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Psychopathy, Empathic Concern, and Emotional-Sentence Processing: An N400 ERP Study

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Abstract

Using an undergraduate sample, the present study examined how psychopathic traits (assessed by the Psychopathic Personality Inventory-Revised) and empathic concern (assessed by the Interpersonal Reactivity Index) affect emotional-information processing using event-related potentials (ERPs) and a sentential priming paradigm. Participants had their electroencephalogram (EEG) recorded while they silently read sentences with three types of endings: congruent, incongruent, and emotionally negative. We hypothesized that participants with high levels of psychopathic traits and participants with low levels of empathic concern would find the emotionally negative sentence endings less unexpected and disturbing (yielding a smaller N400), compared to participants with low levels of psychopathic traits and participants with high levels of empathic concern. Although results indicated no significant difference in N400 amplitude between the high and low PPI-R groups across sentence types, there were significant differences between the high and low Empathic Concern (EC) groups. Both EC groups showed the typical semantic priming effect (smaller N400s for congruent compared to incongruent sentence endings); however, for the high EC group, the emotionally negative sentence endings elicited large N400s, similar in amplitude to the N400s elicited by the incongruent endings. In contrast, for the low EC group, the emotionally negative sentence endings elicited small N400s, similar in amplitude to the N400s elicited by the congruent endings. Given that the N400 is believed to index the difficulty with which a word is retrieved from semantic memory, our data suggests that individuals low in empathic concern for others did not find the emotionally negative sentences particularly disturbing.

Keywords: psychopathy, empathy, empathic concern, N400, ERP, emotional processing

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Psychopathy and Affect

Psychopathy is a personality construct characterized by a distinct cluster of affective (e.g., shallow emotions, lack of empathy and remorse, callousness), interpersonal (e.g., manipulative, superficial charm), behavioral (e.g., impulsivity, irresponsibility), and lifestyle (e.g., sensation seeking, antisocial behavior) traits. Psychopathy shares some overlapping features with the diagnosis of Antisocial Personality Disorder (ASPD; American Psychiatric Association, 2013), but whereas the diagnostic criteria for ASPD are predominantly behaviorally focused, the construct of psychopathy encompasses core affective and interpersonal features, in addition to behavioral indicators. Although there is ongoing debate among researchers regarding the centrality of criminal/antisocial behavior to the construct of psychopathy (e.g., Hare & Neumann, 2010; Skeem & Cooke, 2010), there is general agreement that the affective and interpersonal traits are fundamental to the psychopathic personality.

In his seminal work, *The Mask of Sanity*, Cleckley (1941) observed that psychopathic individuals demonstrate an absence of nervousness, a lack of remorse and shame, and an incapacity for love or the formation of deep interpersonal relationships. Cleckley further remarked that although psychopathic individuals may at times put on theatrical displays of emotion, these emotional displays are largely superficial, and lack the intensity and depth of emotions experienced by normal, non-psychopathic individuals. In *Without Conscience,* Hare (1993) expanded on the type of affective dysfunction associated with psychopathy. Regarding their cardinal lack of empathy, Hare posited that psychopathic individuals can only understand others' emotions from a strictly intellectual standpoint; they are not able to actually feel them.

Thus, Hare advised that psychopathic individuals are unable to describe their emotions in detail or distinguish subtle differences among them. Hare also noted that psychopathic individuals tend to lack the normal physiological reactions typically associated with emotional states (e.g., increased electrodermal and cardiovascular activity when anxious; Ogloff & Wong, 1990). A number of neurobiological theories have been proposed to account for the atypical affective functioning associated with psychopathy (e.g., Blair, 2005; Glenn & Raine, 2008; Kiehl, 2006). Although the models differ in their focus on various brain structures, they share the opinion that the affective deficits of psychopathy cannot be traced to a single neurobiological cause.

Research examining the affective deficits of psychopathy has traditionally focused on criminal psychopaths or offender populations; however, recent years have seen a substantial increase in studies using non-criminal samples. Psychopathy research has thus evolved to view the construct as dimensional, rather than strictly categorical (Hall & Benning, 2006; Skeem, Poythress, Edens, Lilienfeld, & Cale, 2003), and self-report measures like the Psychopathic Personality Inventory-Revised (PPI-R; Lilienfeld & Widows, 2005) have allowed for the assessment of psychopathic traits in non-criminal populations like community members and undergraduate students. Notably, many of the affective deficits first documented in studies using criminal psychopaths (e.g., abnormal startle modulation patterns to emotional stimuli; Levenston, Patrick, Bradley, & Lang, 2000; Patrick, Bradley, & Lang, 1993; Sutton, Vitale, & Newman, 2002) have since been replicated in studies using non-criminal samples (e.g., Benning, Patrick, & Iacono, 2005; Justus & Finn, 2007; Vanman, Mejia, Dawson, Schell, & Raine, 2003). These findings support the contention that the emotional blunting associated with psychopathy is central to the construct, as it is present even in non-criminal samples with sub-clinical levels of psychopathic traits.

It is possible that the antisocial tendencies commonly associated with psychopathy are developed in part as a consequence of their emotional and empathic poverty. As Hare (1993) remarked, socialization processes depend to some degree on fear of punishment, the experience of shame and guilt, and the ability to think about and be motivated by the feelings of others. If psychopathic individuals do not have the emotional repertoire to experience fear, guilt, or attachment to others, efforts at socialization may be ineffective, and their conscience or other internal controls may fail to properly develop. If emotional poverty is indeed at the root of psychopathy and its connection to antisociality, it is important to continue studying the affective experience of individuals with psychopathic traits in order to better understand the breadth and the nuances of their affective dysfunction. The current study builds upon this research by investigating psychopathy-related differences in emotional processing using linguistic stimuli and an undergraduate sample.

Psychopathy and Emotional-Language Processing

Of particular relevance to the present study is research that focuses on how psychopathic traits affect the ability to process emotional words. Cleckley (1941) theorized that psychopathic individuals may experience what he described as a form of "semantic aphasia" or "semantic dementia," in which they are able to understand the literal or denotative aspects of words, but not the words' emotional or connotative meanings. As Johns and Quay (1962) famously remarked, "the psychopath… knows the words but not the music" (p. 217). The linguistic cues that provoke strong emotional reactions in non-psychopathic individuals are therefore theorized to evoke little or no emotional response from psychopathic individuals (Patrick, 1994). According to Cleckley, this may be due to a lack of prior association between strong emotional reactions and affectively-charged words. It may also account for the discordance between psychopathic individuals' expressed experiences of emotion (i.e., what they say they feel) and their actual experiences of emotion (i.e., what they actually feel). Hare, Williamson, and Harpur (1988) found support for Cleckley's theory regarding psychopathic individuals' atypical processing of emotional words. In their study of word matching with 23 male inmates, participants were presented with word triads (e.g., *foolish*, *shallow*, *deep*) and asked to select the two words that were closest in meaning. Whereas the non-psychopathic group matched words based on their emotional characteristics (e.g., *foolish* and *shallow*, which both carry negative connotations), the psychopathic group matched words according to their non-emotional, literal meanings (e.g., *shallow* and *deep*, which both describe depth).

Support for atypical processing of emotional words in psychopathy has been established by other studies as well. Day and Wong (1996) found that male inmates with psychopathy (n = 20) responded faster to negative emotional words when they were presented to the right visual field using hemifield presentation, than to the left visual field. In healthy individuals, the brain's right hemisphere is believed to play a dominant role in processing emotional stimuli and the connotative aspects of language, whereas the left hemisphere is thought to be more analytically-oriented, and predominates in processing the denotative aspects of language (Badzakova-Trajkov, Corballis, & Haberling, 2016; Borod, Andelman, Obler, Tweedy, & Welkowitz, 1992; Day & Wong, 1996; Ross, 2010). The non-psychopathic male inmates (n = 20) showed the expected right-hemisphere advantage when processing negative emotional words, as evidenced by higher accuracy and faster reaction times for words presented in the left visual field. In contrast, the psychopathic group demonstrated a right visual field advantage for the emotional words, indicating a more dominant role of the left hemisphere. Given the hemispheric specialization related to language processing (Badzakova-Trajkov et al., 2016; Borod et al., 1992; Day & Wong, 1996; Ross, 2010), these results are in line with the observations of Hare et al. (1988); psychopathic individuals appear not to process or attend to the emotional facets of language, and are instead predominantly focused on the literal meaning of words.

Blair et al. (2006) examined whether psychopathy modulated affective and semantic priming with a sample of 52 male prisoners. Priming paradigms are used to explore how concepts are represented and connected in semantic memory (Federmeier & Kutas, 1999). In the affective priming task, participants were presented with emotionally congruent prime-target word pairs (e.g., *song-love*) and emotionally incongruent prime-target word pairs (e.g., *bomb-love*), and indicated whether the target word was positive or negative. In the semantic priming task, participants were presented with categorically-related (e.g., *dog*, *cat*) or categorically-unrelated (e.g., *apple*, *cat*) pairs of animals and fruits/vegetables, and indicated whether the target word was an animal or a fruit/vegetable. In these priming paradigms, the degree to which the second (target) word is related to the first (prime) word in semantic memory determines whether reaction time to the target word is facilitated (i.e., for congruent or related prime and target words) or inhibited (i.e., for incongruent or unrelated prime and target words; Blair et al., 2006). Although there were no differences between the psychopathic and non-psychopathic groups for the semantic priming task, the groups differed on the affective priming task. The non-psychopathic group demonstrated the expected pattern of results: their reaction times were facilitated for congruent emotional word pairings, and inhibited for incongruent pairings. However, reaction time was not modulated by the congruency of the emotional words in the psychopathic group. These results indicate that psychopathy may be related to intact semantic priming, but reduced affective priming. The authors therefore suggested that the language-processing deficits of psychopathy may be selectively limited to emotional words. Of note, the psychopathic group was able to correctly classify the emotional target words as either positive or negative, indicating that although psychopathic individuals may have linguistic knowledge regarding the definitions of emotional words, their emotional responses to the words are still reduced. These findings clearly support the contention put forward by Johns & Quay (1962) that psychopathic individuals “know the words, but not the music” (p. 217).

Results from a single photon emission computerized topography (SPECT) study conducted by Intrator et al. (1997) offer a different perspective: psychopathic individuals may actually require additional cognitive resources to process emotional words. In this lexical decision task, 17 men (8 of whom were classified as psychopathic) from an inpatient substance abuse program and 9 controls were presented with letter-strings and indicated whether or not each one formed a real word. Half of the letter-strings were real words, and half were pronounceable non-words. Of the real words, half were neutral (e.g., *carpet*, *ounce*) and half were emotionally negative (e.g., *corpse, torture*). All three groups showed the typical pattern (Strauss, 1983) of faster reaction times to emotional words compared to neutral words, and there were no differences among the groups in terms of their performance. However, the SPECT cerebral blood flow (rCBF) findings varied significantly. Whereas the non-psychopathic and control groups demonstrated greater activation (i.e., increased rCBF) in the frontal temporal cortex and subcortical regions for neutral words, the psychopathic group demonstrated greater activation in these regions for the emotional words. The authors concluded that, because of their emotional deficits, psychopathic individuals may have required additional cognitive resources to process emotional words. In contrast, in non-psychopathic individuals, the emotional connotations of the words facilitated their decision-making, thus resulting in less cognitive activation for affective compared to neutral words.

Event-Related Potentials (ERPs)

Event-related potential (ERP) studies provide another source of empirical evidence for the emotional blunting and atypical affective functioning associated with psychopathy. ERPs are very small voltages generated in the brain in response to specific events or stimuli (such as reading emotional words), which are recorded using electroencephalography (EEG) (Luck, 2005). Because ERPs are time-locked to stimulus presentation, the non-stimulus specific background EEG can be cancelled out by averaging the brain's response to multiple stimuli, making the ERPs more prominent (Luck, 2005). The amplitude and latency of the ERPs can then be used to examine how psychopathy affects the neural correlates associated with emotional processing (Luck, 2005). Specific ERP components (e.g., N400) are named for their direction (i.e., N connotes a negative-going wave, and P connotes a positive-going wave), and when they occur after stimulus presentation (e.g., the N400 wave is a negative wave that occurs 400 ms after the presentation of a word or picture), and are thought to reflect various cognitive processes (Luck, 2005). ERPs are known for their high temporal resolution, and they are particularly useful for studying the timing of neural processes (Luck, 2005). Furthermore, ERPs can offer a more objective measure of stimulus processing than behavioral measures (e.g., reaction time, accuracy), which may be more susceptible to biased responding or other confounding factors (Luck, 2005).

Early ERP studies investigating the neural correlates of emotional-language processing may have been confounded by using a very small number of electrodes (often over non-language areas of the brain), and by having participants make verbal responses, which contaminate the ERPs with muscle movement artifacts. However, their findings suggest that in healthy subjects, ERPs elicited by words with emotional connotations (e.g., taboo words or words rated as extremely bad or good; Begleiter & Platz, 1969; Chapman, McCrary, Chapman, & Bragdon, 1978; Chapman, McCrary, Chapman, & Martin, 1980) can be differentiated from ERPs elicited by non-emotional words. More recently, both the N400 and a later slow wave—the LPP—have been shown to be modulated by the affective content of words in healthy participants (Holt, Lynn, & Kuperberg, 2009; Kanske & Kotz, 2007; Van Berkum, Holleman, Nieuwland, Otten, & Murre, 2009).

Previous studies with healthy participants have shown that hearing or reading a word reliably elicits an N400 ERP (Kutas & Federmeier, 2000; Kutas & Hillyard, 1984; Luck, 2005). The N400 is a negative wave that peaks about 400 ms after stimulus presentation, and is maximal over the centroparietal region of the scalp (Kutas & Federmeier, 2000; Kutas & Hillyard, 1984; Luck, 2005). N400 waves can be elicited from single words, word-pairs, and sentences (Federmeier & Kutas, 1999; Kutas & Federmeier, 2000, Kutas & Hillyard, 1984). The amplitude of the N400 is dependent on the degree of activation required to retrieve the information from semantic memory, with more unexpected or unfamiliar words eliciting larger (i.e., more negative) N400s (Kutas & Federmeier, 2000; Kutas & Hillyard, 1984). In N400 sentential priming paradigms, predictable, or expected, final words in a sentence yield smaller (i.e., less negative) N400s, while unpredictable final words yield larger N400s (reflecting difficulty in integrating the final word into the context of the sentence; Kutas & Federmeier, 2000; Kutas & Hillyard, 1984).

N400 studies using healthy participants to examine emotional-language processing have found somewhat inconsistent results, which may be partly due to the different paradigms used across studies. Specifically, it appears that emotional words that are presented in isolation may be processed differently than when they are presented in the context of other words (i.e., in a word pair) or in a sentence (Holt et al., 2009). Holt et al. (2009) found words that added negative or positive emotional content to a sentence (e.g., "Cheryl's baby cried when she took him to bed. She quieted him with a *drug* [or *lullaby*].") elicited larger N400s compared to words that added neutral content (e.g., "Cheryl's baby cried when she took him to bed. She quieted him with a *pacifier*."). The authors suggested this may be because it was more difficult for participants to integrate the emotional words than neutral ones, because the preceding sentence had a neutral context. Research from Van Berkum et al. (2009) supports the assertion that emotional words may sometimes require more effort to process than neutral ones; they found words that made a sentence morally offensive (e.g., "I think euthanasia is an *acceptable* course of action.") elicited larger N400s compared to words that made the sentence morally acceptable (e.g., "I think euthanasia is an *unacceptable* course of action.") sentences. The authors theorized that the morally offensive sentences produced stronger emotional reactions compared to the morally acceptable sentences, and this heightened state of arousal led participants to more consciously attend to the sentence (resulting in increased neural effort and a larger N400). However, another N400 study found contradicting results. In a lexical decision task in which participants had to classify letter strings as real words or non-words, Kanske and Kotz (2007) reported smaller N400 amplitudes (and shorter reaction times) in response to positive and negative emotional words compared to neutral words. As Holt et al. (2009) suggested, these results imply that when emotional words are presented without context, their emotional content facilitates semantic processing. In contrast, when an emotional word is presented within the context of an otherwise neutral sentence (Holt et al., 2009; Van Berkum et al., 2009), the word's meaning is more surprising; it therefore requires more effort for retrieval from semantic memory, and produces a larger N400.

Another ERP reported relatively often in studies of emotional-language processing is the Late Positive Potential (LPP). The LPP is a slow, positive-going wave, maximal over the centroparietal regions of the scalp (Hajcak, MacNamara, & Olvet, 2010). The LPP begins as early as 200 ms after stimulus presentation, and lasts for the duration of the stimulus (Hajcak et al., 2010). The LPP is thought to index the amount of attention and cognitive effort expended in processing a stimulus (Kok, 2001; Lang & Bradley, 2010), and in healthy subjects, its amplitude is generally larger for emotional linguistic stimuli than for neutral linguistic stimuli (Holt et al., 2009; Kanske & Kotz, 2007; Van Berkum et al., 2009).

Psychopathy and ERP Studies of Emotional Language Processing

Early ERP studies using lexical decision tasks found that psychopathic individuals failed to show the same ERP differentiation between affective and non-affective words as non-psychopathic controls (Kiehl, Hare, McDonald, & Brink, 1999; Williamson, Harpur, & Hare, 1991). In their study of 16 male inmates, Williamson et al. (1991) found that the non-psychopathic group had faster reaction times and larger LPPs to emotional than to neutral words. In contrast, the psychopathic group responded faster to neutral compared to emotional words, and both neutral and emotional words elicited similar LPP amplitudes. However, the psychopathic and non-psychopathic groups both rated the affective valence of the words similarly (i.e., negative words were rated as bad and positive words were rated as good). In line with Johns and Quay's (1962) suggestion that "[they] know the words but not the music," (p. 217), the authors posited that although psychopathic individuals can understand that a word is emotionally positive or negative, affective words do not carry the same emotional or motivational significance as they do for non-psychopathic individuals.

In a similar vein, Kiehl et al. (1999) found no psychopathy-related differences in ratings when male inmates (*n* = 29) rated positive and negative words as pleasant or unpleasant. They also found that in the non-psychopathic group, negative emotional words elicited significantly larger LPPs than positive words, whereas the psychopathic group did not exhibit significant LPP modulation based on word type. The authors therefore suggested that the brains of psychopathic individuals may not discriminate between positive and negative affect in language.

Notably, in these two studies of emotional-language processing, Williamson et al. (1991) and Kiehl et al. (1999) both observed that their psychopathic groups had abnormally large N400 waves compared to their non-psychopathic groups. Williamson et al. (1991) interpreted this as indicating that the psychopathic group had greater difficulty processing all word meanings (emotional and neutral words) regardless of word type. However, in a later study, Kiehl, Laurens, Bates, and Little (2006) suggested that the large N400s reported by Williamson et al. (1991) and Kiehl et al. (1999) may not indicate atypical semantic processing per se, but may have been related to the demands of the decision-making tasks used. Both tasks employed in the earlier studies by Williamson et al. (1991) Kiehl et al. (1999) required participants to make an immediate decision and respond to the word to which the N400 was also measured. Decision-making and responding typically produce large positive potentials, and some have reported that these potentials are smaller in psychopathic individuals (Kiehl, Bates, Laurens, Hare, & Liddle, 2006; Kiehl, Hare, Liddle, & McDonald, 1999). Kiehl et al. (2006) suggested that the large N400s may therefore have been due to the overlap between the decision positivity and the semantic-specific N400. Other authors have also warned against using tasks in which response-related ERP components may overlap with the N400 (Deacon, Dynowska, Ritter, & Grose-Fifer, 2004). Indeed, when in a later study Kiehl et al. (2006) had participants respond one second after stimulus presentation, their psychopathic group did not demonstrate abnormally large N400s to neutral terminal words in sentences. Kiehl et al. (2006) also found that psychopathic offenders (*n* = 50) had intact semantic sentential priming for emotionally neutral sentences. Their priming paradigm used 100 sentences: half with a semantically congruent final word (e.g., "The referee blew the *whistle*."[1]) and half with a semantically incongruent final word (e.g., "The referee blew the *pizza*."), and participants indicated whether or not the sentence made sense. The psychopathic and non-psychopathic groups both had slightly higher accuracy for congruent sentence endings, and both groups displayed larger N400s for the incongruent sentence endings. Moreover, there were no differences in accuracy or N400 amplitude between the psychopathic and non-psychopathic groups. The results suggest that semantic processing is not necessarily dysfunctional for psychopathic individuals; however, Kiehl et al. (2006) did not utilize emotional words in their paradigm. It may be that psychopathic individuals have intact semantic processing, but atypical processing of affective language. This notion is further supported by the findings from Intrator et al. (1997) and Blair et al. (2006), which suggest that the language-processing deficits observed in psychopathic individuals are not all-encompassing, and may be present only for emotional words.

In light of the limited research using ERP designs to investigate psychopathy and affective processing (especially related to linguistic stimuli and the N400), further research is needed to better understand the neural correlates of the emotional blunting and shallow affect associated with psychopathy. Additionally, given the importance of internalized speech and its affective power in the development of a conscience and general self-control (developmental areas which are theorized to be weak or absent in psychopathy; Eisenberg, 2000; Hare, 1993;

[1] The authors did not provide sample stimuli in their article. The examples given illustrate typical types of sentence stem and terminal word pairings used in semantic priming paradigms.

Kochanska & Thompson, 1997; Williamson et al., 1991), it is helpful to further investigate emotional-language processing in psychopathic individuals. The N400 is a useful and reliable indicator of the amount of neural effort employed during semantic processing (Kutas & Federmeier, 2000; Kutas & Hillyard, 1984), and can therefore be used to index psychopathy- and empathy-related differences in the processing of emotional-language. The N400 is thought to reflect relatively automatic processes related to semantic memory access, and therefore, is less likely to be modulated by top-down processes such as increased cognitive effort (Deacon et al., 2004). Furthermore, given the increasing recognition of the heterogeneity of psychopathy, it is important to continue investigating affective processing with non-criminal samples, as the majority of research in this area has focused on criminal samples. The current study extended this investigation to the processing of emotional words, using ERPs and an N400 sentential priming paradigm with a sample of undergraduate students.

Current Study

By recording EEG during a sentential priming paradigm, the current study investigated emotional information processing (reflected by N400 amplitude) in undergraduate students classified as having high and low levels of psychopathic traits (measured by the PPI-R). In addition, participants were also classified as having high and low levels of empathic concern (measured by the Interpersonal Reactivity Index; Davis, 1980), as this construct is closely related to psychopathy and may be an even better predictor of blunted responses to emotional stimuli. Participants read sentences with three different types of endings: congruent (e.g., “I like to watch puppies *play*.”), incongruent (e.g., “I like to watch puppies *vote*.”), and emotionally negative (e.g., “I like to watch puppies *burn*.”), while their EEG was recorded. Although other linguistic ERP studies have found psychopathy-related effects reflected in the amplitudes of both the LPP and the N400, we optimized our study design to measure the N400 by using a short stimulus duration. Therefore, we could not measure the LPP.

We hypothesized that participants with high psychopathic traits and participants with low empathic concern would find the emotionally negative sentence endings less unexpected and disturbing than participants with low psychopathic traits and participants with high empathic concern. For participants with high psychopathic traits and participants with low empathic concern, we expected that the N400 amplitudes elicited by the congruent and emotionally negative sentence endings would be similar to one another, and significantly smaller than the N400s elicited by the incongruent endings (indicating less difficulty in retrieving these words from semantic memory). In contrast, we hypothesized that participants with low psychopathic traits and participants with high empathic concern would find the emotionally negative sentence endings more unexpected and disturbing, resulting in more difficulty in retrieving the meanings from semantic memory (as evidenced by larger N400 amplitudes). For these participants, we expected that the N400 amplitudes elicited by the incongruent and emotionally negative sentence endings would be similar to one another, and significantly larger than the N400s elicited by the congruent endings.

Methods

Research Design

The current study consisted of two parts. Part 1 comprised self-report surveys to assess various personality traits (i.e., psychopathy, empathy, anxiety. This part of the study was designed to recruit a subset of participants for the ERP study (Part 2) who scored relatively high or low on the PPI-R. Part 2 utilized electroencephalogram (EEG) recordings to assess participants’ neural activity while they read three different types of sentences.

Participants

Participants were recruited from a North-Eastern university in the United States in exchange for course credit. Inclusion criteria were as follows: 18 years of age or older, fluent in English before age 8, no uncorrected vision problems, and no recent history of psychological and/or neurological disorders.

Part 1. One-hundred thirty participants completed Part 1. Participants' ages ranged from 18 to 36 years, with a mean age of 19.91 years (*SD* = 2.96). Participants were 80.8% female (*n* = 105) and 19.2% male (*n* = 25). One-third of participants (27.7%) identified their race/ethnicity as Caucasian (*n* = 36), 50.0% identified as Hispanic (*n* = 65), 18.5% identified as African American (*n* = 24), 10.0% identified as Asian (*n* = 13), and 11.5% identified as Other (*n* = 15)[2]. The majority of participants (76.9%) reported English as their first language (*n* = 100), and 23.1% of participants reported another language as their first (*n* = 30).

Participants were excluded from Part 2 if they scored 45 or above on the Trait scale of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983); scored 65 or above on the Deviant Responding scale of the PPI-R; or scored 45 or above on the 40-item Inconsistent Responding scale of the PPI-R. All other participants were invited to participate in Part 2 of the study.

Part 2. Twenty-seven participants completed Part 2. Participants' ages ranged from 18 to 25 years, with a mean age of 19.11 years (*SD* = 1.55). Participants were 74.1% female (*n* = 20) and 25.9% male (*n* = 7). A quarter of participants (25.9%) identified their race/ethnicity as Caucasian (*n* = 7), 63.0% identified as Hispanic (*n* = 17), 3.7% identified as African American (*n* = 1), 11.1% identified as Asian (*n* = 3), and 3.7% identified as Other (*n* = 1). The majority of

[2] Percentages do not total 100% because participants were allowed to select more than one race/ethnicity.

participants (77.8%) reported English as their first language ($n = 21$), and 22.2% of participants ($n = 6$) reported another language as their first.

Participants were separated into High PPI-R and Low PPI-R groups based on their PPI-R Total *t*-scores. Participants who scored above the median (*t*-score = 54) of the full sample from Part 1 were included in the High PPI-R group ($n = 13$), and those who scored at or below the median were included in the Low PPI-R group ($n = 14$). The High PPI-R group's Total PPI-R *t*-scores ranged from 56 to 76, and the Low PPI-R group's Total PPI-R *t*-scores ranged from 32 to 48. The mean Total PPI-R *t*-score of the High PPI-R group ($M = 62.69$, $SD = 7.41$) was significantly higher than the mean of the Low PPI-R group ($M = 41.86$, $SD = 4.67$), $t(25) = 8.81$, $p < .001$, $d = 0.553$.

We also classified participants according to their IRI Empathic Concern (EC) scores, as this subscale is purported to assess emotional empathy (Davis, 1983). Participants were separated into High EC and Low EC groups based on their IRI EC scores. Participants who scored above the median (score = 20) of the full sample from Part 1 were assigned to the High EC group ($n = 15$), and those who scored at or below the median were assigned to the Low EC ($n = 12$). The High EC group's IRI EC scores ranged from 21 to 28, and the Low EC group's IRI EC scores ranged from 14 to 20. The mean IRI EC score for the High EC group ($M = 24.27$, $SD = 2.01$) was significantly higher than the mean score for the Low EC group ($M = 17.50$, $SD = 1.93$), $t(25) = 8.65$, $p < .001$, $d = 1.736$.

Demographic information for the High and Low PPI-R and EC groups are displayed in Table 1. *T*-tests and chi squares (using Fisher's exact test) revealed no significant differences in mean age, race/ethnicity, or language between the comparative groups (all *p*s > .10).

Measures

Demographics. Participants completed a basic demographic information questionnaire. Participants also reported any history of psychological or neurological problems, the age at which they became fluent in English (if not their first language), and if they had any uncorrected vision problems.

State-Trait Anxiety Questionnaire (STAI; Spielberger et al., 1983). The STAI is a self-report measure of state and trait anxiety. Participants read statements describing various emotional states and indicate how often they generally experience them. Responses are given on a 4-point Likert scale ranging from 1 (Almost Never) to 4 (Almost Always). For the current study, the 20-item Trait scale was used to screen for high levels of anxiety. Participants were excluded from the final sample if they scored 45 or higher[3], to avoid potential confounding effects of anxiety on the ERPs. The STAI is reported to have good to excellent internal consistency, with Cronbach's alphas ranging from .86 to .95 (Spielberger et al., 1983). In the present study, Cronbach's alpha was .84 for the ERP sample.

Interpersonal Reactivity Index (IRI; Davis, 1980). The IRI is a 28-item self-report measure of empathy. Participants read statements regarding their thoughts and feelings in various situations. Responses are given using a 5-point Likert scale ranging from 0 (Does Not Describe Me Well) to 4 (Describes Me Very Well). The IRI consists of four subscales: Perspective Taking (PT; i.e., ability to adopt the perspective of others); Fantasy (FS; i.e., tendency to become immersed in fictional worlds depicted in books, movies, or plays); Empathic Concern (EC; i.e., feelings of concern or sympathy for others' misfortune); and Personal Distress (PD; i.e., feelings of anxiety in stressful situations). The IRI scales are reported to have

[3] This is approximately one standard deviation above the mean for working adults (men M = 34.89, SD = 9.19; women M = 34.79, SD = 9.22) reported by Speilberger et al. (1983).

acceptable internal consistency, with Cronbach's alphas ranging from .70 to .78 (Davis, 1980). The EC scale was used in the present study, with a Cronbach's alpha of .76 for the ERP sample.

Psychopathic Personality Inventory-Revised (PPI-R; Lilienfeld & Widows, 2005). The PPI-R is a 154-item self-report measure of psychopathic personality traits. Respondents are presented with a statement and asked to indicate the degree of their agreement with the item on a 4-point Likert scale ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). Higher scores are indicative of higher levels of personality traits associated with psychopathy. Along with a total score, the PPI-R gives scores for eight subscales: Machiavellian Egocentricity (ME; i.e., manipulative, selfish, feelings of superiority), Rebellious Nonconformity (RN; i.e., defiance of norms, easily bored), Blame Externalization (BE; i.e., failure to accept personal blame; hostile perception of the world), Carefree Nonplanfulness (CN; i.e., impulsive, lack of forethought), Social Influence (SOI; i.e., socially dominant, self-confident), Fearlessness (F; i.e., risk-taking), Stress Immunity (STI; i.e., calm under pressure, lack of anxiety), and Coldheartedness (C; i.e., callous, lack of empathy and guilt). Of these subscales, seven can be combined to create two factors: Fearless Dominance (FD; includes SOI, F, and STI) and Self-Center Impulsivity (SCI; includes ME, RN, CN, and BE). Coldheartedness is not included in either FD or SCI, and is considered its own factor (Benning, Patrick, Hicks, Blonigen, & Krueger, 2003). Participants' full scale and factor-level *t*-scores (converted using PAR, Inc. PPI-R software) were utilized in subsequent analyses.

The PPI-R also includes scales to detect careless and inconsistent responding. High scores on the Deviant Responding (DR) scale may be indicative of participants "faking bad" by endorsing bizarre items, or otherwise responding carelessly or inconsistently (Lilienfeld & Widows, 2005). Likewise, high scores on the Inconsistent Responding (IR) scale may indicate participants are responding carelessly or randomly, or are deliberately providing bizarre responses (Lilienfeld & Widows, 2005). In the present study, participants with *t*-scores of 65 or above on the DR scale, and 45 or above on the 40-item IR scale were excluded from the ERP sample in order to screen out potential careless or dishonest responding on the PPI-R (Lilienfeld & Widows, 2005).

The full PPI-R scale and its factors are reported to have acceptable to excellent internal consistency in community and college samples, with Cronbach's alphas of .93, .91, .92, and .78 for PPI-R Total, FD, SCI, and C, respectively (Lilienfeld & Widows, 2005). PPI-R Total, FD, and C *t*-scores were used in the present study, with Cronbach's alphas of .91, .89, and .72, respectively.

Part 1 Procedures

Participants provided signed informed consent prior to completing the self-report questionnaires. Participants were informed that they were participating in Part 1 of a two-part study. They were notified that based on their responses to the questionnaires they may be eligible to participate in Part 2 of the study, which entailed an EEG recording. Interested participants were asked to provide their email addresses so they could be contacted by the researchers if they qualified for Part 2. Part 1 took approximately 45-60 minutes to complete.

Part 2 Procedures

Participants provided signed informed consent prior to the start of the ERP experiment. The EEG was recorded using a Neuroscan Synamps RT amplifier and SCAN 4.4 acquisition software (Compumedics Neuroscan, Charlotte, NC). Participants were outfitted with an elasticized electrode cap (Quik-Cap; Compumedics Neuroscan, Charlotte, NC) and Quik-Gel conductive gel was applied to the scalp. The electrodes on the cap correspond to 62 standard scalp locations based on the International 10-20 system (Jasper, 1958). During recording, the electrode sites were referenced to a central midline electrode. All electrode impedances were below 11.4 kΩ. The EEG was recorded continuously, and digitized at 1000 Hz. Participants were instructed to remain as still as possible during the EEG recording in order to minimize noise or other artifacts. A research assistant monitored the ongoing EEG recording for equipment recording issues, artifacts due to participant movement, excessive blinking, and increased alpha rhythm due to falling asleep. The research assistant reminded participants to remain still or pay attention as needed. Part 2 took approximately 2-3 hours to complete.

Stimuli

The stimuli consisted of 80 sentence triplets. The sentence meanings were manipulated through the terminal word, which varied in terms of predictability and affect. A norming study (described below) was conducted prior to the current study in order to determine the cloze probability (CP) of the terminal words (i.e., the likelihood the word would be chosen to complete a sentence stem). Each sentence triplet comprised a sentence stem (e.g., "I like watching puppies…") followed by a terminal word. The terminal words were of three types: (1) *congruent* – a word with a relatively high CP that was semantically congruent with the sentence stem (e.g., "I like watching puppies *play.*"); (2) *incongruent* – a word with a CP of zero that was semantically incongruent with the sentence stem (e.g., "I like watching puppies *vote.*"); and (3) *emotionally negative* – a word with a CP of zero that conveyed an emotionally negative connotation (e.g., "I like watching puppies *burn.*"). Sentences were four to twelve words long (M = 7.35 words, SD = 1.58), and terminal words were balanced for length (M = 5.49 letters, SD = 1.61) and frequency (M = 43.00, SD = 70.84; Francis & Kucera, 1982) across the three types.

The 80 sentence stems combined with three different terminal words yielded a total of 240 sentences.

Cloze Probability (CP) Norming Study

CPs were calculated from a norming study that was conducted prior to the current study. Forty-four adults (16 men; 19-39 years old, *M* = 25.23 years, *SD* = 4.57) completed the norming study. None of these participants participated in the ERP study. The participants were shown 90 sentence stems compiled by the researchers. The sentence stems were written so that they could be completed with a terminal word that carried either an emotionally neutral connotation or an emotionally negative connotation. Participants were asked to complete each sentence with "the first word that comes to mind." Based on their responses, 80 of the 90 sentence stems were selected for use as stimuli. The mean CP for the congruent sentence endings was 44%, indicating that 44% of the participants in the norming study completed the sentence stems with these words. The CP for the congruent sentences was lower than in traditional N400 studies; however, this can be attributed to the way the sentence stems were written (Grose-Fifer, Hoover, Zottoli, & Rodrigues, 2011); the sentence stems had to be constructed in a less constrained manner to allow for the possibility of an emotionally negative ending. The incongruent and emotionally negative terminal words were chosen by the researchers so that no one from the norming study had selected these words as endings for the sentence stems (i.e., 0% CP).

ERP Task

Participants silently read sentences as they were presented one word at a time in the center of a Dell 1908 Flat Panel LCD monitor. Sentences were presented over eight blocks using ePrime 2.0 E-Run software (Psychology Software Tools Inc., Sharpsburg, PA). Each block contained 30 sentences presented in random order, and took approximately 6 minutes to complete. Participants were encouraged to rest between the blocks. Each sentence was preceded by a fixation point (+) for 500 ms, and each word in the sentence was displayed for 200 ms. After the presentation of the terminal word, a question mark (?) appeared for 1 s, followed by a probe word which was displayed for 6 s (or until the participant made a response). The probe word was either a noun or verb repeated from the previous sentence, or a new noun or verb. Participants were asked to press one mouse button if the probe word was a repeat, and the other mouse button if the probe word was not a repeat. This task was used to ensure that participants were attending to and reading the sentences. Because this task does not require an overt or immediate response to the terminal word (participants responded to the probe word 1 s after the terminal word was presented), overlap between decision-making ERP components and N400 activity was prevented. In the inter-trial interval, a screen with the words "Blink Now" was displayed for 2 s; participants were instructed to try and blink only when this screen was displayed to prevent contamination of the ERP by blink artifacts. Prior to beginning the experiment, five practice sentences were used to familiarize the participant with the task.

Sentence Rating Task

After completion of the ERP experiment, participants were again presented with all of the congruent and emotionally negative sentences in a different randomized order. For this task, the entire sentence was displayed at the same time (as opposed to one word at a time), and remained on the screen until a response was made. Participants were asked to press a number on the computer keyboard to indicate the degree to which they felt the sentence was "emotionally disturbing" using a 5-point Likert scale ranging from 1 (Not at All) to 5 (Very). Responses were logged using E-Prime 2.0 (Psychology Software Tools Inc., Sharpsburg, PA). This task provided a self-report measure of how emotionally disturbing the participant perceived the sentences to be.

Due to a technical error in recording responses, sentence rating data was available only for 23 of 27 participants.

ERP Analysis

ERP analyses were performed offline using Neuroscan SCAN 4.4 Edit software (Compumedics Neuroscan, Charlotte, NC). Sweeps consisted of 1201 data points, sampled from 200 ms preceding the terminal word to 1000 ms after its onset. The electrode sites were re-referenced to an average reference. The recorded EEG was filtered with a bandpass of 0.1 to 30 Hz (12 db/oct). Baseline correction was performed using the averaged EEG in the 200 ms interval before the terminal word was presented. Artifact rejection was used to exclude sweeps where the EEG exceeded ±50 μV. Individual averages were compiled for each sentence ending type, and grand averages were created for each sentence type for the High PPI-R, Low PPI-R, High EC, and Low EC groups separately. The N400 was calculated using the mean amplitude from 250 to 450 ms after the onset of the terminal word. This time window was chosen because it represents 100 ms on either side of the N400 grand average peak (350 ms).

Statistical Analyses

Sentence ratings. Repeated measures MANOVAs were performed using a within-subjects factor of Sentence Type (congruent, emotionally negative) and a between-subjects factor of PPI-R Group (High PPI-R, Low PPI-R) or EC Group (High EC, Low EC) for sentence ratings.

N400 amplitude. Repeated measures MANOVAs were performed using within-subjects factors of Sentence Type (congruent, incongruent, emotionally negative) and Electrode (FC1, FCZ, FC2, C1, CZ, C2, CP1, CPZ, CP2, P1, PZ, P2), and a between-subjects factor of PPI-R Group (High PPI-R, Low PPI-R) or EC Group (High EC, Low EC). Planned comparisons were made between the three sentence types for the High PPI-R, Low PPI-R, High EC, and Low EC groups separately, and for each sentence type across PPI-R and EC Group.

Statistical reporting. For ease of interpretation, for all measures, when Levene's test for equality of variances was significant ($p > .05$) for *t*-tests, we reported the uncorrected degrees of freedom along with the adjusted *t*- and *p*-values. Likewise, when Mauchly's test of sphericity was significant ($p > .05$) for MANOVAs and ANOVAs, we applied a Greenhouse-Geisser correction; the uncorrected degrees of freedom are reported along with the adjusted *p*-value.

Results

Correlations

Correlations among the mean scores of the ERP sample for PPI-R Total, PPI-R FD, PPI-R C, and IRI EC are displayed in Table 2. Unexpectedly, PPI-R and IRI EC scores were not significantly correlated, although PPI-R C showed a trend toward a negative correlation with IRI EC, $r = -0.36$, $p = .067$.

ERP Task Accuracy

Participants' accuracy for the attentional task was high overall, ranging from 90-100% ($M = 97.57$, $SD = 3.12$). The high accuracy confirms that participants were attending to and reading the sentences. There were no significant differences in accuracy between the High PPI-R ($M = 97.08$, $SD = 3.32$) and Low PPI-R groups ($M = 98.04$, $SD = 2.96$), $t(25) = -.793$, $p = .435$, $d = 0.097$, or between the High EC ($M = 96.80$, $SD = 3.87$) and Low EC groups ($M = 98.54$, $SD = 1.43$), $t(25) = -1.610$, $p = .124$, $d = 0.187$.

Sentence Ratings

Mean sentence ratings of the congruent and emotionally negative sentence endings for the High PPI-R, Low PPI-R, High EC, and Low EC groups are displayed in Table 3.

PPI-R groups. When we classified participants in terms of their PPI-R Total scores, there was a significant main effect of Sentence Type, $F(1, 21) = 220.932$, $p < .001$, $\eta_p^2 = .913$. The emotionally negative sentence endings were rated as significantly more emotionally disturbing (*M* = 3.96, *SD* = 1.10) than the congruent sentence endings (*M* = 1.20, *SD* = 0.16). There was also a significant main effect of PPI-R Group, $F(1, 21) = 8.280$, $p = .009$, $\eta_p^2 = .283$. The High PPI-R group rated the sentence endings as significantly less emotionally disturbing (*M* = 2.29, *SD* = 0.66) than the Low PPI-R group (*M* = 2.91, *SD* = 0.29) than the High PPI-R group (*M* = 2.29, *SD* = 0.66). This was qualified by a significant interaction effect between Sentence Type and PPI-R Group, $F(1, 21) = 7.766$, $p = .011$, $\eta_p^2 = .270$. Post hoc ANOVAs revealed that the High PPI-R group rated the emotionally negative sentence endings as significantly less emotionally disturbing (*M* = 3.42, *SD* = 1.24) than the Low PPI-R group (*M* = 4.56, *SD* = 0.47), $F(1, 21) = 8.205$, $p = .009$, $\eta_p^2 = .281$. In contrast, there was no significant difference in ratings for the congruent sentence endings between the High PPI-R (*M* = 1.16, *SD* = 0.13) and Low PPI-R groups (*M* = 1.25, *SD* = 0.17), $F(1, 21) = 2.326$, $p = .142$, $\eta_p^2 = .100$.

EC groups. As expected from above, when participants were grouped according to their IRI EC scores, there was a significant main effect of Sentence Type, $F(1, 21) = 152.925$, $p < .001$, $\eta_p^2 = .879$. However, there was no main effect of EC Group $F(1, 21) = 0.189$, $p = .668$, $\eta_p^2 = .009$, and no interaction effect between Sentence Type and EC Group, $F(1, 21) = 0.929$, $p = 0.346$, $\eta_p^2 = .042$.

N400 Amplitude

The N400 was largest on the centroparietal region of the scalp. Mean N400 amplitudes for the three different sentence endings are shown in Table 4 for the High and Low PPI-R and

EC groups. See Figure 1 for the grand averages of the N400 amplitude (measured at electrode CZ) for the High and Low PPI-R groups, and Figure 2 for the grand averages for the High and Low EC groups.

PPI-R groups. There was a significant main effect of Sentence Type, $F(2, 50) = 13.223$, $p < .001$, $\eta_p^2 = .346$ for N400 amplitude. Planned contrasts showed that the incongruent sentence endings elicited significantly larger (i.e., more negative) N400 amplitudes ($M = -0.203$, $SD = 0.85$) than both the emotionally negative sentence endings ($M = 0.157$, $SD = 1.01$), $t(26) = 3.091$, $p = .005$, $d = 0.595$, and the congruent sentence endings ($M = 0.417$, $SD = 0.96$), $t(26) = 4.661$, $p < .001$, $d = 0.897$. The emotionally negative sentence endings also elicited larger N400 amplitudes than the congruent sentence endings, $t(26) = -2.473$, $p = 0.020$, $d = 0.475$. The main effect of PPI-R Group was not significant, $F(1, 25) < 0.001$, $p = .996$, $\eta_p^2 < .001$, and, contrary to expectations, there was no significant interaction effect between Sentence Type and PPI-R Group, $F(2, 50) = 0.012$, $p = .988$, $\eta_p^2 < .001$.

EC groups. As above, there was a significant main effect of Sentence Type, $F(2, 50) = 17.275$, $p < .001$, $\eta_p^2 = .409$. There was no significant main effect of EC Group, $F(1, 25) = 2.203$, $p = .150$, $\eta_p^2 = .081$, but there was a significant interaction effect between Sentence Type and EC Group, $F(2, 50) = 4.693$, $p = .014$, $\eta_p^2 = .158$. To further explore the interaction effect, post hoc ANOVAs were performed for each EC Group separately.

For the Low EC group, there was a significant difference in N400 amplitude among the different sentence types, $F(2, 22) = 20.759$, $p < .001$, $\eta_p^2 = .654$. Planned contrasts showed that the incongruent sentence endings elicited significantly larger N400 amplitudes ($M = -0.149$, $SD = 0.99$) than both the emotionally negative ($M = 0.543$, $SD = 1.25$), $t(11) = 3.808$, $p = .003$, $d =$

1.100, and congruent endings (*M* = 0.796, *SD* = 1.02), $t(11) = 8.570$, $p < .001$, $d = 2.474$. The N400s elicited by the emotionally negative sentence endings were similar in amplitude to those elicited by the congruent endings, $t(11) = -1.635$, $p = .130$, $d = 0.471$.

For the High EC group, the differences in N400 amplitude among the sentence types was not significant, $F(2, 28) = 2.749$, $p = .102$, $\eta_p^2 = .164$, although planned contrasts showed the expected trends. The emotionally negative sentence endings elicited N400s that were similar in amplitude (*M* = -0.151, *SD* = 0.67) to those elicited by the incongruent endings (*M* = -0.245, *SD* = 0.76), $t(14) = 0.820$, $p = .426$, $d = 0.211$. The congruent sentence endings (*M* = 0.113, *SD* = 0.82) elicited smaller N400s than both the incongruent, $t(14) = 1.782$, $p = .096$, $d = 0.460$, and emotionally negative endings, $t(14) = -1.794$, $p = .094$, $d = 0.463$, although these differences only approached significance.

Exploratory analyses. Given that significant differences were found based on EC Group, but not PPI-R Group, we performed additional analyses on the ERP data using the PPI-R factors thought to be most theoretically relevant to empathy and emotional functioning: Fearless Dominance (FD) and Coldheartedness. FD encompasses traits such as stress immunity and a lack of anxiety, while Coldheartedness is characterized by callousness and a lack of empathy.

FD groups. We reclassified the ERP participants into High FD and Low FD groups based on their PPI-R FD *t*-scores. Participants who scored above the median of the full sample from Part 1 (*t*-score = 51) were assigned to the High FD group ($n = 15$), and those who scored at or below the median were included in the Low FD group ($n = 12$). The High FD group's PPI-R FD *t*-scores ranged from 53 to 74, and the Low FD group's PPI-R FD *t*-scores ranged from 36 to 51. The mean FD *t*-score of the High FD group (*M* = 62.80, *SD* = 6.48) was significantly higher than the mean of the Low FD group (*M* = 45.75, *SD* = 5.07), $t(25) = 7.460$, $p < .001$, $d = 0.490$.

Similar to the results for the PPI-R groups, repeated measures MANOVA indicated a significant main effect of Sentence Type, $F(2, 50) = 13.084$, $p < .001$, $\eta_p^2 = .344$, but no main effect of FD Group, $F(1, 25) = 0.012$, $p = .913$, $\eta_p^2 < .001$, nor interaction effect between Sentence Type and FD Group, $F(2, 50) = 0.002$, $p = .998$, $\eta_p^2 < .001$.

Coldheartedness groups. We also reclassified the ERP participants into High Coldheartedness and Low Coldheartedness groups based on their PPI-R C *t*-scores. Participants who scored above the median of the total sample from Part 1 (*t*-score = 51) were assigned to the High Coldheartedness group ($n = 11$), and those who scored at or below the median were assigned to the Low Coldheartedness group ($n = 16$). The High Coldheartedness group's PPI-R C *t*-scores ranged from 53 to 79, and the Low Coldheartedness group's PPI-R C *t*-scores ranged from 34 to 51. The mean PPI-R C *t*-score of the High Coldheartedness group ($M = 60.55$, $SD = 7.84$) was significantly higher than the mean of the Low Coldheartedness group ($M = 42.38$, $SD = 5.05$), $t(25) = 7.348$, $p < .001$, $d = 0.455$.

Again, repeated measures MANOVA demonstrated a significant main effect of Sentence Type, $F(2, 50) = 13.177$, $p < .001$, $\eta_p^2 = .345$, but no main effect of Coldheartedness Group, $F(1, 25) = 0.360$, $p = .554$, $\eta_p^2 = .014$, nor interaction effect between Sentence Type and Coldheartedness Group, $F(2, 50) = 0.272$, $p = .763$, $\eta_p^2 = .011$.

Discussion

To investigate emotional-information processing deficits associated with psychopathic traits, we conducted an ERP study using a sentential priming paradigm with undergraduate participants with high and low levels of psychopathic traits and high and low levels of empathic concern. To measure participants' N400 ERPs, we recorded their EEG while they read sentences with congruent, incongruent, and emotionally negative endings.

Our analyses of the N400 ERP component indicated that across participants, the incongruent sentence endings elicited the largest (i.e., most negative) N400 amplitudes, and the congruent sentence endings elicited the smallest (i.e., least negative) N400 amplitudes. Therefore, we were successful in replicating a commonly reported finding in N400 semantic priming studies (e.g., Federmeier & Kutas, 1999; Kiehl et al., 2006; Kutas & Federmeier, 2000; Kutas & Hillyard, 1980). Given that N400 amplitude reportedly indexes the difficulty with which information is accessed from semantic memory, such that larger N400s are produced in response to unexpected than to predictable final words in a sentence (Federmeier & Kutas, 1999; Kutas & Federmeier, 2000; Kutas & Hillyard, 1980; Luck, 2005), our results indicate that normal semantic priming was evident in our participants. This is not surprising, as the incongruent sentence endings were chosen because participants in the norming study found them highly unexpected (i.e., 0% CP). In contrast, the congruent sentence endings were chosen as stimuli because more participants in the norming study selected these endings to complete the sentences (i.e., 44% CP).

The critical experimental condition in this study was the emotionally negative sentence endings. The emotionally negative sentence endings were chosen as stimuli because they not only had negative emotional connotations, but participants in the norming study did not select them as endings for the sentence stems (i.e., 0% CP). It is therefore not surprising that the N400 amplitudes they generated were generally larger than the N400s generated by the congruent endings. The N400s generated by the emotionally negative sentence endings were generally smaller than those generated by the incongruent endings. This suggests that the emotionally negative sentence endings were less difficult to process than the incongruent ones, because even though the emotionally negative endings were highly unexpected, they were more semantically congruent than the incongruent endings.

Perhaps more importantly, we found that the amplitude of the N400 elicited by the emotionally negative sentence endings was modulated by participants' level of empathic concern. We had hypothesized that when participants were classified based on their IRI EC scores, the low EC group would find the emotionally negative sentence endings less disturbing and unexpected, thereby producing significantly smaller N400 amplitudes compared to the high EC group. As hypothesized, for the low EC group, the N400s elicited by the emotionally negative sentence endings were not significantly different than the N400s elicited by the congruent endings. Furthermore, the N400s elicited by the emotionally negative sentence endings were significantly smaller in size than the N400s elicited by the incongruent endings. These results suggest that participants low in empathic concern had little difficulty accessing the emotionally negative endings in semantic memory, and found it as easy to integrate these emotionally disturbing terminal words within the context of the sentence as when the terminal word was congruent, but not disturbing. This seems to imply that participants low in empathic concern did not find the emotionally negative sentence endings particularly emotionally distressing.

Although there was a smaller difference in N400 amplitudes among the different sentence endings for the high EC group compared to the low EC group, the results did show a trend in the hypothesized direction. For the high EC group, the incongruent and emotionally negative sentence endings elicited N400s that were very comparable in amplitude, suggesting that participants high in empathic concern probably had similar difficulty in processing both the incongruent and emotionally negative sentence endings. Similarly, there was a trend for the N400s elicited by emotionally negative sentence endings to be larger than the N400s elicited by the congruent endings. Again, this suggests that participants high in empathic concern may have had more difficulty accessing the emotionally negative sentence endings in semantic memory, and found it hard to integrate the disturbing terminal words within the context of the sentence. This seems to imply that participants high in empathic concern found the emotionally negative endings to be more emotionally disturbing than participants with low empathic concern. This interpretation is consistent with research by Davis, Hull, Young, and Warren (1987), which showed that participants high in empathic concern (measured by the IRI EC scale) had more pronounced negative emotional reactions to emotionally negative video clips than participants low in empathic concern. In addition, Stanger, Kavussanu, Willoughby, and Ring (2012) found that IRI EC scores were significantly correlated with negative valence ratings of unpleasant pictures of sports injuries, as well as higher levels of arousal (although this correlation was not significant). Thus, it appears that individuals with high levels of empathic concern are particularly prone to experiencing distress when confronted with emotionally negative stimuli, including disturbing sentences, upsetting video clips, and unpleasant images.

Empathy is a moral emotion which plays a role in regulating both prosocial and antisocial behavior (Eisenberg, 2000). Empathy has both cognitive and affective components, and is thought to be influenced by both genetic and social learning factors (Decety & Lamm, 2006; Eisenberg, 2000; Kochanska & Thompson, 1997). Emotional aspects of empathy, like empathic concern, involves feeling concerned for the welfare of others. These feelings can act as motivation to help those in need, thereby promoting prosocial behaviors like volunteering and giving to charity (Eisenberg, 2000). Empathic concern can also act as a deterrent for harming others, thereby inhibiting antisocial behaviors like lying, stealing, or aggression, as such behaviors typically lead to feelings of guilt (Eisenberg, 2000). Researchers have theorized that the development of a conscience is to some degree dependent on the ability and propensity to feel self-conscious emotions like guilt, shame, embarrassment, and pride (Eisenberg, 2000; Schalkwijk, Stams, Stegge, Dekker, & Peen, 2016). These emotions appear to require a rudimentary sense of empathy and concern for the feelings of others (e.g., one feels guilt when one causes someone to feel pain, or feels proud when one is admired by someone else). The present study's findings suggest that individuals high in empathic concern experience more marked distress when faced with affectively negative linguistic stimuli compared to those with low empathic concern. This propensity for a stronger automatic reaction to unpleasant compared to neutral linguistic stimuli may also be reflected in their inner monologue (i.e., conscience), making it more affectively charged and enabling them to better regulate their behavior. In contrast, if individuals low in empathic concern do not extract motivational or affective significance from emotional words, their inner monologue may lack emotional impact, and may therefore have little influence in regulating their behavior.

In light of the affective deficits, impaired empathy, and emotional blunting associated with psychopathy, we had also hypothesized that participants high in psychopathic traits (like those low in empathic concern) would find the emotionally negative sentences less disturbing and unexpected than participants with low levels of psychopathic traits, and would therefore demonstrate significantly smaller N400s in response to the emotionally negative sentence endings. However, this hypothesis was not supported. The results indicated no significant PPI-R group differences in N400 amplitude, nor any group by sentence ending interaction.

Given the disparate results between psychopathic traits and empathic concern for N400 modulation, and the fact that psychopathy is a multidimensional construct, additional exploratory analyses were conducted based on the PPI-R factors most theoretically relevant to affective functioning. Fearless Dominance (FD) encompasses traits such as stress immunity and a lack of anxiety, while Coldheartedness is characterized by callousness and a lack of empathy. However, there were no significant group differences in N400 amplitude, nor any group by sentence ending interaction when individuals were re-classified as having high and low levels of FD or high and low levels of Coldheartedness. This was particularly surprising for the Coldheartedness factor, which is purported to measure a callous lack of empathy and attachment to others (Lilienfeld & Widows, 2005). The IRI EC subscale is designed to measure a similar construct, namely, feelings of concern and sympathy for others, and is thought to represent the emotional component of empathy (as opposed to the cognitive component; Davis, 1983). Despite the similarities between these two constructs, there was only a trend for a correlation between the two scales for participants in the present ERP study (see Table 2). This may be an issue related to small sample size. Although relatively few studies have correlated PPI-R Coldheartedness with IRI EC, Sorman et al. (2016) reported a significant negative correlation between PPI-R Coldheartedness and IRI EC scores in a large community sample ($n = 227$). Alternatively, PPI-R Coldheartedness and IRI EC may represent related, but distinct constructs. The IRI EC scale may provide a more narrow and specific assessment of feelings of concern for others, whereas the Coldheartedness subscale may assess a broader range of callous traits.

Taken together, we found that empathic concern modulated emotional-information processing, whereas psychopathic traits did not. These findings are contrary to previous studies that found significant psychopathy-related differences in emotional-language processing (e.g., Blair et al., 2006; Day & Wong, 1996; Hare et al., 1988; Intrator et al., 1997; Kiehl et al., 1999; Williamson et al., 1991). However, these studies used male offender samples with clinically high levels of psychopathy. It is possible that the sub-clinical levels of psychopathic traits of our high-functioning, undergraduate sample were not sufficient to produce the previously reported atypical processing of emotional-language. The cut-scores for the high and low PPI-R groups were created based on the median scores from the full sample from Part 1 in order to have sufficient numbers of participants in each group. These sample-based cut-scores may therefore not have been high enough to capture truly elevated levels of psychopathic traits. Although the mean PPI-R Total *t*-score of the high PPI-R group corresponded to the 82nd to 94th percentiles[4] (suggesting the group did possess a high level of psychopathic traits compared to other community members), the *t*-scores of the individual participants in this group ranged from the 77th to 99th percentiles. Similarly, the mean PPI-R Total *t*-score of the low PPI-R group corresponded to the 18th to 28th percentiles (suggesting the group did possess a low level of psychopathic traits compared to other community members). However, the individual participants in this group ranged from the 3rd to 43rd percentiles. It may be that the range of PPI-R scores within each group was too wide to detect between group differences. Differences in N400 amplitude between the groups may have been more pronounced had there been less variance within the groups. The present study also had a predominantly female sample. Gender differences in empathy and the manifestation of psychopathic traits (Rogstad & Rogers, 2008) may be reflected by gender-related variations in emotional-language processing as well. Future studies should seek to increase the number of male participants in their non-criminal samples to investigate how gender interacts with psychopathic traits to impact the N400. An additional

[4] The exact percentile is dependent on age and gender. *T*-score and percentile conversions are available in the PPI-R manual (Lilienfeld & Widows, 2005).

point to note is that there appeared to be more variation in language experience between the PPI-R groups than between the EC groups. Although the chi-square test was not significant, the high PPI-R group had more participants with English as a second language than the low PPI-R group (see Table 1). In contrast, the two EC groups were more similar in terms of the number of participants with English as a second language. We assumed that all our participants had comparable English proficiency, and we screened out participants who were not fluent in English before age eight, but it is still possible that early language exposure may have created some linguistic processing differences between the PPI-R groups that confounded our ability to see N400 group differences.

Null relationships were also found for PPI-R FD and Coldheartedness. Again, although the mean *t*-scores of the high groups corresponded to high percentiles, and the mean *t*-scores of the low groups corresponded to low percentiles, there was a wide range of scores within each group, which may account for the lack of N400 differentiation between the high and low groups (See Table 5 for *t*-scores and percentiles of the high and low PPI-R, FD, and Coldheartedness groups).

To our knowledge, only two studies (Kiehl et al., 1999; Williamson et al., 1991) have utilized ERPs to examine the effects of psychopathy on emotional-language processing. Both found evidence for atypical psychopathy-related modulation in ERPs elicited by emotional words. However, these studies also utilized tasks which required participants to make an immediate decision regarding whether a letter-string formed a real word (Williamson et al., 1991) or whether a target word was positive or negative (Kiehl et al., 1999). In these paradigms, the decision-making process elicits another ERP known as the P3 (a positive-going wave beginning around 300 ms after stimulus presentation), which has a similar timing and scalp distribution to the N400 and can confound its measurement (Hajcak et al., 2010; Kiehl et al., 2006; Kok, 2001; Luck, 2005). Therefore, it is possible that the significant differences found between the psychopathic and non-psychopathic groups in these studies reflect psychopathy-related abnormalities in decision-making processes, rather than abnormal emotional-information processing. This potential explanation is supported by Kiehl et al.'s (2006) finding of no difference in N400 amplitude between psychopathic and non-psychopathic offenders during a non-emotional semantic sentential priming task, when participants responded one second after presentation of the terminal word. In the present study, participants did not respond to the terminal word in the sentence. Instead, to ensure that participants were reading the sentences carefully, they responded to a probe word that was presented one second after the critical terminal word. In this way, the decision-making process did not impact the amplitude of the N400.

Of note, although the high and low EC groups demonstrated different patterns of N400 modulation in response to the emotionally negative sentence endings, there were no differences in how they rated the sentences. Both EC groups rated the emotionally negative sentence endings as significantly more emotionally disturbing than the congruent sentence endings. This disparity between self-report and ERP data seems to indicate that individuals low in empathic concern "know the words, but not the music" (Johns & Quay, 1962, p. 217). That is, individuals with low levels of empathic concern may have an intellectual understanding that the emotionally negative sentence endings are supposed to be emotionally disturbing, but they may not actually experience an emotional reaction to them. On the other hand, our null result may be because there was missing data from three participants in the low EC group; therefore, we may not have had enough power to detect group differences. Unexpectedly, the opposite pattern was observed for the PPI-R groups. Although there were no significant differences in N400 modulation between the high and low PPI-R groups, the two groups rated the emotionally negative sentence endings differently. The high PPI-R group rated the emotionally negative sentence endings as significantly less emotionally disturbing than the low PPI-R group, while both groups rated the congruent endings similarly. It is difficult to account for this result, as emotional-processing studies typically have not found significant psychopathy-related differences in self-report data (e.g., Blair et al., 2006; Kiehl et al., 1999; Medina, Kirilko, & Grose-Fifer, 2016; Williamson et al., 1991).

Limitations and Future Directions

The present study is not without limitations. The ERP sample was comprised of mostly female undergraduate students, with a limited range in both age and psychopathic traits. The results therefore may not be generalizable to other populations. Future studies should utilize more diverse non-criminal samples. Additionally, the ERP sample was relatively small (n = 27). Although it is not uncommon for ERP studies to have samples of this size, a larger sample would lend more statistical power to the analyses. The present study also used self-report measures to assess psychopathic traits and empathic concern, which carry the risk of dishonest or careless responding from participants. Furthermore, psychopathic individuals are known for a characteristic lack of insight (Lilienfeld & Fowler, 2006). This limited self-awareness may have affected the ability of participants high in psychopathic traits to self-reflect and accurately report their feelings, traits, and tendencies.

As previously mentioned, the cut-scores for the high and low PPI-R and EC groups were sample-driven. Using higher cut-scores or alternate classification methods may yield more robust differences between the groups. For example, future studies may consider including only those whose PPI-R scores (for Total, FD, *and* Coldheartedness) are at or above the 75th percentile (or higher) in the high PPI-R group, and including only those whose scores are at or below the 25th percentile (or lower) in the low group. Of course, this will necessitate an even larger pool of participants from which to recruit for the ERP portion (Part 2) of the study. In the present study, 130 participants completed Part 1, but not all were eligible for Part 2. Of those that were eligible, many were not interested in participating in Part 2, had scheduling conflicts, or did not respond to the recruitment emails. We found it particularly challenging to recruit participants with high PPI-R scores for Part 2 of the study. It is important to note that we excluded participants who scored 45 or above on the STAI from the ERP sample, because high levels of anxiety have been shown to modulate ERPs to emotional stimuli (e.g., Bar-Haim, Lamy, & Glickman, 2005). Excluding participants with high trait anxiety further narrowed our selection of participants with both relatively high and relatively low PPI-R scores, as trait anxiety is negatively related to the FD factor of the PPI-R, but positively correlated to the Self-centered Impulsivity (SCI) factor (Falkenbach, Stern, & Creevy, 2014; Lilienfeld & Widows, 2005).

Although this study focused on the N400, there is evidence that other ERP components (e.g., the LPP) are atypically modulated in individuals with high levels of psychopathic traits for both emotional words (Kiehl et al., 1999; Williamson et al., 1991) and emotional images (Carolan, Jaspers-Fayer, Asmaro, Douglas, & Liotti, 2014; Medina et al., 2016). Further investigation is needed to establish whether other ERP components like the LPP are affected by psychopathic traits in the processing of emotional language.

Conclusion

In sum, our findings contribute to the literature demonstrating that the N400 is a useful and reliable index of semantic priming. Furthermore, the present study found that empathic concern, but not psychopathic traits, modulated the N400 ERP elicited by emotionally negative sentence endings. However, given the strong negative relationship between psychopathy and empathy, these results require further investigation. Future research in this area should consider using larger, more generalizable non-criminal samples, along with different measures of psychopathy and empathy, and different methods of classification into high and low groups as well. Future research may also consider investigating possible gender differences in how psychopathy and empathy impact emotional-language processing. ERP studies offer an unobtrusive and objective means of assessing an individual's neural responses to emotional stimuli, and should prove fruitful in continuing this exploration of psychopathy, empathy, and emotional processing.

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Table 1

Demographic information for the High and Low PPI-R and EC groups

	High PPI-R (*n* = 13)	Low PPI-R (*n* = 14)
Mean Age	18.92 (*SD* = 1.94)	19.29 (*SD* = 1.14)
Sex		
Male	23.1% (*n* = 3)	28.6% (*n* = 4)
Female	76.9% (*n* = 10)	71.4% (*n* = 10)
Race/Ethnicity		
Caucasian	15.4% (*n* = 2)	35.7% (*n* = 5)
Hispanic	69.2% (*n* = 9)	57.1% (*n* = 8)
African American	0.0% (*n* = 0)	7.1% (*n* = 1)
Asian	15.4% (*n* = 2)	7.1% (*n* = 1)
Other	7.7% (*n* = 1)	0.0% (*n* = 0)
First Language		
English	69.2% (*n* = 9)	85.7% (*n* = 12)
Other	30.8% (*n* = 4)	14.3% (*n* = 2)

	Low EC (*n* = 12)	High EC (*n* = 15)
Mean Age	19.58 (*SD* = 2.15)	18.73 (*SD* = 0.70)
Sex		
Male	25.0% (*n* = 3)	26.7% (*n* = 4)
Female	75.0% (*n* = 9)	73.3% (*n* = 11)
Race/Ethnicity		
Caucasian	41.7% (*n* = 5)	13.3% (*n* = 2)
Hispanic	50.0% (*n* = 6)	73.3% (*n* = 11)
African American	8.3% (*n* = 1)	0.0% (*n* = 0)
Asian	16.7% (*n* = 2)	6.7% (*n* = 1)
Other	0.0% (*n* = 0)	6.7% (*n* = 1)
First Language		
English	75.0% (*n* = 9)	80.0% (*n* = 12)
Other	25.0% (*n* = 3)	20.0% (*n* = 3)

Note: Percentages for race/ethnicity may not total 100% because participants were allowed to select more than one race/ethnicity.

Table 2

Correlations among PPI-R Total, PPI-R FD, PPI-R C, and IRI EC scores for the ERP sample (n = 27)

	PPI-R Total	PPI-R FD	PPI-C
PPI-R Total	--		
PPI-R FD	.855**	--	
PPI-R C	.532**	.332	--
IRI EC	-.213	-.132	-.358

* *p* < .05, ** *p* < .01

Table 3

Mean sentence ratings (SD) for congruent and emotionally negative sentence endings for the High and Low PPI-R and EC groups

	High PPI-R (*n* = 12)	Low PPI-R (*n* = 11)
Congruent	1.16 (0.13)	1.25 (0.17)
Emotionally negative*	3.42 (1.24)	4.56 (0.47)
	Low EC (*n* = 9)	High EC (*n* = 14)
Congruent	1.26 (0.21)	1.16 (0.10)
Emotionally negative	3.77 (1.15)	4.09 (1.09)

* $p < .05$

Table 4

Mean N400 amplitudes in µV (SD) elicited by congruent, incongruent, and emotionally negative sentence endings for the High and Low PPI-R, EC, FD, and Coldheartedness groups

	High PPI-R (*n* = 13)	Low PPI-R (*n* = 14)
Congruent	0.428 (0.78)	0.406 (1.14)
Incongruent	-0.203 (0.71)	-0.202 (0.99)
Emotionally negative	0.150 (0.89)	0.164 (1.14)
	Low EC (*n* = 12)	High EC (*n* = 15)
Congruent	0.796 (1.02)	0.113 (0.82)
Incongruent	-0.149 (0.99)	-0.245 (0.76)
Emotionally negative	0.543 (1.25)	-0.151 (0.67)
	High FD (*n* = 15)	Low FD (*n* = 12)
Congruent	0.399 (0.81)	0.439 (1.16)
Incongruent	-0.216 (0.67)	-0.186 (1.07)
Emotionally negative	0.137 (0.86)	0.182 (1.22)
	High Coldheartedness (*n* = 11)	Low Coldheartedness (*n* = 16)
Congruent	0.526 (0.59)	0.341 (1.16)
Incongruent	-0.124 (0.79)	-0.256 (0.91)
Emotionally negative	0.340 (0.92)	0.032 (1.08)

Table 5

PPI-R t-scores and corresponding percentiles for High and Low PPI-R, FD, and Coldheartedness groups

	High PPI-R (*n* = 13)	Low PPI-R (*n* = 14)
Mean PPI-R Total *t*-score	62.69 (7.41)	41.86 (4.67)
Percentiles	82% - 94%	18% - 28%
Range of PPI-R Total *t*-scores	56-78	32-48
Percentiles	77% - 99%	3% - 43%
	High FD (*n* = 15)	Low FD (*n* = 12)
Mean PPI-R FD *t*-score	62.53 (6.42)	45.75 (5.07)
Percentiles	88% - 94%	30% - 42%
Range of PPI-R FD *t*-scores	53-74	36-51
Percentiles	65% - 99%	10% - 60%
	High Coldheartedness (*n* = 11)	Low Coldheartedness (*n* = 16)
Mean PPI-R C *t*-score	60.55 (7.84)	42.38 (5.04)
Percentiles	82% - 90%	12% - 32%
Range of PPI-R C *t*-scores	53-79	34-51
Percentiles	66% - 99%	5% - 60%

Note: Exact percentiles are dependent on sex and age. *T*-scores and percentiles are available in the PPI-R manual (Lilienfeld & Widows, 2005). PPI-R Total *t*-scores and percentiles are displayed for the High and Low PPI-R groups. PPI-R FD *t*-scores and percentiles are displayed for the High and Low FD groups. PPI-R C *t*-scores and percentiles are displayed for the High and Low Coldheartedness groups.

Figure 1

Grand averages of N400 amplitude (measured at electrode CZ) for the High and Low PPI-R groups

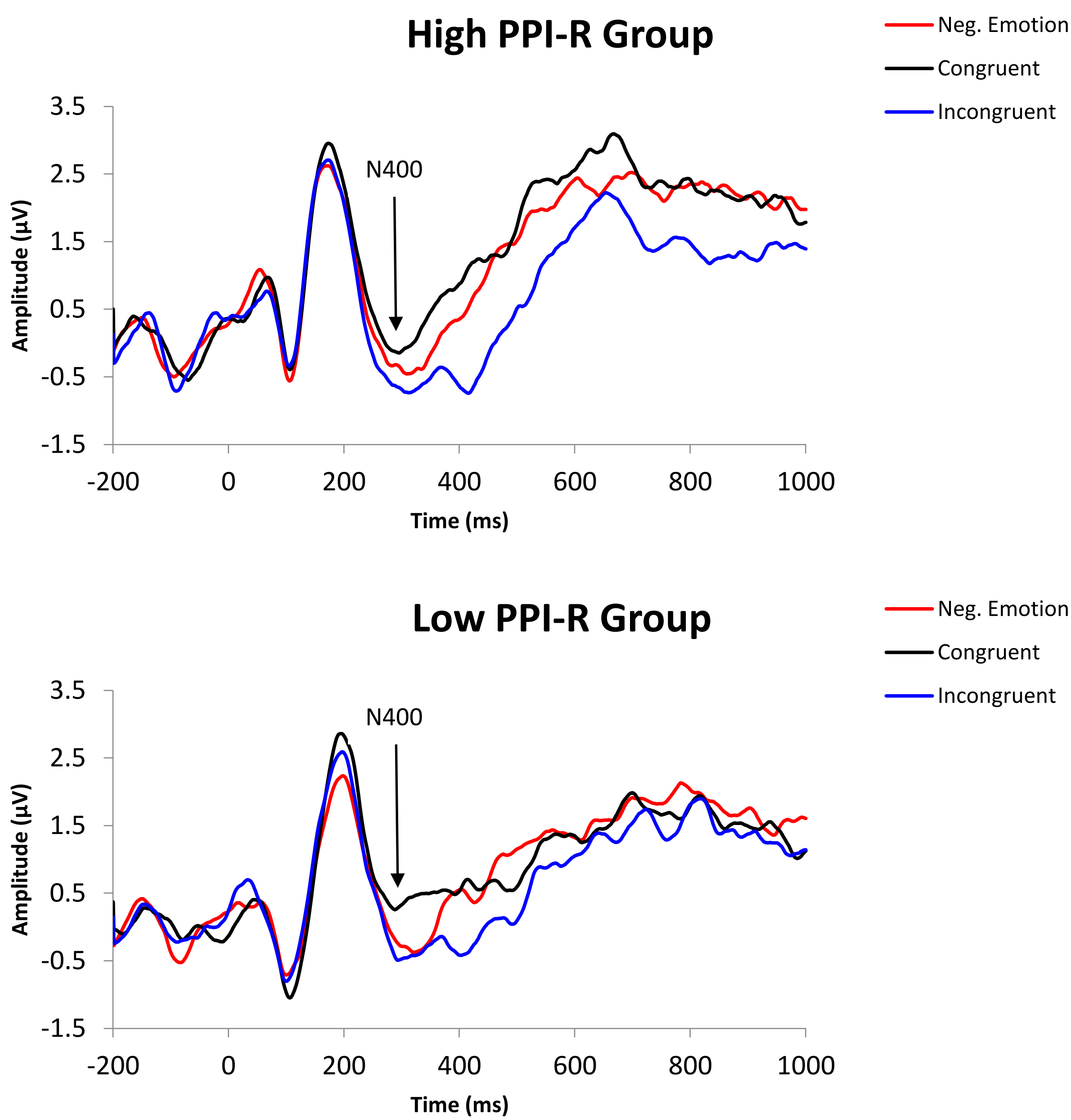

Figure 2

Grand averages of N400 amplitude (measured at electrode CZ) for the High and Low EC groups