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BRIEF REPORTS

Differential Subjective and Psychophysiological Responses to Socially and Nonsocially Generated Emotional Stimuli

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Sociality may determine the subjective experience and physiological response to emotional stimuli. Film segments induced socially and nonsocially generated emotions. Comedy (social positive), bereavement (social negative), pizza scenes (nonsocial positive), and wounded bodies (nonsocial negative) elicited four distinct emotional patterns. Per subjective report, joy, sadness, appetite, and disgust were elicited by the targeted stimulus condition. The social/nonsocial dimension influenced which emotional valence(s) elicited a skin conductance response, a finding that could not be explained by differences in subjective arousal. Heart rate deceleration was more responsive to nonsocially generated emotions. Taken together, these findings suggest that sociality affects the physiological profile of responses to emotional valence.

Keywords: emotion, behavioral, film, skin conductance, heart rate

Emotion evocation leads to nervous system activation and a number of researchers have shown that discrete physiological profiles might be associated with specific emotions. In general, emotion can be characterized along dimensions of valence (unpleasant to pleasant) and arousal (calm to excited), or alternatively as discrete states (happy, sad, fear, disgust). Although some studies have associated unique physiological patterns with different classifications, others have not (Boiten, 1996). The valence dimension has been associated with heart rate (HR) while arousal has been associated with skin conductance response (SCR; Bradley, Cuthbert, & Lang, 1996). Specific emotions, such as happy, sad, fear, and disgust, have been distinguished by their physiological patterns (Ekman, Levenson, & Friesen, 1983; Ekman & Davidson, 1994; Levenson, Ekman, & Friesen, 1990). Associating specific patterns of physiological responses with particular emotions may render a degree of validity to these classification schemes, suggesting that biologically meaningful correlates to these dimensions might exist. However, the psychophysiological patterns reported are not sufficiently distinct, the associations are not exclusive, and the classifications themselves are not comprehensive enough to account for the richness and complexity of the phenomena of emotions. Additional, or different, biologically meaningful dimensions might exist along which the emotional responses of the organism are organized. One possible dimension is whether the emotions are directed toward addressing individual's biological/visceral need versus more remote social goals.

It has been recognized that emotions exist along a social/nonsocial emotional dimension (Fridland, 1994; Hess, 1995), and that sociality may change how emotional valence is expressed physiologically. However, how social stimuli modulate the physiological response associated with specific emotions has not been explored directly. Can physiological measures distinguish emotions within the same valence based on a social dimension? To address this question adequately, both social and valence factors need to be captured in a single design.

Emotions often promote individual survival by directing immediate physiological responses and prompting appropriate behaviors (Darwin, 1998). Approach behavior, such as consummatory and sexual activity, is prompted by the possibility of attaining goals and relieving innate desires, resulting in satisfaction and heightened reinforcement value. Harm-avoidance/self-preservation behavior, including fighting or fleeing, is evoked to protect, prevent bodily harm, and promote survival (Frijda, 1988). Appetite/food desire and disgust have been selected to represent nonsocially generated emotions requiring immediate physiological action. These emotions, appetite and disgust, may be evoked more directly by simple affective properties of a stimulus or event. Appetite/food desire is a positive incentive response that can be triggered by food cues, as well as potentiated by physiological drive (Wyvell &

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Berridge, 2000). Disgust is an aversive response that can be triggered by repulsive food candidates as well as by a variety of other stimuli including mutilated body parts (Rozin, Haidt, & McCauley, 2000). Thus, physical stimuli, such as food or bodily injury, are particularly effective at eliciting positively valenced appetite and negatively valenced disgust.

Emotions are also motivated by innate drives to direct long-term social behaviors. Specific emotional/motivational states might have evolved to respond to complex social stimuli because effective achievement of social needs (cooperation, hierarchy, mating, etc.) provides an important selective advantage to organisms that live in social groups. Social emotions often communicate how other people feel and guide subsequent interpersonal interactions. Joy and sadness have been selected to represent socially generated emotions requiring socially appropriate behaviors (Gehricke & Shapiro, 2001; Jakobs, Manstead, & Fischer, 2001). When people are asked to remember happiness, 69% of recalled episodes involve relationships such as a friendship. Likewise, 36% of recalled episodes of sadness involve the loss of such relationships (Leary, 2000). Thus, social situations are particularly potent elicitors of positively valenced joy and negatively valenced sadness.

We hypothesized that an interaction between sociality (nonsocial and social) and valence (positive and negative) would produce distinctive subjective and psychophysiological profiles. Inducing "social" emotions experimentally that will allow comprehensive psychophysiological assessment is difficult, and to achieve this objective we used film segments as emotion elicitors. Emotions are often induced by dynamic stimuli (Gross & Levenson, 1995), and films are effective at eliciting both positive and negative emotions (Westermann & Hesse, 1996). In this study, we examined (a) psychophysiological patterns (skin conductance and HR) associated with both positively and negatively valenced emotional stimuli and (b) the effect of social versus nonsocial stimuli on these patterns. We used film segments that elicited similar levels of subjective arousal to minimize potential effects of arousal differences on psychophysiological patterns. Previous studies found skin conductance responses to musical clips evoking happiness and fear were significantly greater than sadness (Khalfa, Isabelle, Jean-Pierre, & Manon, 2002); therefore, we expected the SCR to film clips inducing joy and disgust to be greater than film clips inducing appetite and sadness. Consistent with previous findings, we expected HR decreases in negative emotions (Hubert & de Jong-Meyer, 1991b; Hubert & de Jong-Meyer, 1991a), and as compared with other negative emotions, disgust to induce lower HR levels (Ekman et al., 1983; Levenson et al., 1990). Our study aimed to examine whether the social dimension of emotions, in addition and in interaction with valence and subjective arousal, contributes to these complex patterns of physiological response.

Method

Participants

Forty healthy participants (age: 19.3 ± 1.2 years; 19 male) were recruited from advertisements placed at local universities. Inclusion criteria consisted of native-English speaking, right-handed participants with corrected-to-normal vision and normal hearing. Participants did not have a chronic medical illness or current substance abuse/dependence. After complete description of the study, all participants provided written informed consent approved by the University of Michigan Institutional Review Board. For their involvement, participants were either paid $10/hour or received course credit.

Apparatus

While sitting in a sound-attenuating booth, stimuli were presented to participants on a laptop computer (Macintosh Powerbook, Apple Computer, Inc., Cupertino, CA). Film segments were shown using QuickTime (QuickTime, Apple Computer, Inc.) and participants listened to each film using headphones set at a comfortable volume. Still frames were displayed and subjective responses were recorded using SuperLab software (SuperLab, Cedrus, Inc., San Pedro, CA).

Procedure

Short film segments (~2 min) were shown to induce discrete emotional states. Immediately following each film, participants were asked to maintain the emotions evoked while 10 static picture frames extracted from each film were shown in a chronological sequence, to assist the subject with focusing on film content. Each picture was shown for 3 s. The still frames were included to provide a controlled segment for subsequent neuroimaging experiments using this paradigm, since we had additional hypotheses that social and nonsocial stimuli will activate different brain regions.

Stimuli

Stimuli varied in sociality (social or nonsocial) and valence (positive, neutral, negative, or blank). Social stimuli included comedy scenes from Robin Williams stand-up routine (An Evening with Robin Williams, 1982) to induce joy/amusement, and bereavement scenes from *Steel Magnolias* (Columbia/Tristar Studios, 1989) and *The Champ* (Warner Home Video, 1979) to induce sadness. Nonsocial stimuli included footage from a pizza commercial (Pizza Hut, Inc., Dallas, TX) to induce appetite, and images of wounded body parts in amputation procedures and burn victims (Hess et al., 1995) were used to induce visceral disgust. Arousal ratings were collected to verify comparable arousal levels. Nonemotional/neutral and blank stimuli were used as two types of control conditions. To control for the processing of human forms and figures in social conditions and general objects in nonsocial conditions respectively, neutral films consisted of home-improvement films on deck building and vinyl flooring, or chair caning and jewelry making (Do-It-Yourself, 1985; IBEX, 1990; Nelson, Nelson, & Hungate, 1991; TauntonPress, 1993), with and without human figures and faces accordingly. The blank condition consisted of a series of gray screens. Two variants of each stimulus condition were shown.

Similarly valenced emotions were elicited in succession. Social positive and nonsocial positive stimuli were shown sequentially and social negative and nonsocial negative stimuli were shown sequentially. The two variants of each condition were shown in blocked form. The order of presentation of different stimuli (social, nonsocial and positive, neutral, negative, blank) was counterbalanced across participants.

Measures

Subjective response. Subjective responses were obtained after each film-picture pair to verify that the target emotional state and arousal level were induced. A series of adjectives were displayed on the screen one at a time. On a 5-point scale (1 = *not at all*, 5 = *extremely*), participants rated, via button-press, the extent to which each adjective described their emotional experience during the condition. The adjective list included words such as happy, joyful, sad, depressed, hungry, desire, disgusted, upset, relaxed, calm, and interested. Several descriptors were averaged together to represent each condition (social positive, social negative, nonsocial positive, and nonsocial negative). Ratings of calm, at ease, and relaxed were averaged to measure subjective arousal. Similarly, baseline mood was measured prior to the induction procedure to assess their current emotional state upon entering the study.

Psychophysiology. To determine the psychophysiological response during mood induction, SCR and HR were recorded during each film using BioPac MP100 Psychophysiological Monitoring System (BioPac System, Santa Barbara, CA).

To monitor skin conductance, Ag/AgCl electrodes filled with isotonic NaCl unibase electrolyte jelly were placed on the second and third fingers of the participant's left hand. Using AcqKnowledge software (BioPacSystem, Goleta, CA), the peak skin conductance during each film was determined. The peak skin conductance during the first 30 s of each film was compared to a 25 s baseline period prior to each film.

HR was monitored via a plethysmograph attached to the index finger of the participant's left hand. Heartbeats were counted during each film. HR during the first 90 s of each film was compared to a 25 s baseline period preceding each film.

Data analyses. The subjective response data was examined using 2 (Sociality: social, nonsocial) × 3 (Valence: positive, neutral, and negative) × 4 (Emotion Type: appetite, disgust, joy, and sadness) repeated measures analyses of variance (ANOVAs). Post hoc analysis determined significant changes in subjective response within each condition (social positive—comedy routines; social negative—bereavement scenes; nonsocial positive—pizza scenes; nonsocial negative—wounded bodies). Paired *t* tests were used to determine significant changes in subjective ratings in each emotional condition as compared with the appropriate neutral condition, which controlled for the effect of human forms and figures. Social positive and social negative were compared with social neutral condition. Nonsocial positive and nonsocial negative were compared with nonsocial neutral. One-Factor (Emotion Type) repeated measures ANOVA and Bonferroni post hoc analysis tested whether the targeted emotion was induced selectively during each respective condition. In addition, paired *t* tests were used to directly compare subjective ratings of arousal between social and nonsocial dimensions within each valence type.

Changes in skin conductance and HR to each emotional stimulus were examined using a two-factor (Sociality and Valence) repeated measures ANOVA and Bonferroni post hoc analysis. In addition, paired *t* tests were used to directly compare social and nonsocial dimensions within each valence type. Further analysis examined the social dimension separately using separate one-factor (Valence) repeated measures ANOVA. Inclusion of baseline mood measures as covariates of noninterest did not alter the main effects noted.

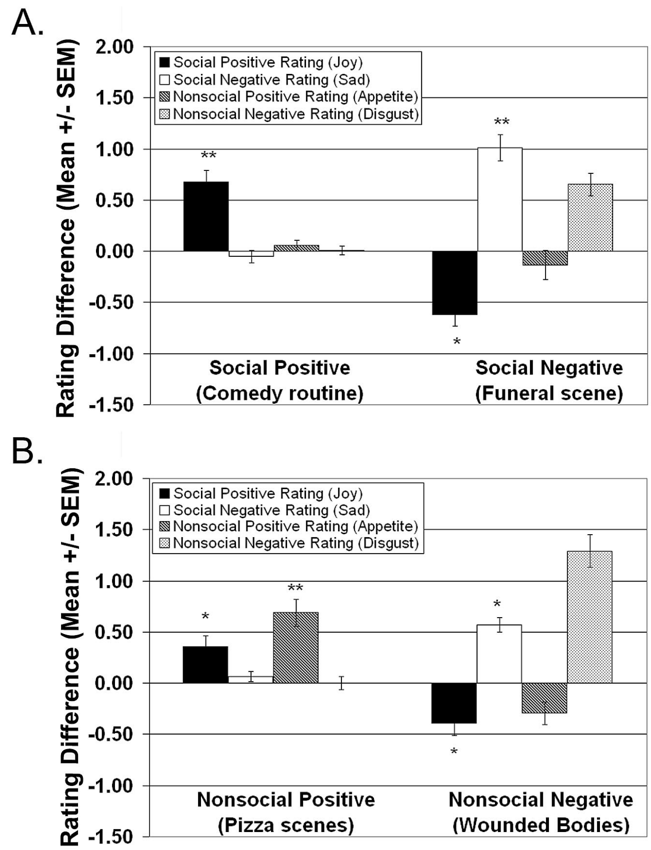

Figure 1. Subjective rating differences (means and standard errors) in (A) social and (B) nonsocial emotional conditions relative to social neutral and nonsocial neutral, respectively. **Significant difference from nontarget emotions (Bonferroni-adjusted $p < .05$) and neutral (pairwise, $p < .05$); *Significant difference from neutral (pairwise, $p < .05$).

Results

Subjective Response

The targeted emotion was elicited by each film/picture condition as intended, and each of the four stimuli conditions produced its own distinct pattern of emotional ratings (see Figure 1). A significant Sociality × Valence × Emotion interaction [$F(6, 234) = 16.11$, $p < .001$] was detected, prompting further post hoc analysis. Social positive stimuli elicited the target emotion (social positive) more than nontarget emotions (social negative, nonsocial positive, and nonsocial negative). Specifically, comedy routines elicited joy [$t(39) = 5.98$, $p < .001$], while producing no sadness, appetite, or disgust. Similarly, nonsocial positive stimuli elicited the target emotion (nonsocial positive) more than nontarget emotions (social positive, social negative, and nonsocial negative). Pizza scenes elicited primarily appetite ratings [$t(39) = 5.32$, $p < .001$]. Pizza stimuli also elicited joy ratings but to a lesser degree than the target emotion, appetite [$t(39) = 3.32$, $p < .002$; emotion effect: $F(3, 117) = 13.51$, $p < .001$, pairwise comparison: $p < .039$]. Social negative stimuli elicited the target emotion (social negative) more than nontarget emotions (social positive, nonsocial positive, nonsocial negative). Bereavement scenes primarily elicited sadness [$t(39) = 7.93$, $p < .001$]. Bereavement scenes also elicited disgust [$t(39) = 5.89$, $p < .001$], but disgust was elicited with a lesser degree than sadness [emotion effect: $F(3, 117) = 33.76$, $p < .001$, pairwise comparison: $p < .005$] and as expected suppressed joy [$t(39) = -5.65$, $p > .001$]. Finally, nonsocial negative stimuli elicited the target emotion (nonsocial negative) more than nontarget emotions (social positive, social negative, and nonsocial positive). Images of wounded bodies primarily elicited disgust [$t(39) = 7.89$, $p < .001$]. Nonsocial negative stimuli also elicited sadness [$t(39) = 8.02$, $p < .001$], but sadness was elicited with a lesser degree than disgust [emotion effect: $F(3, 117) = 38.49$, $p < .001$, pairwise comparison: $p < .001$], and simultaneously suppressed joy [$t(39) = -2.24$, $p > .031$].

Neutral stimuli in social and nonsocial conditions did not significantly differ on any rating ($p > .108$). Arousal ratings in social and nonsocial conditions did not differ significantly for positively, neutrally, or negatively valenced stimuli, suggesting similar arousal levels ($p > .134$; Figure 2A).

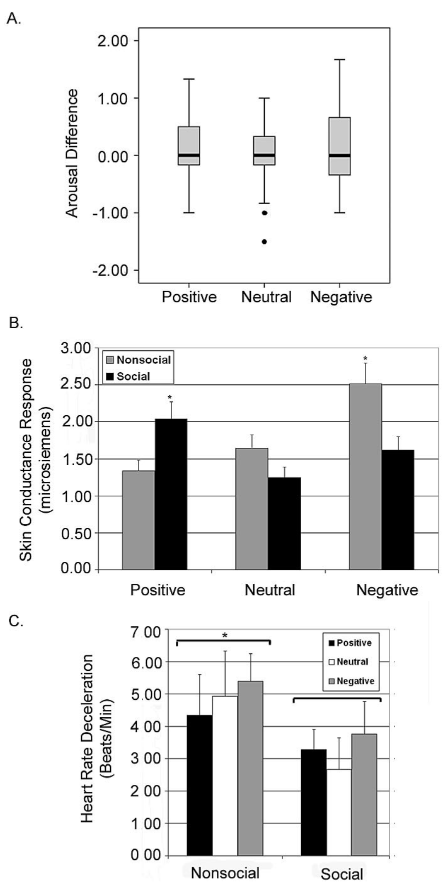

Figure 2. Subjective arousal difference (mean and standard error) between social and nonsocial emotions. (A): Peak SCR (means and standard error) shows Sociality × Valence interaction. (B): HR deceleration (means and standard error) indicates differences between social and nonsocial emotions. * Significant sociality effect ($p < .003$). (C): Heart rate (HR) deceleration (means and standard error) indicates differences between social and nonsocial emotions. * Significant sociality effect ($p < .05$).

Skin Conductance Response

The SCR (see Figure 2B) to nonsocial and social stimuli showed different patterns depending on stimulus valence [Sociality × Valence effect, $F(2, 38) = 4.54$, $p < .024$]. Paired t tests determined the SCR to social positive stimuli was greater than nonsocial positive [$t(39) = 3.54$, $p < .001$], and the SCR to nonsocial negative stimuli was greater than social negative stimuli [$t(39) = 3.13$, $p < .003$].

For nonsocial stimuli, the SCR increased in a linear fashion from positive to negative valence ($p < .041$). SCR to negative stimuli was greater than the response to positive stimuli ($p < .003$) and tended to be greater than neutral stimuli $p < .065$, valence effect: $F(2, 38) = 7.35$, $p < .002$]. On the other hand, SCR to social stimuli showed a different pattern, greater to positive ($p < .042$) and negative ($p < .107$) compared with neutral: valence effect, $F(2, 38) = 3.86$, $p < .031$.

Heart Rate

In all cases, the HR decelerated (see Figure 2C). Overall, compared with social stimuli (-3.077 ± 0.721 bpm), nonsocial stimuli (-4.597 ± 0.912 bpm) elicited a greater change in HR [sociality effect, $F(1, 24) = 7.567$, $p < .011$].

In the nonsocial condition, HR had a similar pattern to the skin conductance response, in that relative changes tended toward being greater in negative valence than to neutral or positive valence; however, unlike SCR, that linear valence effect was not statistically significant for HR. In social stimulus conditions, again similar to SCR, both positive and negative valence elicited a greater response than neutral stimuli.

Discussion

In this novel emotional activation paradigm, films elicited four distinct emotional patterns of subjective and psychophysiological experience. As intended, targeted emotions were elicited significantly more as compared with nontarget emotions for each of the stimuli presented, thus confirming the face validity of the experimental manipulation. SCR response to similarly valenced emotional responses differed, depending on whether a positive or negative emotion was elicited by social or nonsocial stimuli. For nonsocial stimuli, negatively valenced emotion was associated with the strongest SCR response and positively valenced emotion was associated with the weakest SCR response. For social stimuli, both positive and negative stimuli elicited SCR compared with neutral stimuli and furthermore, the highest response was associated with social positive stimuli. Finally, nonsocial stimuli evoked a greater HR deceleration than social stimuli. Heart deceleration has been associated with orienting attention to meaningful stimuli (Simons, Detenber, Roedema, & Reiss, 1999; Turpin, Schaefer, & Boucsein, 1999), suggesting nonsocial stimuli may require more immediate attention. In addition, HR data showed a similar pattern of change with respect to valence as skin conductance, however, statistical significance was not attained.

Subjective ratings validated that each stimulus selectively elicited the intended emotion. As seen with the highest magnitude difference, subjective responses reflected that target emotions were evoked in each condition. These findings are consistent with other film induction studies. Using similar films, 75–80% of subjects agree with targeted emotions of amusement, sadness, and disgust (Gross & Levenson, 1995; Westermann & Hess, 1996). Even though the targeted emotions were elicited significantly more than the nontargeted emotions, more complex emotional states (better characterized by a number of different emotional adjectives) were evoked in each condition. For example, nonsocial negative stimuli (amputation video) evoked both disgust and sadness as seen in elevated subjective ratings. Nonsocial positive stimuli (pizza) evoked both appetite and joy. On the other hand, social positive elicited only joy and not appetite ratings. The social dimension may focus the emotional response and elicit specific emotions so that participants can respond appropriately to the social cues.

Of note, discrete emotions may operate on a single nonsocial/social continuum or two separate nonsocial and social dimensions. If emotions operate on a single nonsocial/social continuum, disgust may vary between a visceral response, such is the case with bodily disgust, and a more social response, such is the case with moral disgust. In addition, appetite may be influenced by the context in which appetizing stimuli is presented, a solitary versus social setting. On the other hand, two independent dimensions may operationalize this concept of nonsocial versus social emotions.

For example, nonsocial objects like spiders, snakes, and heights can evoke fear. Meanwhile, social elements like performance failure and personal rejection can also evoke fear. If independent, these two types of fears can occur simultaneously. For example, simple phobia and social phobia have a high rate of comorbidity (Schneier, Johnson, Hornig, Liebowitz, & Weissman, 1992). In addition, these two independent dimensions may interact. Some social responses such as empathy may be activated by a nonsocial response, that is, bodily disgust, explaining the subjective reports of both disgust and sadness to amputation/burn victim procedures.

The interaction between sociality and valence detected in skin conductance response, a measurement of physiological arousal and task engagement, may reflect the bias toward particular action. In nonsocial stimulus conditions, the greatest SCR was measured during the nonsocial negative condition, as expected. This finding is consistent with the fact that the SCR to musical clips evoking fear, a high-arousing, unpleasant emotion like disgust, was greatest (Khalfa et al., 2002). Disgust elicits an intense visceral response (Gross & Levenson, 1995; Rozin et al., 2000), possibly to prepare action toward immediate threat and danger. Food may also be physiologically arousing, and in binge eaters, food exposure can elicit heightened skin conductance response, HR and startle reflex (Vogele & Florin, 1997). However, for our participants, who were not deprived, SCR was relatively reduced by appetite induction, compared with neutral baseline. A different pattern emerged in social stimulus conditions. The greatest SCR was evoked by positive stimuli in a social context. Joy has been associated with increased arousal whereas sadness has been associated with low arousal, indicating positive social emotions may be more engaging (Christie & Friedman, 2004). This increased arousal or increased engagement in the social positive condition may result because positive stimuli are associated more with self (Phan, personal communication, 2004). These changes in physiological arousal seem to be independent of subjective arousal since no significant ratings differences were detected.

Several limitations of this study should be noted. First, subjective ratings may be influenced by expectancy effects; however, it has been shown that mood induction with and without instruction was similar for both positive and negative stimuli (Westermann & Hesse, 1996). In addition, our psychophysiological measures confirmed the differences in subjective ratings of social and nonsocial emotional stimuli. Second, the difficulty in labeling emotion terms may also prevent an accurate reflection of subjective experience. Several descriptors were used to categorize each emotional state, introducing the potential for ambiguity. For example, *sadness* and *depressed* may be subjectively different. On the other hand, few adjectives describe happiness or amusement. Future studies might incorporate a free labeling approach in addition to reporting discrete emotional states via Likert-type scales to address this issue. Finally, this study is the first attempt to underscore the importance of characterizing emotions based on a social dimension. Future investigations need to determine the validity in the pattern of emotional response in this study. Specifically, do all social positive and nonsocial negative emotions elicit high physiological arousal and do all nonsocial positive and social negative emotions elicit low physiological arousal? Only two social emotions (joy and sadness) and two nonsocial emotions (appetite and bodily disgust) were studied. Future investigations exploring additional social emotions, such as embarrassment, guilt, and shame, and additional nonsocial emotions, such as pain and object fear (e.g., fear of snakes), are clearly needed.

In summary, we have developed an experimental paradigm that allowed independent manipulation of two factors of emotional response: social and valence dimensions. Subjective ratings and skin conductance data suggest a distinct pattern of physiological responses to social versus nonsocial emotions. HR distinguished between social and nonsocial emotions; thus, the social dimension may be an additional important characteristic of emotional response that produces distinctive psychobiological responses. This behavioral experiment was a first step in developing a new emotional paradigm that could examine whether neural activation patterns could also be dissociated based on a social dimension of emotion.

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