

# Pleasing Frowns, Disappointing Smiles: An ERP Investigation of Counterempathy

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The biological predisposition to resonate emotionally with another person is regarded as a critical aspect of social interaction. There are, however, situations in which the emotional response to others is discordant with their emotional experience. Using event-related potentials, the present study investigated the neural underpinnings of this phenomenon, termed “counterempathy.” Participants played a card game under the belief that they were playing jointly with another player who sat in an adjoining room and whose smiles and frowns in response to winning or losing in the game they could observe on a computer screen. Depending upon the experimental setting, the other player’s facial expressions conveyed either of two opposing values to the participant. In the empathic setting, his emotional expressions were congruent with the participant’s outcome (win or loss), whereas in the counterempathic setting, they indicated incongruent outcomes. Results revealed a reversed pattern of brain responses to facial expressions between congruent and incongruent conditions at ~170 ms (N170) over the temporal cortex. That is, N170 was sensitive to frowns in the congruent condition and to smiles in the incongruent condition, both indicating losses for the participant. Furthermore, frowns in the incongruent condition yielded larger medial frontal negativity (MFN) over the medial prefrontal cortex, which correlated with the subjective pleasantness about one’s own winning in the incongruent condition. These findings demonstrate that (1) counterempathic responses are associated with modulation of early sensory processing of emotional cues, (2) that MFN is sensitive to the detection of another person’s loss during positive inequity, and (3) that MFN is associated with a pleasant feeling during positive inequity, which is possibly related to “Schadenfreude.”

*Keywords:* ERP, empathy, N170, MFN, facial expression

Viewing the emotional expressions and gestures of another person may induce a mimicking response in the observer (Niedenthal, 2007; Van Baaren et al., 2009). Similarly, shared neural circuits activated during affective experiences in oneself and their

observation in others indicate our propensity to resonate emotionally with others (Decety, 2011; Decety & Jackson, 2004). However, such a mimicking response is not adaptive in all social interactions as not all our reactions are emotionally congruent; many can be incongruent, or even at odds with the emotional state of the other. This discrepant emotional response has been called “counterempathy.”

Empirical evidence for counterempathic responses was first provided by Aderman and Unterberger (1977), followed by a series of investigations performed by Lanzetta and coworkers (e.g., Englis, Vaughan, & Lanzetta, 1982). These studies measured psychophysiological responses while participants played games against an interaction partner, and found that while facial expressions of happiness and distress promoted symmetrical EMG responses in a cooperative setting, a competitive setting led to asymmetrical (i.e., counterempathic) responses.

In recent years, akin to counterempathy, one study showed a lack of empathy-related neural responses and increased activation in reward-related areas when male participants witnessed a cue signaling the delivery of painful shocks to unfair persons (Singer et al., 2006). Similarly, another study showed that envy induced by stories describing others’ success activated pain-related areas, whereas reading misfortunate events of envied others recruited reward-related areas (Takahashi et al., 2009). A recent neuroimaging study also demonstrated that the failures of an in-group

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member are painful, whereas those of a rival out-group member give pleasure—a feeling that may motivate harming rivals (Cikara et al., 2011). Moreover, neural responses in reward-related areas linked to “Schadenfreude” predicted reduced helping behavior toward fans of an opponent football club (Hein et al., 2010). These studies provide evidence that empathy-related brain responses can be modulated by contextual appraisal, interpersonal factors, and inter group dynamics (Decety & Lamm, 2006; Singer & Lamm, 2009, for review). It remains unclear, though, how the automatic, sensory-driven process of reacting to another person’s emotional expression is modulated in terms of neural responses in an online counterempathic situation.

The aim of the current research was to investigate empathetic and counterempathic evoked neural responses to another person’s facial expressions in an ecologically valid social interaction. Given that neural responses to facial expressions occur within the first 300 ms after stimulus onset, we used high-resolution event-related brain potential (ERP) recordings to monitor these early onset neural responses. Our analyses focused on two distinct ERP components that have been previously associated with the neural encoding of facial expressions (N170) and the detection of errors performed by oneself or another person (medial frontal negativity, MFN). A recent study demonstrated a relationship between the magnitude of N170 and the occurrence of spontaneous facial mimicry (Achaïbou, Pourtois, Schwartz, & Vuilleumier, 2008). This finding renders N170 a target component of the current study, as previous studies of counterempathy (e.g., Englis and colleagues, 1982, see above) have shown counterempathic modulation of facial mimicry. The MFN, on the other hand, is sensitive to an unfavorable outcome for the self (Yeung & Sanfey, 2004, but see Jung et al., 2010, for both favorable and unfavorable outcomes) or for others (Fukushima & Hiraki, 2006; Koban, Pourtois, Vocat, & Vuilleumier, 2010). MFN is usually observed between 200 and 400 ms after stimulus onset, and its neural source is considered to be in anterior cingulate cortex (ACC) (Gehring & Willoughby, 2002; Nieuwenhuis, Yeung, Holroyd, Schurger, & Cohen, 2004); note though that later evidence suggests that this region should now rather be referred to as medial cingulate cortex (MCC) (Vogt, 2005).

Based on this evidence, we predicted that N170 and MFN responses to facial expressions (smiles and frowns) would be different in empathic and counterempathic settings, brought by their different motivational impacts for the self. More specifically, we hypothesized (1) that N170 amplitudes reflecting the encoding of smiles and frowns may show a reversed pattern between the empathic and counterempathic conditions, because the opponent’s frown (disappointment) in the empathic condition does not disappoint the participant in the counterempathic condition, while the opponent’s smile (pleasure) in the empathic condition does not please him in the counterempathic condition; (2) that the MFN amplitude that has been related to performance outcome may similarly be influenced by two conditions with different motivational impact for the self; (3) that the MFN during counterempathic smiles and frowns may be related to subjective disappointment and pleasure, and that this relationship might vary with individual differences in empathic disposition measured by an empathy questionnaire.

## Materials and Method

### Participants

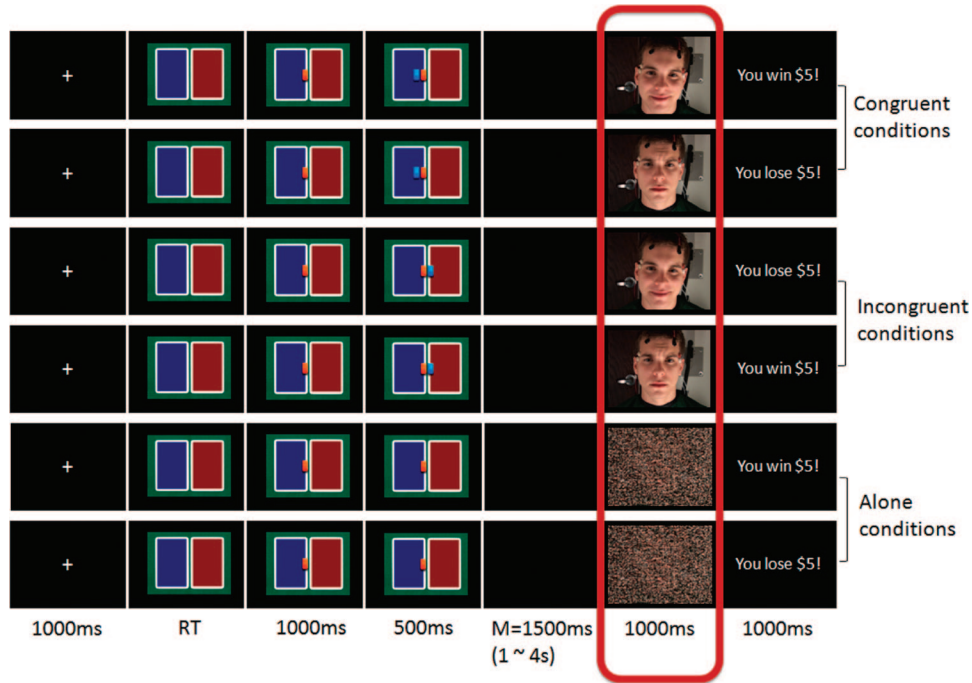
Twenty right-handed healthy male subjects (mean age =  $21 \pm 2$  (*SD*) years), recruited from the University of Chicago community, with no history of neurological or psychiatric disorders, participated in this study. Only male participants were included since the coplayer with whom participants interacted was also male. All participants provided informed written consent, and were paid for their participation. The study was approved by the local ethics committee (University of Chicago Social and Behavioral Sciences Institutional Review Board) and performed in accordance with the Declaration of Helsinki. Data from five participants were discarded because of excessive movement (four subjects) and bad contact of the electrodes (one subject). Thus, the ERP data from 15 subjects were analyzed.

### Stimuli

The facial expressions of a male confederate serving as the coplayer during the experiment were video-taped while he was playing a card game. From these videotapes, 721 still shots clearly expressing discernible smiles and frowns in response to losses and wins were extracted (346 smiles and 375 frowns), and evaluated for their emotional content by three independent raters who were naïve to the goals and predictions of the study. Only stimuli for which all three raters identified the same emotional content (happiness vs. disappointment) were selected, resulting in a final set of 128 stimuli of each category that were used for the ERP experiment.

### Experimental Procedures

Participants were instructed about the rules of the so-called “war card game” that they would play together with another participant. After introducing them to their coplayer and letting them play one round of the game together, they were brought to two separate yet adjacent electromagnetically shielded chambers, and seated ~ 1 m in front of a computer screen. Unknown to the participant, the coplayer was a confederate who did not actually play the game. The war card game is a simple game in which one wins if the number on the card that one has chosen from a set of two cards is higher than that of the other card. Each trial consisted of the following sequence (see Figure 1, which also contains information about the timing of these events). First, the participant was presented with the image of a red and a blue card and prompted to choose one of them. This choice was made via a button press with the right index or middle finger. After making his choice, the participant was shown a display with the choice that the playing partner had made, followed by a display of the coplayers facial expression, which could be either a smile or a frown. Before the experiment, the participant had been told that he would not see the actual outcome of the game (i.e., the numbers on the red and blue cards), but that his coplayer would and that he would see snapshots of his facial reactions captured by a camera set up in the coplayer’s chamber. Finally, the outcome of the trial for the participant was presented with one of two messages: “You win \$5!” or “You lose \$5!” The coplayer’s choices were experimentally predetermined



*Figure 1.* Eight possible sequences of events during a single trial of the war card game. Participants were presented on each trial with a choice of two colored cards, one of which they selected with a keypress. After the screen with the selected card (indicated by an orange tab) for 1,000 ms, they were shown the coplayer’s chosen card (indicated by a blue tab) for 500 ms. After a mean of 1,500 ms delay with a black screen (jittered between 1,000 to 4,000 ms), they were shown the coplayer’s facial expression (frown or smile) or a scrambled image, followed by the outcome (win or lose). RT = response time. The red circle indicates the epoch for the analyses. The baseline epoch is exactly before the face epoch.

such that the choice of card made by the participant could be either the same or opposite to the coplayer, and the sequence of choices was pseudorandomized across conditions. If choices were the same (congruent condition), a smile of the coplayer indicated a win for both participant and coplayer, whereas displaying a frown indicated a loss for both of them. If choices were incongruent (incongruent condition), smiling of the coplayer indicated his win and the participant’s loss, whereas frowning indicated a win for the participant. In an additional control condition, the participants played alone and a scrambled image with the same average luminosity as the facial stimuli was shown during the outcome phase. In reality, the outcome of each trial was controlled by a predetermined trial sequence.

Participants played 13 sessions (40 or 41 trials in each session, 526 trials in total) plus a last session with 35 trials. After 13 sessions, the net amount of money gained was \$0 for all participants, and the last session was included to adjust the net money to yield \$15 for all participants. This last session was discarded from the analyses. After each session, participants were given information regarding how much money they had earned in a given session, which varied between  $-15$  to  $15$  US\$, and that was predetermined experimentally and pseudorandomized across participants. Participants were informed that they would receive the amount of money accumulated at the end of the experiment, that is, after the last session. Three experimental conditions (congruent, incongruent, control) with two outcomes (win, loss) yielded six

conditions (see Figure 1), each of which contained 88 trials. After the experiment, participants filled out questionnaires that asked them to rate the experienced pleasantness about one’s winning, and unpleasantness about one’s losing during each of the four experimental conditions, using a 5-point scale ranging from 0 (not at all) to 4 (very much). In addition, to obtain a trait measure of participant’s empathic disposition, the empathy quotient questionnaire [EQ] was filled in (Baron-Cohen and Wheelwright, 2004).

### EEG Recording and Analysis

EEG signals were recorded using a Geodesic Sensor Net with 128 sensors, and Net Station, Version 4.1.2 software (Electrical Geodesics, Eugene, OR). Electrode impedances were kept under  $60\text{ k}\Omega$ ; electrode Cz was used as the recording reference, and signals were rereferenced offline to an average reference. The EEG was amplified (band pass 0.1–100 Hz) and digitized at a sampling rate of 250Hz. ERP analyses were performed using BESA (BESA 5.2, MEGIS Software GmbH, Munich, Germany). Eye movements and blinks were corrected using an ICA procedure implemented in BESA (Jung et al., 2000). Remaining EEG artifacts exceeding  $\pm 100\text{ }\mu\text{V}$  within a trial were detected on a trial-by-trial basis and excluded from averaging, with trials containing the 1,000 ms epochs during the presentation of the photographs of facial expressions of the coplayer (face epoch, circled in red, Figure 1). These trials were averaged separately for each of the six conditions, and

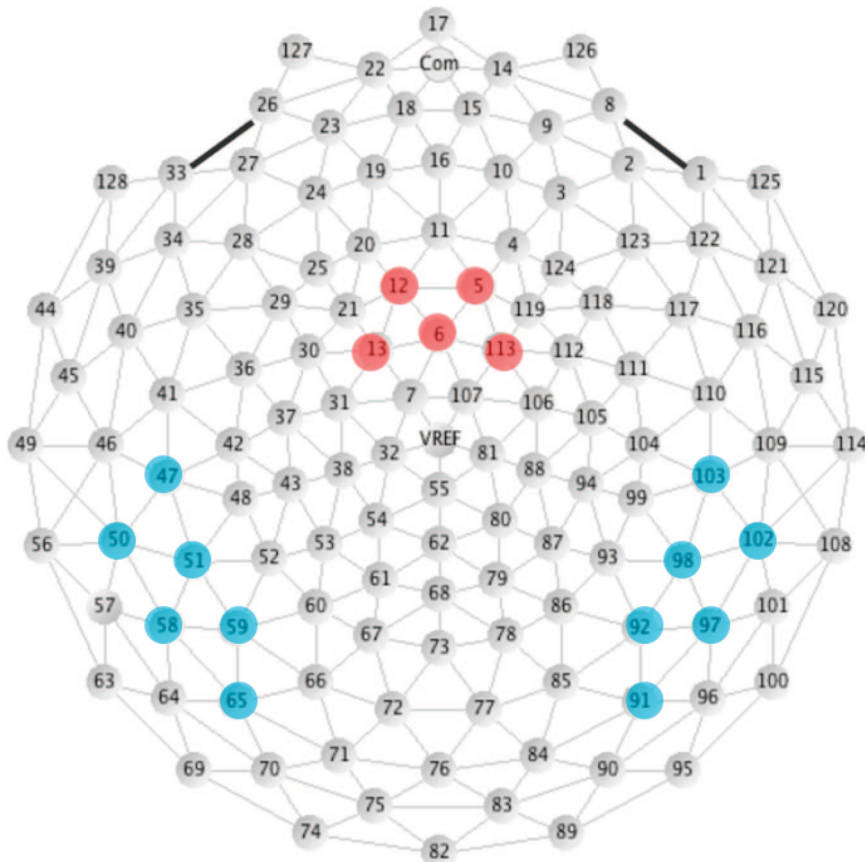
the resulting ERPs were aggregated for three recording sites consisting of the electrodes shown in Figure 2 (left and right temporal-occipital site, and frontal sites). The ERP baseline was set as the mean signal 100 ms before onset of a trial. Based on prior hypotheses and theoretical considerations we focused on two major peaks. The first peak (recognized as N170 at temporal sites) was determined as the most negative peak between 100 and 200 ms at the two (left and right) temporal sites. The second peak (defined as MFN at frontal sites, as defined above) was determined as the most negative peak in the range of 200 to 400 ms at frontal sites. Electrodes for temporal and frontal sites were chosen based upon the existing literature and visual inspection of the current data (see Figure 2). That is, previous ERP studies have yielded consensus that processing of face stimuli is chiefly reflected by ERPs over T5 and T6 in the 10–20 system, which corresponded to channels 58 and 97 in the 128 electrode cap we used. We chose these two electrodes and added surrounding ones that showed a similar waveform as T5 and T6, based on visual inspection of the mean ERPs from all conditions showing faces. Studies of the MFN revealed FCz, which corresponds to channel 6 in ours setup, to show maximum deflection, and we again chose surrounding channels with similar difference waveforms. After artifact exclusion,  $73 \pm 13$  (Mean  $\pm$  SD) trials per condition were available for ERP averaging.

The amplitudes of these components were then scrutinized using a sequence of statistical analyses. The first analysis aimed to establish a specific neural response over the temporal recording sites when seeing faces versus scrambled images. The second and third analysis assessed whether there were specific neural responses over the temporal recording sites (N170), and over the frontal site (MFN), during congruent versus incongruent conditions. Finally, we investigated the relationship between the effects of counterempathy on MFN amplitude and the subjective feeling about one’s winning and losing during other’s winning and losing, as well as between the effects of counterempathy on MFN amplitude and individual variations in trait empathy (EQ sum score; Baron-Cohen & Wheelwright, 2004). In all repeated-measures analyses, potential violations of the sphericity assumption were taken into account by correcting degrees of freedom using Greenhouse-Geisser estimates of sphericity.

## Results

### N170 Responses to Faces

Grand-average ERP waveforms for face stimuli and scrambled images are shown in Figure 3. Based on visual inspection, ERP



*Figure 2.* Temporal channels and frontal channels used in the statistical analyses are shown in blue and red, respectively. Note that channel 6 corresponds to FCz, and channels 58 and 97 correspond to T5 and T6, respectively, in the conventional 10–20 system.

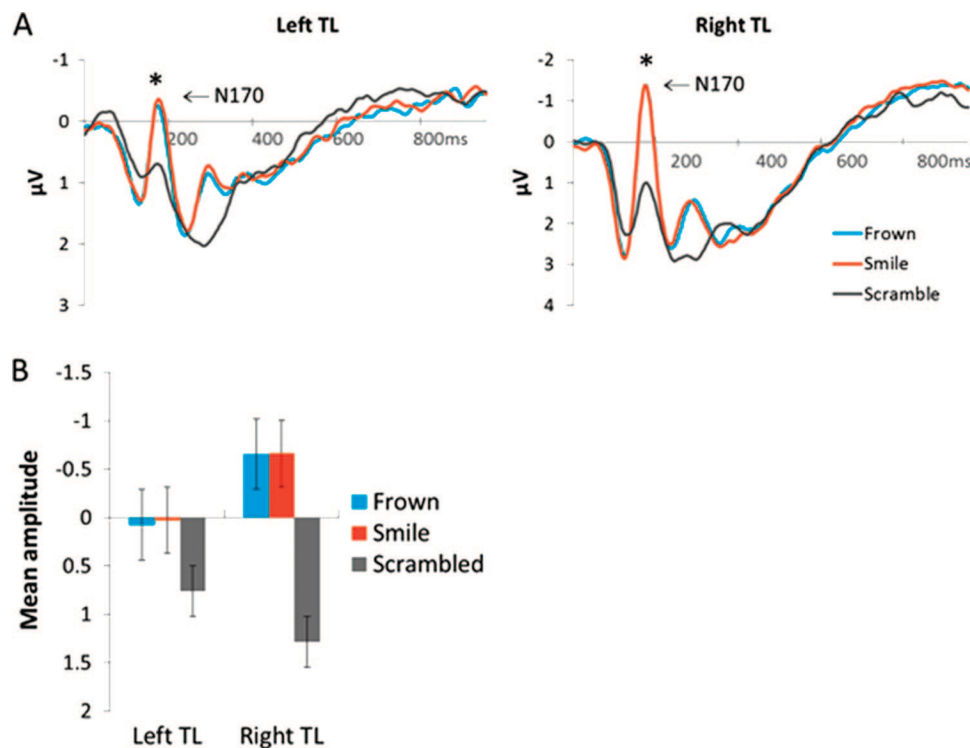


Figure 3. N170. (A) Timecourse (in milliseconds) of the ERP face response for frown, smile, scrambled conditions, displayed for left TL and right TL. Note that the blue line in right TL is hidden behind the red line. (B) Condition effects on N170 amplitude for left TL and right TL. TL = temporal lobe. Note that the mean amplitude was calculated between 150–190 ms. \*  $p < .05$ . Error bars represent SEM.

responses to facial stimuli were characterized by an early positive component, followed by a negative wave (N170, peaking around 170 ms after stimulus onset) bilaterally over the posterior temporal channels (T5, T6). The mean amplitude of the ERP signal between 150 and 190 ms was subjected to repeated measures ANOVA with two within-subject factors: stimulus (levels: frown, smile, scrambled) and hemisphere (left, right) followed by post hoc tests corrected for multiple comparisons using Bonferroni correction. The ANOVA revealed a main effect of stimulus ( $F(1.1, 31.7) = 13.75$ ; partial  $\eta^2 = 0.50$ ;  $p = .005$ ) but no effect of laterality ( $p > .1$ ), and post hoc tests indicated that this effect was because of frowns and smiles yielding larger negative amplitudes than the scrambled images ( $p = .002$ ,  $p = .010$ , for frowns and smiles, respectively) (see Figure 3). Furthermore, a significant interaction between stimulus and hemisphere ( $F(1.2, 6.3) = 4.61$ ; partial  $\eta^2 = 0.25$ ;  $p < .05$ ) indicated that the larger negativities for frown and smile stimuli were significantly higher in the right hemisphere ( $p = .005$ ,  $p = .009$ , respectively).

### N170 and Medial Frontal Negativity to Facial Expressions in Congruent and Incongruent Conditions

After establishing that the face stimuli led to significant modulations of ERPs between 150 and 190 ms over the posterior temporal scalp, and that this effect was more prominent in the right hemisphere, we tested the hypothesis of differential effects of congruency and incongruency on the processing of facial expres-

sions. To this end, the amplitude mean of the congruent condition was compared with that of the incongruent condition with repeated measures ANOVAs with factors facial expressions and conditions, for N170 (separately for each hemisphere) and MFN.

**N170.** In the left temporal channels, the ANOVA revealed a significant interaction between facial expression and condition ( $F(1, 14) = 7.50$ ; partial  $\eta^2 = 0.35$ ;  $p = .016$ ) but no main effects of these factors (facial expression,  $F(1, 14) = 0.07$ ; partial  $\eta^2 = 0.005$ ;  $p = .80$ ; condition,  $F(1, 14) = 0.11$ ; partial  $\eta^2 = 0.008$ ;  $p = .75$ ). Planned comparisons indicated a significant difference between congruent and incongruent conditions for smiles ( $p = .038$ ) and a marginally significant difference for frowns ( $p = .078$ ). In the right temporal channels, the ANOVA revealed no significant interactions ( $F(1, 14) = 0.39$ ; partial  $\eta^2 = 0.03$ ;  $p = .54$ ) or main effects (facial expression,  $F(1, 14) = 0.002$ ; partial  $\eta^2 = 0.00$ ;  $p = .97$ ; condition,  $F(1, 14) = 2.8$ ; partial  $\eta^2 = 0.17$ ;  $p = .12$ ). Planned comparisons testing our a priori interest for differential effects of congruent and incongruent conditions revealed a significant difference for frowns ( $p = .027$ ) but not for smiles ( $p = .47$ ) (see Figure 4). Therefore, N170 amplitude was larger for smiles indicating losses for the participant and wins for the opponent, than for smiles indicating wins for both the participant and the opponent, predominantly in the left hemisphere, and larger for frowns indicating losses for both the participant and the opponent than frowns indicating wins for the participant and losses for the opponent, in the right hemisphere and, by trend, in the left hemisphere. This

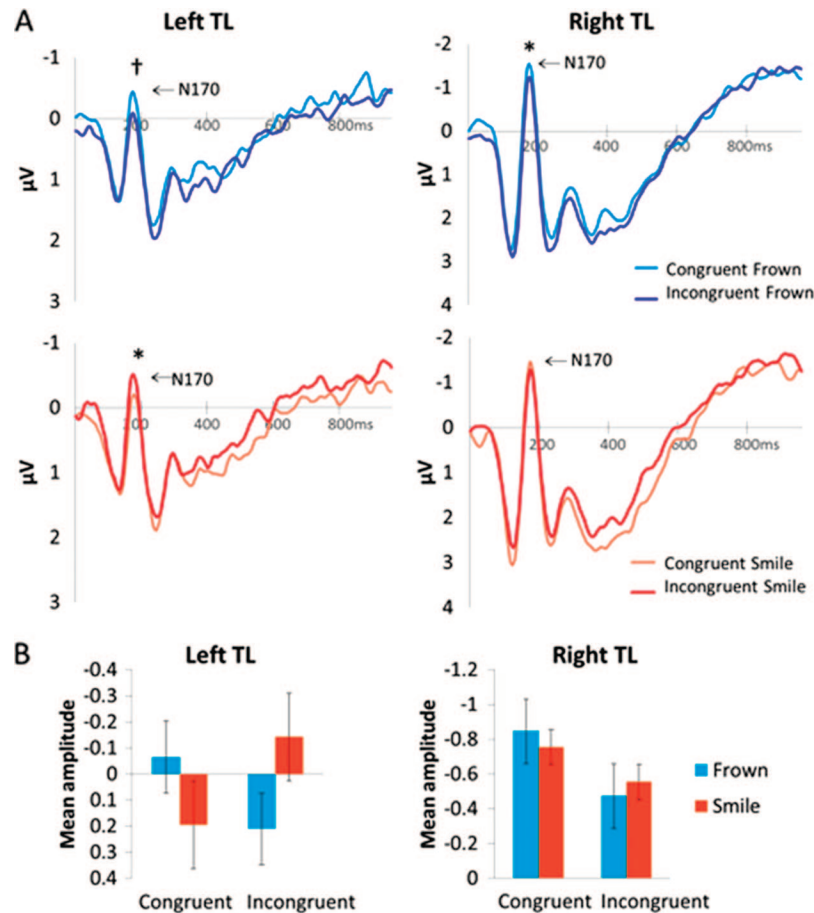


Figure 4. N170. (A) Timecourse of the ERP face response for congruent frown, incongruent frown, congruent smile, incongruent smile conditions, displayed for left TL and right TL. (B) Condition effects on N170 amplitude for left TL and right TL. Note that the mean amplitude was calculated between 150–190 ms in the bar graphs. TL = temporal lobe. \*  $p < .05$ , †  $p < .1$ . Error bars represent SEM.

might suggest that the N170 amplitude was predominantly sensitive to ones' own loss, as conveyed by frowns in the congruent condition and smiles in the incongruent condition.

However, an alternative hypothesis might be that the observed N170 differences were not related to one's own outcomes, but to the outcomes of the other player. If this were true, the N170 amplitude should be modulated by the outcome for of the other player. To explore this possibility, we compared the N170 amplitudes between smiles for the congruent condition and frowns for the incongruent condition, that is, a comparison that kept the outcome for the participant constant ("wins") while modulating the one of the other player, and those between smiles for the incongruent condition and frowns for the congruent condition ("loss" for the participant). These contrasts revealed no significant differences, speaking against the alternative account that the other player's outcomes and associated emotional states were modulating N170 (congruent smiles vs. incongruent frowns in the left hemisphere,  $T(14) = 0.65$ ,  $p = .93$ ; incongruent smiles vs. congruent frowns in the left hemisphere,  $T(14) = 0.36$ ,  $p = .72$ ; congruent smile versus incongruent frowns in the right hemisphere,  $T(14) = -1.2$ ,  $p = .25$ ; incongruent smiles versus congruent frowns in the right hemisphere,  $T(14) = 1.3$ ,  $p = .20$ ).

### Medial Frontal Negativity (MFN)

The MFN data, averaged between 210 and 250 ms, was subjected to a repeated measures ANOVA which revealed no significant interactions ( $F(1, 14) = 2.76$ ; partial  $\eta^2 = 0.16$ ;  $p = .12$ ) or main effects (facial expression,  $F(1, 14) = 1.33$ ; partial  $\eta^2 = 0.09$ ;  $p = .27$ ; condition,  $F(1, 14) = 2.27$ ; partial  $\eta^2 = 0.14$ ;  $p = .15$ ). Planned comparisons testing our a priori interest for differential effects of congruent and incongruent conditions revealed a significant difference between congruent and incongruent conditions for frowns ( $p = .036$ ), indicating a more negative MFN for incongruent frowns than for congruent ones. No difference was observed for smiles ( $p = .92$ ) (see Figure 5).

### Correlation Analyses

To investigate the effect of counterempathy, MFN difference scores were computed separately for frowns [incongruent frowns – congruent frowns] and smiles [incongruent smiles – congruent smiles]. Correlation analyses revealed that the MFN difference score for frowns was negatively correlated with subjective pleasantness ratings (Spearman  $r = -0.82$ ,  $p < .001$ ) (see Table 1). This indicates

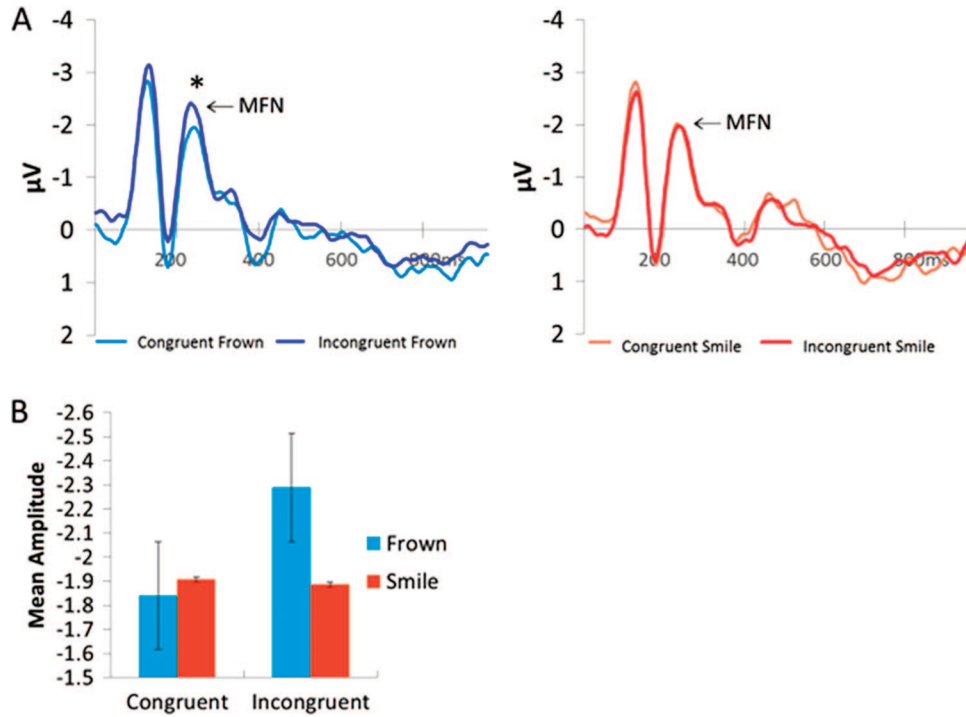


Figure 5. Medial frontal negativity (MFN). (A) Timecourse of the ERP face response for congruent frown, incongruent frown, congruent smile, incongruent smile conditions. (B) Condition effects on MFN amplitude. Note that the mean amplitude was calculated between 210–250 ms in the bar graphs. \*  $p < .05$ . Error bars represent *SEM*.

that participants with higher levels of pleasure about one’s winning during the other’s loss showed larger MFN responses during incongruent frowns compared to congruent frowns (see Figure 6). No significant correlation was found for smiles and subjective disappointment ratings ( $r = -0.006, p = .98$ ), and for correlations between the MFN difference scores and the EQ score (for frowns,  $r = -0.04, p = .9$ ; for smiles,  $r = .37, p = .18$ ).

**Discussion**

In this study, we investigated evoked neural responses to facial expressions in online empathic and counterempathic sit-

uations, revealing three main findings. First, a reversed pattern of N170 was found between the congruent and incongruent conditions over the left and right temporal cortex. While the neural response was modulated by frowns in the congruent condition in the right hemisphere and, by trend, in the left hemisphere, the response was sensitive to smiles in the incongruent condition only in the left hemisphere. Second, in the incongruent condition, frowns but not smiles yielded larger MFN over the medial frontal cortex than that in the congruent condition. Third, the MFN difference scores for frowns in the incongruent versus congruent conditions correlated with the

Table 1  
Correlations of Differences in the MFN Amplitude Between Incongruent and Congruent Conditions for Frown With Pleasantness Ratings, for Smile With Disappointment Ratings, and With Empathy Quotient (EQ)

	MFN difference for frowns	MFN difference for smiles	Subjective disappointment <sup>1</sup>	Subjective pleasantness <sup>2</sup>	EQ
Mean ( <i>SD</i> )	-1.8 (0.7)	-0.9 (0.8)	3.1 (1.3)	3.2 (0.6)	43.6 (10.9)
Subjective disappointment <sup>1</sup>	—	-0.006	—	—	—
Subjective pleasantness <sup>2</sup>	-0.82***	—	—	—	—
EQ	-0.04	0.37	0.58*	-0.03	—

Note. All correlation values are Spearman rank correlations.  
<sup>1</sup> Subjects were asked to rate how much disappointment they felt when they lost while the other player won, on a 5-points scale (0 = not at all, 4 = very much). <sup>2</sup> Subjects were asked to rate how much pleased they felt when they won while the other player lost, on a 5-points scale (0 = not at all, 4 = very much).  
 \*  $p < .05$ . \*\*\*  $p < .001$ .

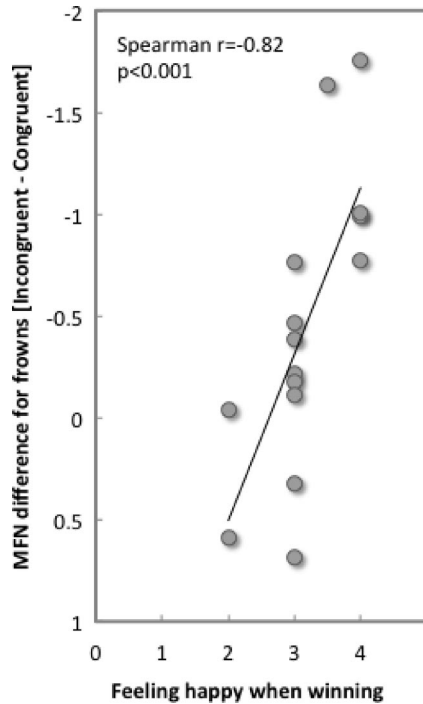


Figure 6. Scatterplot of the correlation between the MFN difference for frowns and the subjective pleasure about one's winning during the other's loss.

subjective pleasure about one's own winning during the other player's loss.

Earlier work on counterempathy showed a reversed pattern of facial mimicry in competitive and noncompetitive settings (Englis et al., 1982). Considering that mimicry to emotional faces was found to modulate N170 (Achaibou et al., 2008), the reversed pattern of N170 between congruent and incongruent conditions in the current study demonstrates contextual influences on the encoding of facial expressions. This is also in line with previous findings that emotional context modulates the encoding of facial expressions, as reflected by N170 (Righart & de Gelder, 2006, 2008).

In addition, frowns in the congruent condition and smiles in the incongruent condition both signaled unfavorable outcomes, that is, one's loss in the card game. Although it remains controversial whether N170 is associated not only with the structural encoding of faces but also affected by emotional expressions, a number of recent studies have reported emotional modulation of N170 amplitude (Ashley, Vuilleumier, & Swick, 2004; Batty & Taylor, 2003; Campanella et al., 2002; Eger et al., 2003; Miyoshi et al., 2004; Pizzagalli et al., 2002). The larger N170 amplitude for frowns in the congruent than in the incongruent conditions, and the larger amplitude for smiles in the incongruent than the congruent conditions, therefore, may represent negative emotional processes associated with one's outcome rather than emotions perceived in the coplayer. This interpretation of self-related processes of N170 was further supported by the additional statistical comparison rendering it unlikely that N170 was modulated by the other player's out-

come. Thus, when the motivational impact of others' facial expressions contradicts those of the observer, emotional facial expressions might be processed automatically and preferentially in association with one's own affective values as early as about 200 ms after stimulus onset. A similar motivational influence on N170 amplitude was recently observed in the domain of verbal information processing and social categorization, revealing larger N170 elicited by negative adjectives (Montalan et al., 2008).

In previous two-player gambling games, MFN was elicited by the sight of the opponent's loss not only in a cooperative situation but also when the opponent's loss was beneficial to the observer (Fukushima & Hiraki, 2006; Koban et al., 2010). A recent fMRI study also found that activation in the medial frontal cortex was enhanced for errors when an observed error resulted in a gain for the participant (de Bruijn et al., 2009). The larger MFN amplitudes for frowns in the incongruent condition, which signaled "gain" for the self and "loss" for the other are in line with these findings. Notably, the examination of post-experimental subjective feelings about one's own outcome revealed that the magnitude of MFN observed during positive inequity was associated with a pleasant feeling. This might be related to the experience of Schadenfreude. Together with previous fMRI studies (Cikara et al., 2011; Singer et al., 2006; Takahashi et al., 2009), the current findings indicate that we might not only be predisposed to show concern for others. In certain social settings, pleasure at the sight of another's misfortune might also be an inescapable part of human nature manifesting itself as rapidly as 210 ms after stimulus onset, as indicated by MFN. Although MFN is sensitive to the sight of failure, the psychological impact for the observer is indeed self-related "pleasantness," as is indicated by our correlation analyses. Notably, a similar relationship between MFN and favorable outcomes for the self has recently been demonstrated by intracerebral EEG recordings from dACC/MCC (Jung et al., 2010).

Finally, it might be argued that the observed MFN can be explained by account of conflict detection, because MFN was also reported in studies on conflict detection (Botvinick et al., 2001; Holroyd & Coles, 2002). However, if the detection of conflict accounted for larger MFN for frowns in the incongruent condition, smiles in the incongruent condition should have elicited larger MFN than in the congruent condition as well. Because this was not observed, it renders generalized conflict detection an unlikely explanation of the current findings.

While most of the recent neuroscientific investigations have predominantly assessed the neural mechanisms of sharing emotions, everyday social life is full of situations in which we interact with others in a counterempathic setting. The current findings extend pioneering psychophysiological findings by Lanzetta and colleagues to the domain of modulated neural responses. We have shown a reversed pattern of facial processing between congruent and incongruent conditions over the temporal cortex as reflected by N170, for an ERP component that has been repeatedly related to face processing. This suggests that top-down processes, such as contextual appraisal and motivation, have a substantial impact on early sensory processing. Notably, MFN during positive inequity seems to signal the losses (and errors) of others accompanied with pleasant feelings

related to one's winning in face of the other's loss. The latter finding indicates that competitive situations result in counter-empathic responses, triggering Schadenfreude for negative outcomes of others during positive inequity. This newly detected evidence for counterempathic responding is well in line with accumulating recent evidence from social neuroscience arguing for a strong malleability of affective responses to the emotions of others (e.g., Cheng et al., 2007; Decety, Echols, & Correll, 2009; Decety, Yang, & Cheng, 2010; Lamm, Decety, & Singer, 2011; Lamm, Meltzoff, & Decety, 2010). Together, these findings provide strong support for multifaceted models of empathy (e.g., Decety, 2011; Decety & Jackson, 2004; Shamay-Tsoory, 2009; Singer & Lamm, 2009) proposing that empathy relies on a complex interplay between automatic, sensory-driven with controlled, reflective processes that are flexibly and rapidly recruited according to the context and goals of the ongoing social interaction.

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