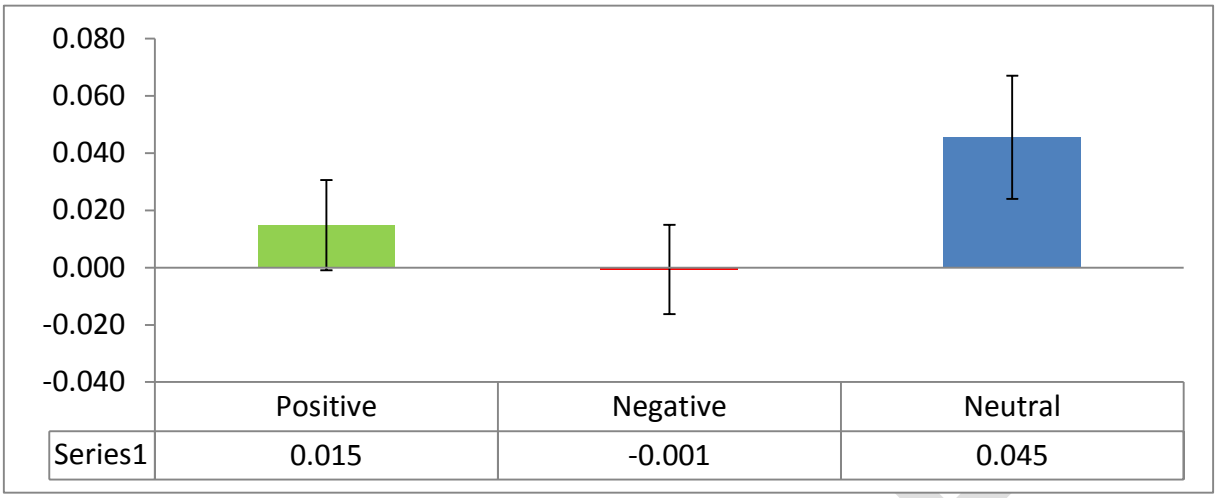


Figure 5: GSR Amplitudes 2.5-3.5s After Image Presentation. Negative amplitudes were significantly different from neutral amplitudes, $t(30) = -2.337$, $p = .026$. Positive and neutral amplitudes did not significantly differ, $t(30) = -1.723$, $p = .095$.

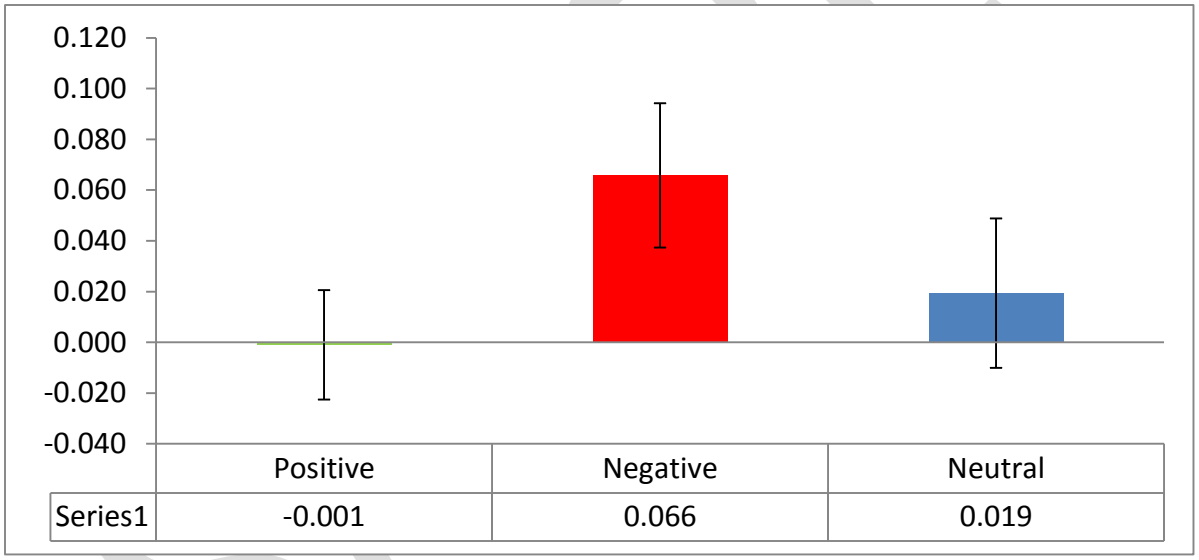


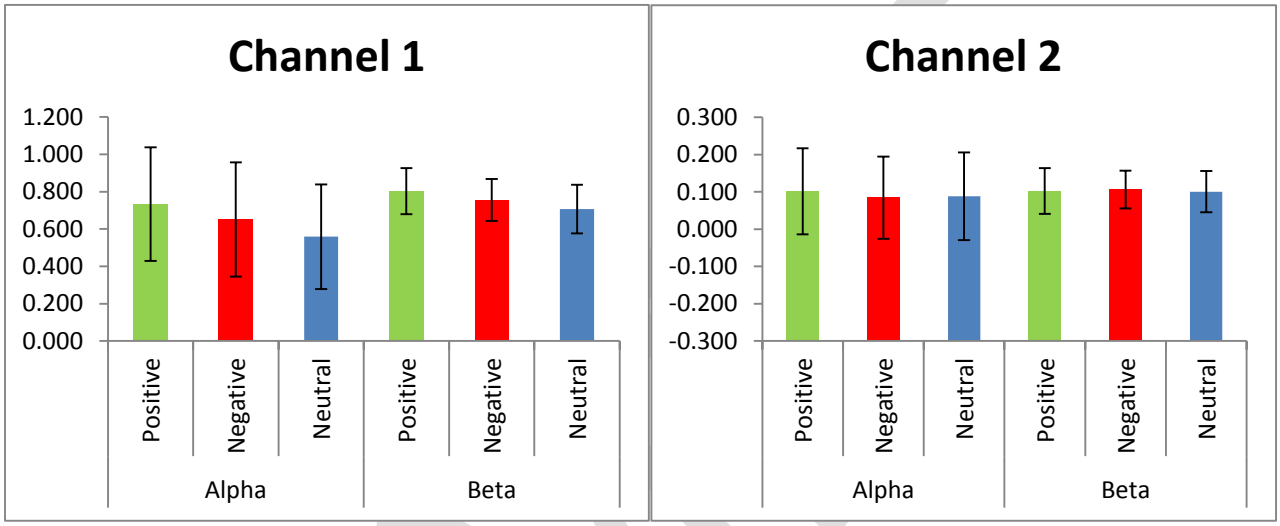
Figure 7: GSR Amplitudes 4-5s After Image Presentation. Positive and Negative amplitudes were significantly different, $t(30) = -2.252$, $p = .032$; however, no other comparisons were significantly different. Despite this pairwise difference, ANOVA results were not significant.

EEG

Average physiological amplitudes were calculated using MatLab software. EEG amplitudes were calculated at the alpha (8-13 Hz) and beta (13-30 Hz) ranges as different from a 1/F curve. To calculate the amplitudes, a basic 1/F curve was subtracted from the data curve (the

maximum difference from the 1/F curve within a given Hz range that corresponds to either aloha or beta waves). For Channels 1 and 2, no significant differences were shown for alpha or beta outputs (Figures 7 and 8).

Channel 1 Alpha: $F(2, 60) = 1.187$, $p = .312$; Channel 1 Beta: $F(2,60) = 1.770$, $p = .179$; Channel 2 Alpha: $F(2,60) = .069$, $p = .933$; Channel 2 Beta: $F(2,60) = .036$, $p = .964$.



Figures 7 & 8: EEG amplitudes for alpha and beta waves on Channels 1 and 2. Errors bars indicate a lack of significant differences between wave types in response to different valences.

Personality

Correlations between emotional expression survey responses were not significant (Table 2).

Table 2: No relationships found between physiological data and emotionality score.

Variable Correlated with Emotional score	Pearson *r*	*p* value
HR, positive, 2.5-3.5 seconds	.066	.722
HR, negative, 2.5-3.5 seconds	-.161	.387

GSR, positive, 2.5-3.5 seconds	-.229	.214
GSR, negative, 2.5-3.5 seconds	-.158	.395
GSR, neutral, 2.5-3.5 seconds	.078	.675
EEG, alpha waves on channel 1, positive	-.084	.652
EEG, alpha waves on channel 1, negative	-.142	.446
EEG, beta waves on channel 2, positive	.263	.153
EEG, beta waves on channel 2, negative	.195	.294

In addition, the range of self-reported valence was calculated for each image per participant. A wide range of ratings would represent high emotional expression (a wide range of feelings) and a narrow range would represent low emotional expression (restricted range of emotion). The range of self-report survey responses to the images was not significantly correlated with scores on the emotionality survey, r (29) = .038, p = .840.

Discussion Part 2

HR

Part of our hypothesis regarding HR changes was supported; HR did significantly decelerate in response to negative stimuli; however, there were not significant differences between positive and neutral conditions. HR deceleration has been found in several studies (Codispoti, et. al., 2008; Gross & Levenson, 1995); however, the current study was not able to produce a significant deceleration in response to positive stimuli as well (Codispoti, et. al., 2008).The lack of difference between positive and neutral conditions for the HR variable suggests that the positive stimuli elicited not an emotional response, but rather a response to any on-screen stimulus, independent of emotional content. The neutral condition acted as a control

and a measure of responses to stimuli rather than emotion, and the results of this study suggest that positive stimuli do not produce a strong physiological reaction.

GSR

There was a significant change in GSR 2.5-3.5 seconds post-presentation of stimuli; however, it was opposite of what was predicted. If the GSR change was higher in response to negative stimuli rather than lower, the hypothesis would have been supported and would have corresponded with previous research. Burbridge, Larsen, and Barch (2005) found that participants experienced higher HR and more frequent GSR changes in response to negative stimuli, but not in response to positive or neutral stimuli. It is possible that the differences observed were due to random chance.

EEG

Despite research showing that alpha waves are higher during neutral stimuli than emotional stimuli, and the opposite for beta waves (Lefrancois, 2012), the current study did not find significant EEG results on either channel. There may be several explanations for this; one is that the data had too many artifacts to record valid EEG signals. Several participants were nervous or unsure about the nature of the EEG equipment, and this may have contributed to unnecessary movements, eye blinks, or body shifts that affected the data recording. Other possible confounds include anxiety felt when using the keypad to rate images and increased anxiety caused by unfamiliar equipment.

Personality

When personality variables were correlated with physiological responses, no significant results were found despite the isolation of emotionality items from the original LKATS. There was variability across participants in the total survey scores, so the lack of differences may not

be attributed to faults in the survey but instead to invalid physiological data, or simply a lack of physiological differences between these personality traits. Other possible explanations will be discussed in the following section.

General Discussion

Emotional stimuli (films and images) were validated as a research tool; however, the personality surveys chosen were not validated. The images taken from a previous study, although validated through ERP analysis (Fall 2013 Neuro seminar), produced no significant EEG responses. Both EEG and ERP techniques measure electrical current on the scalp that passes through the meninges of the brain and the skull (Frith & Friston, 2013). The ERP is best for rapid stimuli, while EEG records over longer durations, and both methods are very temporally accurate and are, therefore, excellent for measuring quick responses to stimuli (Coles & Rugg, 1995). It is possible that the images chosen did not elicit an emotional response strong enough to be sustained and recorded over longer period of time with EEG recordings. It is also possible that because the images do not represent real stimuli and are just representations of the real world, responses to them were too transient to register through EEG.

In addition, although HR decelerated in response to negative stimuli (2.5-3.5s), no other variables or time courses were significant in the predicted direction. Typically, increased emotional arousal is reflected in increased activity in the sympathetic nervous system, which would increase HR (Graham & Clifton, 1966). The acceleration in HR may reflect a "rejection" of unpleasant environmental stimuli, as HR acceleration is related to decreased memory performance (Graham & Clifton, 1966). A deceleration is associated with increased attention and memory; therefore, HR deceleration may reflect orienting towards a stimulus rather than an emotional reaction to it. It is possible that the current study's negative images were arousing

enough for participants to pay close attention to them, and the neutral and positive images were not arousing enough to elicit increased attention and therefore a deceleration in HR.

Zhang, Kalinowski, Saltuklaroglu, and Hudock (2010) studied HR response to negative stimuli (stuttered speech) and found a sustained HR deceleration over 1 minute. It is possible that the images chosen for the current study were not negative enough to produce a prolonged response similar to Zhang et al. (2010), or perhaps images are more subject to emotional habituation because they are constant over the duration of physiological measurement. HR response to images may have a shorter duration than responses to other types of stimuli. Another explanation is that the randomization of the images reduced the strength of response to each one. For example, if a positive stimulus was presented first followed by a neutral one, there may be residual response to the positive stimulus that carries over to the neutral image and thus confounds the neutral response, leading to a lack of differences between the two conditions. Future research could increase the duration of image presentation and compare longer-term responses to images and other types of emotional stimuli.

The lack of significance for the personality variables in both parts of the current study suggests that the LKATS survey does not reliably differentiate between personality patterns or types of emotional expression in the examined population. Results close to significance in Part 1 suggest a small effect size that is only observable in large samples. For reasons stated in the Discussion section for Part 1, the LKATS survey may not be appropriate to use in college samples. Limitations on this study include small sample size and a homogenous sample. All participants were selected from psychology classes at Roanoke College, which is a predominantly Caucasian female subject pool. It is possible that a more diverse sample is needed to observe effects of personality on emotional expression.

Research on emotional reactivity to stimuli is useful in the field of clinical psychology in that many psychological disorders involve distinct emotional characteristics. These characteristics can be examined using physiological measurements and used as diagnostic aids, reports of treatment progression, and methods of gaining insight into the physiological and biological nature of psychological disorders. Physiological data is a tool that is becoming more popular because of its objectivity and ability to measure processes that are not directly observable in a client, and they are more reliable than self-report methods over time (Nishith, et. al., 2002; Richard & Huprich, 2011). HR has been useful in assessing fear activation and habituation in treatments for rape victims with PTSD (Nishith, Griffin, & Weaver, 2002), and GSR has been studied in newborn babies to determine when their "emotional sweating" response develops (Gladman & Chiswick, 1990). Physiological differences in relation to personality traits have been observed in other research; for example, Weinberger, Schwartz, and Davidson (1979) found that those who actively repressed anxiety but self-reported low levels of anxiety had significantly higher skin conductance levels than those with openly low or high anxiety levels. Although dissimilar to previous research in the area, the current study adds to this clinical literature in its investigation of clinically relevant personality patterns and emotional expression.

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Appendix A: Film Clip descriptions

Neutral

	Length	Description	Movie	Sound/ Silent
1	30.81s	Mass production of potato chips. Chips move past screen on a conveyor belt.	Discovery Channel How It's Made Pringles Episode	Silent
2	30.00	A rainbow ribbon of light shifts and moves	Amazing Screen Saver for Windows 7 [Full HD – 1080p] Youtube	Silent
3	29.48s	An abstract moving object of light and color dances on screen	Flurry Screen Saver from Mac Computer	Silent
4	29.65s	Traveling along a mountain road. Mountains, trees, and clouds populate the background.	♥♥ Yellowstone's Tower General Store to Canyon Village (3 of 5) YouTube	Sound
5	30.15s	Ducks and geese swimming and eating bread thrown onto the shore.	Very Cute Carolina Ducks Swimming in a Pond, Water, Eating YouTube	Sound
6	29.0	Traveling along a mountain road. Mountains, trees, and clouds populate the background.	♥♥ Yellowstone's Tower General Store to Canyon Village (3 of 5) YouTube	Sound

Sad Clips

	Length	Description	Movie	Sound/ Silent
1	29.88s	A man on a screen wished he could be at her wedding. They both cry as he says goodbye.	Armageddon	Sound
2	30.0s	A little boy cries as he asks his dead father to wake up.	Champ	Sound
3	30.18s	A sick man stumbles and falls in the rain while calling to his son who is getting into a car with his family. They hear the man calling and run over to be with him as he dies.	Click	Sound
4	30.0s	A son confronts his father in prison. He writes on a piece of paper that he forgives what he has done and they both cry.	Venia (Forgiveness)	Silent
5	31.50s	A man cries at his brother's grave because he wasn't able to save him in a battle. A woman tries to comfort him.	Legends of the Fall	Silent
6	30.53s	A man runs through a crowd and into a bathroom to find his brother shot dead on the floor. He cradles his body as he sobs.	American History X	Silent

Disgust Clips

	Length	Description	Movie	Sound/ Silent
1	30.13s	A woman breaks the ankles of a man tied to a bed. She used a sledge hammer and beats his feet against a block of wood.	Misery	Silent
2	30.15s	An eye surgeon performs Lasik eye surgery which includes cutting off a flap of the cornea. The scene shows the doctor touching the patient's eye with various instruments.	Discovery How It's Made Lasik Eye Surgery	Silent
3	30.64s	A witch doctor chants some incantations then reaches into a captive man's chest to pull out his still beating heart/	Indiana Jones and the Temple of Doom	Silent
4	30.0s	Thousands of rats take over a room. A woman falls into a pit full of them and they crawl over her and fall on top of her.	The Rats	Sound
5	30.08s	A man wakes up in a bed with blood on his hands and legs. He throws back the covers to find a bloody severed horse head and he screams.	The Godfather	Sound
6	30.0s	A man cuts off a woman's dangling bloody eyeball and pus oozes out of her bleeding face.	Hostel	Sound

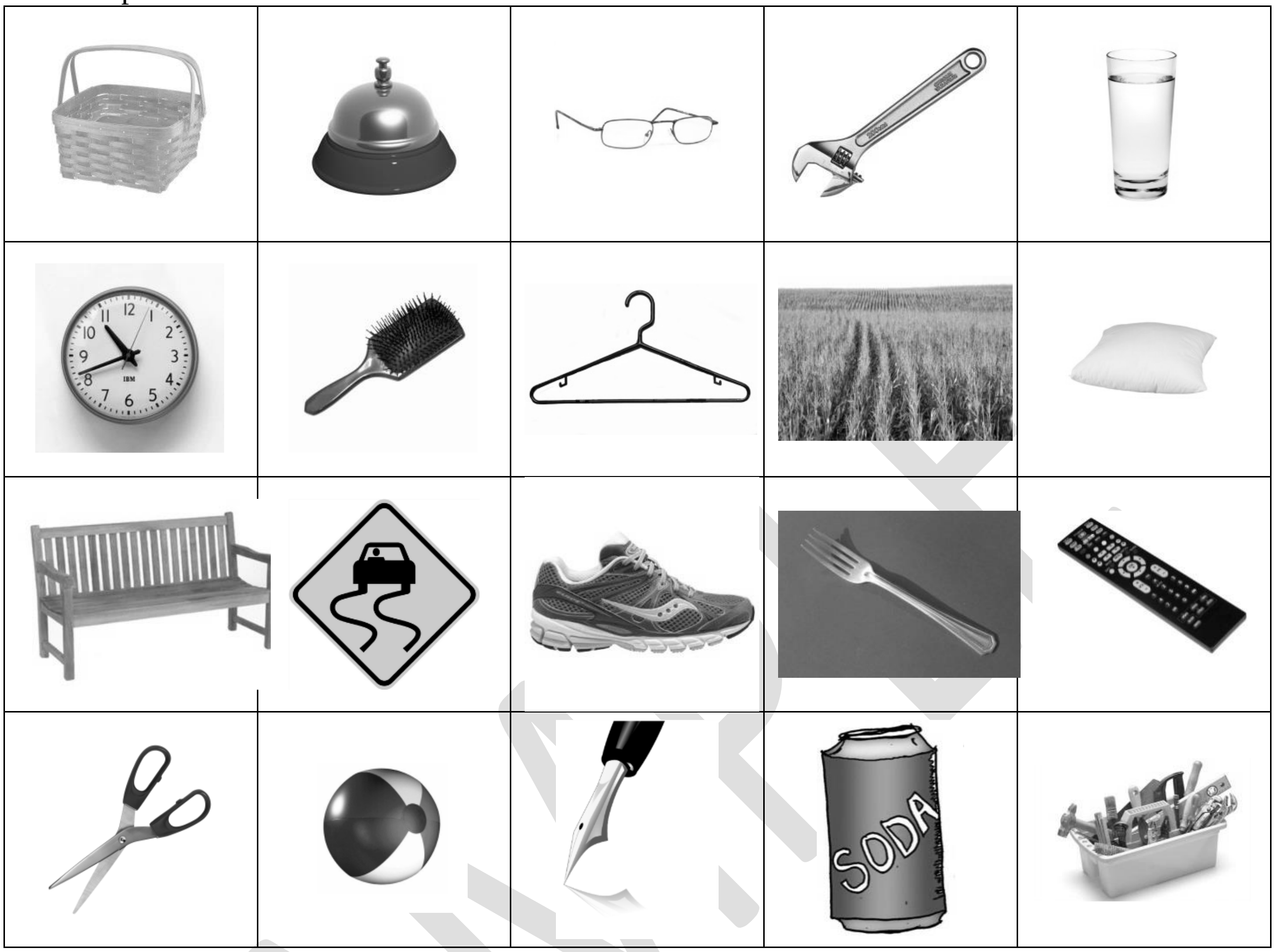
Happy Clips

	Length	Description	Movie	Sound/ Silent
1	29.59s	A man in a military uniform kisses a factory worker while the other workers look on. He picks her up and carries her out of the factory while the others cheer. The man and woman smile and laugh.	An Officer and a Gentleman	Silent
2	30.33s	People gather on an airport tarmac. A man looks around the area and sees his little son running towards him. They hug and are joined by a woman, presumably the boy's mother.	Armageddon	Silent
3	30.36s	A man dressed as an old woman cooks dinner, but catches the female body suit on fire.	Mrs. Doubtfire	Silent
4	30.0s	A woman and a man are talking at a New Year's Eve party. The woman is moved to tears and the two embrace and kiss.	When Harry Met Sally	Sound
5	24.0s	A young man raises his hand to ask a man in a wheel chair about dodging balls. The old man throws a wrench at the boy which hits him in the face.	Dodgeball	Sound
6	30.07s	A priest prepares to give a wedding speech, but he has a terrible speech impediment.	The Princess Bride	Sound

Appendix B: Images borrowed from Fall 2013 Neuro Seminar at Roanoke College

Positive picture stimuli

Neutral picture stimuli



Negative picture stimuli

Appendix C: Emotionality subscale questions taken from the larger LKATS survey (Lazare,Klerman, & Armor, 1966). LKATS questions are mixed with other non-LKATS questions.

Please read each of the following statements carefully. If you agree with the statement, or if it is generally true for you, write "T" on the line before it. If you do not agree with it, or if it is generally not true for you, then write "F" on the line. Please make a response for each statement.

1. _____ I enjoy the outdoors.
2. _____ I am calm and placid most of the time.
3. _____ I am rather sensitive, impressionable, and easily stirred.
4. _____ I have intense likes and dislikes.
5. _____ I often find myself daydreaming.
6. _____ My feelings and emotions are easily aroused.
7. _____ It takes a good deal to make me angry.
8. _____ I give full vent to my sentiments when I am stirred.
9. _____ I have one or two hobbies that I am very passionate about.
10. _____ I take pride in my ability to control my emotions.
11. _____ I display "temper" when the occasion warrants it.
12. _____ I am considered somewhat excitable by my friends.
13. _____ I can easily focus on a task for long periods of time.
14. _____ I usually express myself with caution and restraint.
15. _____ I find it difficult to control my emotions.
16. _____ Interacting with people has never been a problem for me.
17. _____ I am moderate in my tastes and sentiments.
18. _____ I have a habit of waking up early, even if I don't need to.
19. _____ My emotional life is marked by moderation and balance.
20. _____ I do things in a leisurely sort of way without worry or irritation