**Please cite the Publisher’s copy: https://doi.org/10.1080/17470919.2021.1886165**

**Exploring the relationship between social power and the ERP components of empathy for pain**

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**Abstract**

Social power (the ability to control or influence another’s thoughts, feelings, or behaviours) and empathy (the ability to both share and understand the thoughts and feelings of others) are fundamental social forces. Here, we explore the relationship between social power and the ERP components associated with empathy for pain. Participants were induced into states of high and low social power via a double blind version of the episodic recall task (e.g., “recall a time you felt powerful”). Afterwards, they completed a pain categorization task, viewing pictures of hands that were in pain or not in pain, from a first-person or third-person visual perspective. Whereas both high and low social power states were associated with enhanced N2 amplitudes when observing another in pain, only the high social power state was associated with an enhancement of the P3. We interpret this finding as suggesting that, while social power does not seem to impact the emotional response to another’s pain (as indexed by the N2), low social power seems to be associated with impaired cognitive evaluations of another’s pain relative to high social power (as indexed by the P3). We discuss our findings in relation to the broader literature on power and empathy.

**Keywords:** Social Power, Empathy, Empathy for Pain, ERP Components, ERPs, EEG

**1. Introduction**

Social power is commonly defined as the ability to control or influence another’s thoughts, feelings, or behaviours (e.g., Keltner et al., 2003; Guinote, 2017). Empathy is commonly defined as the ability to both share and understand the thoughts and feelings of others (e.g., Preston & de Waal, 2002; de Waal & Preston, 2017; Rameson & Lieberman, 2009; Tremblay et al., 2018), and is often distinguished between two types: affective empathy, which refers to the emotional sharing, or “resonating”, between the subject and object of empathy, and cognitive empathy, which refers to a person’s ability to engage in self-other processing such as being able to take the perspective of others and/or “mentalize” (e.g., Tremblay et al., 2018). That there is some sort of relationship between social power and empathy is captured succinctly by Lord Acton’s (1887/1997) well-known adage: “Power tends to corrupt and absolute power corrupts absolutely”. And indeed, current cultural tropes (at least amongst Western societies) often portray the powerful (e.g., CEOs, politicians, bankers, etc.) as greedy and lacking in empathy.

Early work by Galinsky et al. (2006) corroborated this culturally-held stereotype. In one of their experiments, participants were induced to states of high or low social power via the episodic recall task, in which participants are induced into states of high, low, or neutral social power by recalling and writing about a time when they felt powerful, powerless, or in the case of a neutral condition, what they did the previous day. After the power manipulations, participants were instructed to draw the letter “E” on their foreheads as quickly as they could. Within this task, participants could either decide to draw the E in an other-oriented manner (where the “E” is drawn in the correct direction relative to third-person observers) or in a self-oriented manner (where the “E” is drawn in the correct direction relative to the drawer). Galinsky et al. (2006) report that participants in the high social power condition were almost three times more likely to spontaneously draw the “E” in a self-oriented manner compared to participants in the low social power condition. They took this as evidence that perspective taking can be negatively affected in states of high social power.

Further corroboration is provided by Van Kleef et al. (2008). In their study, participants were randomly paired with another participant, and participant took turns recounting a time that caused them emotional suffering. Van Kleef et al. (2008) reported that participants with a higher sense of power (measured via self-report) experienced less distress and less compassion during the conversation (as compared to participants with a lower sense of power). In conjunction with Galinsky et al.’s (2006) results, these studies seem to suggest that social power modulates both affective (e.g., less distress and compassion during a conversation) and cognitive (e.g., perspective taking indexed via the “E” task) empathy; specifically, high social power seems to diminish empathy related processing.

Interestingly, and in contrast to Galinsky et al. (2006) and Van Kleef et al. (2008), Mast et al. (2009) found that high social power can lead to better interpersonal sensitivity. In one of their experiments, participants were induced to states of high, low, or neutral social power via the episodic recall task. Immediately after this, participants completed the DANVA-2 Adult Facial Expressions Test (Nowicki & Duke, 1994), which tests for emotional recognition/accuracy. They found that participants in the high social power condition scored higher on the DANVA-2 compared to both the low social power and neutral conditions. The low social power and neutral conditions did not significantly differ, suggesting that, while participants in the high social power condition showed an increase in emotional recognition accuracy, participants in the low social power condition did not show an equivalent decrease. Mast et al. (2009) speculated that inducing their participants to a state of high social power led them to adopt a global cognitive style (i.e., more abstract thinking), which has been associated with increased interpersonal sensitivity (e.g., Ambady & Gray, 2002; Patterson & Stockbridge, 1998).

In addition to behavioural research, more recent neurophysiological research by Hogeveen et al. (2014) has shown that inducing participants (via the episodic recall task) to a state of high or low social power reduces or increases motor resonance, respectively, as indexed via TMS-induced motor evoked potentials. Motor resonance refers to the automatic activation of the motor cortex during observation of another person’s actions. In so far as motor resonance relates to action understanding as a result of action observation in the motor cortex (e.g., Rizzolatti & Luppino, 2001; but see Cook et al., 2014), Hogeveen et al. (2014) speculate that these results may suggest that high or low social power individuals are less or more inclined to understand others, respectively. In conjunction with Galinsky et al. (2006) and Van Kleef et al. (2008), these results imply that states of high social power seems to attenuate empathic processing (also see Varnum et al., 2016; Farwaha & Obhi, 2019).

The aim of the current study is to extend this line of research by exploring if and how social power influences the event-related potential (ERP) components associated with empathy for pain. Fan & Han (2008) were the first to report that both early (N1, P1, N2) and late (P3, LPP) components were sensitive to pain vs. no pain observation, with the early components commonly thought to index affective empathy (i.e., the emotional response to another’s pain) and the later components commonly thought to index cognitive empathy (i.e., the cognitive evaluation of another’s pain). However, it is important to note that this distinction and association between early-emotional and late-cognitive processing is overly simplistic; for example, recent work by Hesse et al. (2016) and Decety et al. (2018) suggest that early components can also reflect (and be influenced by) cognitive factors during a pain observation task. A more recent meta-analysis and review by Coll (2018) suggests that the most robust components are the N2, P3, and LPP, with the later components being more reliably found compared to the early (Coll (2018) in fact found non-significant overall effects of the N2; however, this may be due to the ambiguity of the direction of the effect, with some studies finding more negative mean amplitudes, and others more positive, when comparing pain vs. no-pain – see Galang et al. (2020) for a longer discussion of this point). With that said, follow up studies have generally corroborated and extended Fan & Han’s (2008) original findings (e.g., Li & Han, 2010; Sessa et al., 2014; Cui et al., 2016; Coll et al., 2017; Galang et al., 2020).

However, no study to date has explored whether social power can modulate these ERP components. This research is needed as previous work seems to provide incongruent results – with Galinsky et al. (2006), Van Kleef et al. (2008), and Hogeveen et al. (2014) showing that high social power leads to an impairment of empathic processing, while Mast et al. (2009) show that high social power accentuates empathic processing; as such, the results of this study may aid in strengthening one of these two hypotheses. Furthermore, the results of this study will also show whether the connection between social power and empathy can be seen at the neurophysiological level of ERPs (i.e., automatic, and involuntary responses). Lastly, showing that social power does indeed modulate these components will extend our growing understanding of how the ERP components associated with empathy for pain are influenced by top-down factors.

To explore this issue, we employed the episodic recall task to induce our participants (primarily female; see limitations section below) into either a state of high or low social power. Afterwards, participants completed a pain recognition task (e.g., Fan & Han, 2008; Fabi & Leuthold, 2017; Galang et al., 2020) to elicit the ERP components associated with empathy for pain. In this task, participants observed either an image of a hand getting pricked by a needle (Pain) or being touched by a Q-tip (No Pain). Participants had to categorize the images as either “Pain” or “No Pain” as fast as they could. Furthermore, we showed these images shot from either a first-person or third-person visual perspective, to explore whether visual perspective taking modulates how social power interacts with pain observation.

We could make a number of predictions based on previous works. For example, given that Van Kleef et al. (2008) found that a sense of high social power reduced distress and compassion towards a suffering other and that Galinsky et al. (2006) found that inducing high social power led to lower perspective taking, it might be expected that high social power will attenuate both the early and late components of empathy for pain, and will diminish any influence of visual perspective. Alternatively, the picture is somewhat complicated by Mast et al.’s (2009) findings that high social power can also lead to *greater* interpersonal sensitivity, specifically in regard to emotional recognition. This suggests that high social power could lead to an increase in later (or early-related) cognitive components. Lastly, given both the novelty and exploratory nature of the current study, it is possible that social power will not have any influence over the ERP components of empathy for pain. In this case, we at least expect to corroborate previous ERP research on empathic pain observation (i.e., differential effects of pain vs. pain observation in both the early and late components).

As a final point, it should be noted that participants also completed the Interpersonal Reactivity Index (IRI; Davis, 1980, 1983), the Sense of Power Scale (SOP Scale; Anderson et al., 2012), and the Behavioural Inhibition/Activation System Scale (BIS/BAS Scale; Carver & White, 1994) at the end of the experiment. The IRI consists of four subscales (Perspective Taking (PT), Empathic Concern (EC), Fantasy Scale (FS), and Personal Distress (PD)) and is the most widely used self-report measure of trait-levels of empathy. The SOP scale is a trait-level measure of feelings of power, and the BIS/BAS scale is a trait-level measure of motivational (inhibition-withdrawal/activation-approach) systems; these motivations systems have been related to states of social power (e.g., Boksem et al., 2012; Li et al., 2016; Galang & Obhi, 2020). There were two primary reasons these scales were included in this study: first, as exploratory measures to see if, for example, trait-levels of empathy are associated with social power states; and second, as a manipulation check to see whether random sampling did indeed provide us with unbiased groups in each Social Power condition (i.e., to make sure that our effects were due to the episodic recall task, rather than having one condition contain a large amount participants with high trait levels of empathy, power, and/or BIS/BAS – for example, rather than high social power participants showing attenuated responses in the late or early components, it may instead be due to having a large number participants with low trait levels of empathy in that condition).

**2. Methods**

*2.1 Participants*

64 right-handed participants were recruited for course credit (n = 32 per social power condition; Mean Age = 18.8; Males = 9; note that this gender imbalance is a limitation in this study, see limitations). A simulation-based sensitivity analysis (via the SuperPower (ver. 0.0.3) R package, Lakens & Caldwell, 2019) shows that, for a 2x2x2 mixed-model ANOVA (with 1 between-subjects factor and 2 within-subjects factors) interaction effect, n = 32 (per between-subjects group) is sensitive enough to detect *partial-eta* = ~0.12 at ~80% power. Furthermore, 1 participant was removed from final analysis due to making too many errors during the pain categorization task (>65% error rate; suggesting lack of attention to the stimuli). This left us with n = 63 (high social power = 31; low social power = 32). Note that, even with 1 participant excluded, the remaining sample size per condition generally matches what is found in the ERP literature (and, if anything, is on the higher end; Coll, 2018). Furthermore, there was roughly the same number of males in each social power condition (high social power = 5; low social power = 4) and participant age did not significantly differ across conditions (high social power = 18.8 [SD = 3]; low social power = 18.8 [SD = 2.5]; *p* > 0.92). Prior to participation, participants provided written informed consent. This study was approved by the McMaster Research Ethics Board (MREB).

*2.2 Apparatus and Stimuli*

The experiment was programmed and presented using SuperLab ver. 5 (Cedrus Corporation, San Pedro, CA, USA), and was run on a Lenovo P910 ThinkStation. Participants responded with their right and left index fingers using a Cedrus RB series Response Pad. The visual stimuli consisted of a picture depicting a male Caucasian hand either being pricked by a needle or touched by a Q-tip from either the first-person perspective or third-person perspective (adapted from video stimuli used by Avenanti et al., 2010). We manipulated visual perspective taking by presenting both picture stimuli either upright to showcase a first-person perspective or inverted for a third-person perspective (a similar method to manipulate visual perspective was used by Bucchioni et al., 2016 & Galang et al., 2020). The pictures were gray scaled to limit the influence of color in the tasks (See Figure 1(a)). EEG was recorded using a 62 channel Neuroscan Quik-Cap throughout the experiment. Participants also completed the Interpersonal Reactivity Index (IRI; Davis, 1980, 1983), the Sense of Power Scale (SOP Scale; Anderson et al., 2012), and the Behavioural Inhibition/Activation System Scale (BIS/BAS Scale; Carver & White, 1994) at the end of the experiment.

**FIGURE 1 ABOUT HERE**

*2.3 ERP Components*

While Fan & Han (2008) analyzed multiple components in their initial analysis, follow up studies have not always examined the same components. For example, some studies have only replicated the effects of pain observation in the P3/LPP (Lyu et al., 2014; Sessa & Meconi, 2015), while others find only a subset of the early components (e.g., N1, P2 but no presence of the N2; Decety et al., 2010). Furthermore, some studies split up the P3 into its ascending phase, peak, and descending phase for separate analysis (e.g., Li & Han, 2010; Suzuki et al., 2015), while others focus on the total P3/LPP waveform (Coll et al., 2017). As Coll (2018) points out, there is a danger of increased analytical flexibility in the literature, thus potentially inflating Type 1 error rates. As such, to help minimize Type 1 error inflation, we limit ourselves by using the same components, time windows, and electrode schemes used in our previous study (i.e., Galang et al., 2020).

Specifically, we focus our analysis on the N2, P3, and LPP (the most reliably found components in the literature; Coll, 2018). Following Galang et al. (2020), the N2 time window was determined to be between 200ms-300ms, the P3 to be between 350ms-450ms, and the LPP to be between 500ms-800ms. The N2 was analyzed using the average waveforms from the Fz, F3, F4, FCz, FC3, and FC4 electrodes (“Frontal-Central region”) and the P3/LPP were analyzed using the average waveforms from Cz, C3, C4, CPz, CP3, CP4, Pz, P3, and P4 electrodes (“Central-Parietal region”); note that Galang et al. (2020) based these regions of interest are on the electrode scheme originally used by Fan and Han (2008).

*2.4 Design*

The experiment used a 2x2x2 mixed design, wherein Picture Valence (Pain, No-Pain (NP) and Visual Perspective (1st Person (1P), 3rd Person (3P)) were the within-subjects factors, and Social Power (High, Low) was the between-subjects factor. Participants were randomly assigned into the Social Power conditions. The four stimuli making up the Picture Valence x Visual Perspective factors (1P-Pain, 1P-NP, 3P-Pain, 3P-NP) were presented 60 times each, giving an overall trial count of 240. The 2x2x2 mixed design was applied to the N2, P3, and LPP. We also report correlations between the IRI, SOP, and BIS/BAS and these components.

*2.5 EEG Acquisition and Processing*

EEG was recorded using a 62 channel Neuroscan Quik-Cap. Impedance levels were below 15kΩ before the start of the experiment. The EEG was sampled at 1000Hz and was online referenced to an electrode near Cz. After data collection, the data was transferred to EEGLab (Delorme & Makeig, 2004). In EEGLab, the data was down sampled to 250Hz, band-passed filtered at 0.1-40Hz, and bad channels were identified and removed via the *clean\_artifacts* function (all default settings). The data was then re-referenced to the common average.

Independent Component Analysis (ICA) was then run on each dataset using EEGLab’s *runica* function (Infomax Extended). The ICLabel plugin (Pion-Tonachini et al., 2019) was then used to automatically classify and subsequently remove components classified as artifacts (i.e., sources coming from eye blinks, muscle movements, heart beats, line noise, and channel noise)[[1]](#footnote-1). Afterwards, removed channels were interpolated. The data was then epoched [-200ms 1000ms] based on each condition (using the ERPLab plugin – Lopez -Calderon & Luck, 2014); epochs were time locked to a photo-receptor marker for increased accuracy of stimulus onset. Epochs that corresponded to bad behavioral trials (i.e., anticipatory responses (< 200ms), slow responses (> 1500ms), errors, or missing responses) were removed (less than 4% of trials on average). To check whether the number of valid trials per condition did not significantly differ from one another, we conducted a 2x2x2 mixed design ANOVA, with Picture Valence and Visual Perspective as the within-subjects factor and Social Power as the between-subjects factor, on the total number of valid trials. No significant results were found (all *p* > 0.23). The breakdown of the average number of valid trials per condition is as follows: Pain\_1P\_High = 57.2 [SD = 4.5], NP\_1P\_High = 57 [SD = 3.1], Pain\_3P\_High = 57.6 [SD = 3.8], NP\_3P\_High = 57.2 [SD = 4.4], Pain\_1P\_Low = 57.7 [SD = 2.3], NP\_1P\_Low = 57.5 [SD = 2.6], Pain\_3P\_Low = 58 [SD = 2.5], NP\_3P\_Low = 57.7 [SD = 2.8].

Using the ERPLab plugin, subject ERPs were created by averaging together epochs within each condition (1P-Pain, 1P-NP, 3P-Pain, 3P-NP). Fz, F3, F4, FCz, FC3, and FC4 were averaged together to create the “Frontal-Central” region for analysis of the N2 component, and Cz,C3, C4, CPz, CP3, CP4, Pz, P3, and P4 were averaged together to create the “Central-Parietal” region for analysis of the P3 and LPP components. Subject ERPs were then averaged together to create the Grand Average ERPs used for visualization. Finally, ERPLab’s ERP measurement tool was used to obtain mean amplitudes between 200–300ms for the N2 in the Frontal-Central region and 350–450ms/500–800ms for the P3/LPP components, respectively, in the Central-Parietal region.

*2.6 Procedure*

Participants first read over a letter of information going over the tasks in the study. If they were comfortable with the procedures, they were asked to sign a consent form. Afterwards, participants were fitted with a 62-channel EEG cap (Compuscan, Neuromedics). Once this was complete, participants sat with their eyes open and closed alternating every two minutes for twelve minutes – EEG data was collected during this time. Afterwards, participants completed the episodic recall task using Microsoft Word to type their recollections – EEG data was also collected during this time. It should be noted that the EEG data collected during the eyes open/closed baseline period and the episodic recall task are meant for another project related to the use of Frontal Alpha Asymmetry as an index of approach/withdrawal motivations (Boksem et al., 2012; Li et al., 2016; Galang & Obhi, 2019). As this topic is not directly related to the current study’s aims, we do not report this data here. We merely mention this point for the sake of completeness in reporting our procedures.

Participants were randomly assigned to either the High Social Power or Low Social Power conditions. As described in the introduction, the episodic recall task requires participants to write about a time when they felt powerful or powerless. Exact instructions were as follows (based on Galinsky et al., 2003):

**High Social Power:** Please recall a particular incident in which you had power over another individual or individuals. By power, we mean a situation in which you controlled the ability of another person or persons to get something they wanted, or were in a position to evaluate those individuals. Please describe this situation in which you had power – what happened, how you felt, etc.

**Low Social Power:** Please recall a particular incident in which someone else had power over you. By power, we mean a situation in which someone had control over your ability to get something you wanted, or was in a position to evaluate you. Please describe this situation in which you did not have power—what happened, how you felt, etc.

Participants were informed that they would have 10 minutes to complete the task, and that they should write as much as possible within that time window. To keep the experimenter blind to the participants’ condition (to alleviate possible confounding effects of experimenter belief; Gilder & Heerey, 2018), the Microsoft Word file was premade by another member of the lab (who did not directly interact with the participants during the experiment). The Word file contained two pages; the first stated that the participants should first wait for the experimenter to leave the room and to scroll down afterwards, and the second contained the social power prompt. After the allotted time limit was up, the experimenter came back into the room, asked the participant to save the file and scroll back up to the first page (to make sure the experimenter remained blind). Note that the experimenter was trained to interact with the participant in a neutral manner.

After the episodic recall task was completed, the SuperLab program containing the experiment was played and the participant was presented with task instructions. The instructions were also verbally explained by the experimenters: participants were instructed to press either the right or left key if they saw a picture with someone in pain and to press the opposite key if they saw a picture with someone not in pain. Key mappings of categories were counterbalanced between blocks (after 120 trials); for example, if in one block the right button was assigned to painful pictures, then in the next it was assigned to non-painful pictures. The order of the key mappings (i.e., which button maps onto which category first) was counter balanced between participants. All possible combinations of order were accounted for in our counter balancing. At the start of each new key mapping, instructions were presented detailing the change. To make sure participants got used to the key mappings, 20 practice trials were always provided at the start of each block. The picture stimulus (1P-Pain, 1P-NP, 3P-Pain, 3P-NP) were randomly shown throughout the experiment. Participants were given a self-paced break every 60 trials.

Each trial started with a 500ms inter-stimulus interval in the form of a black screen. A picture stimulus then appeared for 200ms; however, the participant was instructed to press the button as soon as they could correctly categorize the stimulus (up to 1500ms after the stimulus onset; see Figure 1(b)). At the end of the computer task, the EEG cap was removed, and participants completed the IRI, SOP, and BIS/BAS scales.

**3. Results**

*3.1 ERP Components*

*3.1.1 The N2 (200-300ms)*

The 2x2x2 mixed-design ANOVA yielded a significant main effect of Picture Valence [*F*(1, 61) = 33.8, *p* < 0.00001, *partial-eta* = 0.36], such that participants showed larger (negative) mean amplitudes when observing the Pain stimuli [*M* = -7.3µV, *SE* = 0.36] compared to No Pain [*M* = -6.7µV, *SE*  = 0.34]. All other effects were non-significant [all *p* > 0.59]. See Figure 2.

**FIGURE 2 ABOUT HERE**

*3.1.2 The P3 (350-450ms)*

The 2x2x2 mixed-design ANOVA yielded a significant main effect of Visual Perspective [*F*(1, 61) = 11.4, *p* = 0.0013, *partial-eta* = 0.16], such that participants showed a larger (positive) mean amplitude when observing the picture stimuli from a First-Person Visual Perspective [*M* = 3.84µV, *SE* = 0.28] compared to a Third-Person Visual Perspective [*M* = 3.61µV, *SE* = 0.28]; a significant main effect of Picture Valence [*F*(1, 61) = 11.15, *p* = 0.0014, *partial-eta* = 0.16], such that participants showed a larger (positive) mean amplitude when observing the Pain stimuli [*M* = 3.84µV, *SE* = 0.28] compared to No Pain [*M* = 3.63µV, *SE* = 0.28].

We also found a significant Visual Perspective x Social Power interaction [*F*(1, 64) = 4.5, *p* = 0.038, *partial-eta* = 0.07]. Follow-up *t*-tests (Holms-Bonferroni corrected) showed that participants in the High Social Power condition showed larger (positive) mean amplitudes when observing the stimuli from a First-Person Visual Perspective [*M* = 3.62µV, *SE* = 0.38] compared to a Third-Person Visual Perspective [*M* = 3.26µV, *SE* = 0.37; *t*(30) = 4.54, *p* = 0.00017, *d* = 0.82]. However, no such difference between First-Person [*M* = 4.05µV, *SE* = 0.42] and Third-Person [*M* = 3.97µV, *SE* = 0.42] Visual Perspectives was found for the Low Social Power condition [*t*(31) = 0.8, *p* > 0.43].

Crucially, we found a significant Picture Valence x Social Power interaction [*F*(1, 61) = 5.02, *p* = 0.029, *partial-eta* = 0.076]. Follow-up *t*-tests (Holms-Bonferroni corrected) showed that participants in the High Social Power condition showed larger (positive) mean amplitudes when observing the Pain stimuli [*M* = 3.62µV, *SE* = 0.37] compared to No Pain [*M* = 3.27µV, *SE* = 0.39; *t*(30) = 4.3, *p* = 0.0003, *d* = 0.8]. However, no such differences between Pain [*M* = 4.04µV, *SE* = 0.43] and No Pain [*M* = 3.97µV, *SE* = 0.41] was found for the for the Low Social Power condition [*t*(31) = 0.73, *p* > 0.47, *d* = 0.13]. See Figure 3 & 4.

**FIGURE 3 & 4 ABOUT HERE**

*3.1.3 The LPP (500-800ms)*

The 2x2x2 mixed-design ANOVA yielded no significant effects [all *p* > 0.07].

*3.1.4 Peak Latencies*

While previous research has primarily focused on mean amplitudes of the ERP components associated with empathy for pain (with a minority of studies using peak amplitude or point-by-point analyses; see Coll, 2018), we thought it may also be interesting to explore whether the peak latency of these ERP components may be influenced by social power. Across all ERP components (N2, P3, LPP), we only found a significant main effect of Picture Valence in the N2 [*F*(1, 61) = 6.6, *p* = 0.013, *partial-eta* = 0.1], which shows that the average N2 peak latency occurred faster as a result of pain observation [*M* = 248ms, *SE* = 2.9] vs. no pain [*M* = 255ms, *SE* = 3]. All others main effects and interactions, across all components, were not significant [all *p* > 0.28].

*3.2 Behavioural Results*

*3.2.1 Reaction Time*

The 2x2x2 mixed-design ANOVA yielded a significant main effect of Picture Valence [*F*(1,61) = 18.2, *p* = 0.00007, *partial-eta* = 0.23], such that participants showed faster reaction times for the Pain stimuli [*M* = 549ms, *SE* = 11.2] compared to No Pain [*M* = 561ms, *SE* = 11.2]. All other effects were non-significant [all *p* > 0.051].

*3.2.2 Errors*

The 2x2x2 mixed-design ANOVA yielded no significant effects [all *p* > 0.18].

*3.3 Correlations with ERP Components*

Given the significant main effect of Picture Valence, for the N2, we correlated each subscale of the IRI (Perspective Taking (PT), Empathic Concern (EC), Fantasy Scale (FS), and Personal Distress (PD)), the SOP and the BIS/BAS scales with the difference (of mean amplitudes) between Pain and No Pain conditions. We found a significant correlation between the N2 [Pain – No Pain] and PD [*r* = 0.38, *p* = 0.005], such that larger N2 effects correlated with larger PD scores. Note that this result remains significant even after correcting for multiple correlations [x7 scales; *p* = 0.035].

We follow the same procedures for the P3. However, given we found a two-way interaction in this component, we correlated each scale to the difference between Pain and No Pain conditions, across Social Power conditions. For the High Social Power condition, we found no significant correlations [all *p* > 0.1]. For the Low Social Power condition, we also found no significant correlations [all *p* > 0.25].

*3.4 Manipulation Checks*

To check that trait differences (in empathy, power, motivational tendencies) did not systemically bias one Social Power group over the other, we entered participant scores on the IRI, SOP, and BIS/BAS scales to an independent samples *t*-test with Social Power as the primary factor of interest. For the IRI subscales, the *t*-test did not yield any significant effects [PT: *p* > 0.32; EC: *p* > 0.42; FS: *p* > 0.37; PD: *p* > 0.82]. No significant difference was also shown for the SOP scale [*p* > 0.15]. Lastly, neither the BIS [*p* > 0.39] nor BAS [*p* > 0.15] scales showed significant differences between Social Power conditions.

To check that participants did indeed follow the instructions of the episodic recall task, we had two blind coders assess the contents of each essay on two dimensions: Social Power (“How much power did the participant hold in the essay? From -3 (least power) to +3 (most power)”) and Emotion (“How strong was their description of emotion in the essay? From -3 (most negative valence) to +3 (most positive valence)”). Following previous work (e.g., Hogeveen et al., 2014), if the episodic recall task was successful, then the High Social Power essays ought to be scored higher on both perceived power and emotional valence compared to Low Social Power essays. Furthermore, we should find a positive correlation with Social Power and Emotional Valence (as predicted by the approach-inhibition theory of social power; Keltner et al., 2003).

First, we found that the two coders showed strong agreement with one another [Social Power: *r* = 0.82, *p* < 0.0001; Emotion: *r* = 0.72, *p* < 0.0001]. As such, the average rating in each dimension was used for analysis. These average ratings were then entered into an independent samples *t*-test (with Social Power as the main factor of interest). The *t*-test showed that raters did indeed rate essays in the High Social Power condition [Social Power: *M* = 1.68, *SE* = 0.16; Emotion: *M* = 0.71, *SE* = 0.28] higher compared to essays in the Low Social Power condition [Social Power: *M* = -2.05, *SE* = 0.14; Emotion: *M* = -1.97, *SE* = 0.15] [Social Power: *t*(61) = 17.9, *p* < 0.00001, *d* = 4.5; Emotion: *t*(61) = 8.5, *p* < 0.00001, *d* = 2.15]. Lastly, we also found a significant correlation between Social Power and Emotional Valence [*r* = 0.82; *p* < 0.00001].

**4. Discussion**

The aim of the current study was to explore if and how Social Power influences the early (N2) and late (P3, LPP) components ostensibly related to empathy for pain. We did not find evidence to suggest that Social Power influences the N2 (although we did find the expected Picture Valence main effect of the N2 – both with mean amplitudes and peak latencies) or LPP (no significant effects); however, our results do suggest that Social Power influences the P3. In the P3, we found the expected main effect of Picture Valence, such that participants showed a larger mean amplitude in the P3 during Pain observation compared to NP. Crucially, this main effect was qualified by a two-way interaction between Picture Valence and Social Power. This interaction effect shows that it is solely the High Social Power condition that is driving the Pain vs. NP effect, as follow-up *t*-tests in the Low Social Power condition do not provide evidence of a Pain vs. NP effect in the P3.

Note that, without a neutral power group to compare to, we cannot conclude that the High Social Power condition is somehow *increasing* the P3 pain observation effect, as it is unclear whether the reported P3 effects would be significantly larger when compared to a neutral group. As such, our results can only be interpreted as a difference between social power conditions: participants in the High Social Power condition demonstrated a significant P3 pain observation effect while those in the Low Social Power condition did not. To consider this finding in more detail, we must rely on previous findings to guide our interpretations of these results. Given that the Low Social Power condition did not produce the pain-related P3 enhancement effect often found in the literature, it is possible that inducing states of Low Social Power somehow impairs cognitive empathy (i.e., the cognitive evaluation of the observed pain) relative to a baseline state, as indexed by the P3. This interpretation is somewhat consistent with Mast et al.’s (2009) results which showed that High Social Power, rather than Low Social Power, leads to greater interpersonal sensitivity. In their study, interpersonal sensitivity was measured using a variety of tasks that essentially involved emotion recognition. As such, the comparison to our study is apt given our use of the pain recognition task. Furthermore, previous studies have also reported that being in a sad mood impaired emotion recognition of faces compared to a neutral condition (Chepenik et al., 2007). Given the tight correlation that we observed between feeling powerless and negative emotional valence, it is possible that inducing a state of powerlessness can also lead to attenuated emotional recognition, or at least regarding pain recognition as indexed by the P3 (it is also possible that the Social Power manipulation induced negative emotional valence, rather than feeling powerless per se; see the limitation section below). Ultimately, more work will be needed to determine the veracity of these interpretations.

In addition to a significant Social Power x Picture Valence interaction effect in the P3, we also found a significant interaction between Social Power and Visual Perspective. The results show larger mean amplitude of the P3 for first-person images (compared to third-person) exclusively in the High Social Power group. These results may suggest that when in a Low Social Power state, individuals might *not* discriminate between self (first-person) vs. other (third-person) related stimuli, whereas individuals in a high social power state may be more sensitive to first person depictions of pain. This finding fits well with previous work on perspective taking and power. In particular, the high social power state has been linked to an ego-centric perspective (i.e, looking at things from the view of the “self”; Galinksy et al, 2006). In our study, such an ego-centric focus could lead to greater processing of first person stimuli as these are more similar to what would be seen if the self were being stimulated.

We also found a tight correlation between the N2 and the PD subscale of the IRI. It is important to note that empathy is often theorized to require the ability to distinguish between the self and other, such that one can distinguish between one’s emotional state vs. another (e.g., Bird & Viding, 2014). However, personal distress suggests that one is focusing on the self, rather than the other. As such, it is possible that the N2, rather than being an index of empathy during a pain categorization task, may instead be a general index of emotional valence and arousal – this interpretation is appropriate as the N2 is treated as such in the wider affective neuroscience literature (e.g., Olofsson et al., 2008).

Lastly, with regard to our ERP results not involving social power, we did not find a significant interaction between Visual Perspective and Picture Valence in the N2, P3, nor the LPP. This is at odds to the results reported in Galang et al. (2020) in which a similar paradigm was employed in the absence of any power manipulations. One possible explanation for this discrepancy is that the current study has no neutral power group, which would have been the state Galang et al.’s (20020) participants were presumably in during that experiment. It is possible then that inducing states of power (both high and low) somehow mitigates the interaction between Visual Perspective and Picture Valence and future studies should consider adding a neutral power group to test this possibility.

The behavioural results from the current study were consistent with previous findings. Specifically, we found that participants were faster to respond when observing Pain stimuli compared to No Pain stimuli. This corroborates previous work on reaction time and pain observation (e.g., Morrison et al., 2007; Fabi & Leuthold, 2017; Han et al., 2017; Galang et al., 2017; Galang & Obhi, 2020; Galang et al., 2020), which suggests that empathy for pain may motivate action (regardless of the action’s utility). Han et al. (2017) suggest that such motivation for action may be a mechanism for relieving self-distress. This behavioural finding may also be related to our peak latency results in the N2 (earlier peak latency after pain observation compared to no pain), which may suggest faster processing of the pain stimuli vs. no pain (perhaps due to the emotional content of the pain stimuli), which facilitated faster categorization of the stimuli. However, as the latency of responses to pain is not commonly analyzed in this literature, more work will be needed before strong interpretations are made.

*4.1 Limitations*

There are a number of important limitations to bear in mind pertaining to this study. In particular it has been suggested that social priming studies can be hard to replicate (Molden, 2014) and while we reviewed a number of studies showing the efficacy of the episodic recall task used here, we would be remiss to not mention cases where it does not influence the primary measures of interest (e.g., Heller & Ullrich, 2017; Zhang & Smith, 2018). Of particular relevance is recent work by Gilder & Heerey (2019) showing that social power effects can be confounded with experimenter beliefs; that is, participants in their studies showed effects congruent with the social power condition to which the experimenters *believed* the participant was assigned, rather than to the actual social power condition itself. To alleviate this possible confound, and to better control for extraneous factors outside of the episodic recall task, we implemented a number of controls.

First, we implemented an experimenter-blind procedure of the episodic recall task (see procedures section). As such, our experimenters were completely unaware of which Social Power condition each participant was assigned to – thereby making sure that experimenter belief cannot influence our results. Second, to account for potential differences in participants recruited to the two power conditions, we had participants complete a number of self-report inventories measuring trait-levels of empathy (IRI), power (SOP), and motivational tendencies (BIS/BAS). In all cases, groups did not significantly differ on these scales. Thus, systematic trait differences in these factors cannot explain our results. Lastly, to make sure participants completed the episodic recall task appropriately, we had two coders, blinded to the experimental design, hypotheses, and social power condition assignments, evaluate each essay on two dimensions: power and emotional valence. We found that High Social Power essays were indeed coded as more powerful and positively valenced than Low Social Power essays.

Relatedly, another limitation is the lack of distinction between the effects of social power vs. emotion. According to the approach-inhibition theory of power (Keltner et al., 2003), social power and emotional valence are closely connected (also evident in the strong correlation between power and emotion scores of the power essays by our blind coders). However, this leads to a problem of causation: what caused the differences in our results, feeling powerful/powerless or feeling happy/sad? Very few studies in the social power literature have attempted to pick apart these two factors (e.g., Mast et al., 2009; Hogeveen et al., 2014). And indeed, it may be possible that these two factors cannot be separated in any meaningful sense (e.g., maybe feeling powerless necessarily involves negative emotional valence). The results of the current study are interpreted following previous work using the episodic recall task (i.e., as an effect of social power). However, we note that there is a rich literature showing that the N2 and P3 are both sensitive to emotional processing (Olofsson et al., 2008). More work will be needed to tease apart the causal roles that power and emotion may have on these effects.

Another major limitation is that we did not pre-register this study – this is particularly problematic given the rather large number of ROIs, time-windows, ERP components, etc. that have been used in previous ERP research on empathy for pain (as discussed above). This of course can lead to increased analytical flexibility due to the researchers’ ability to essentially pick and choose which electrodes, time-windows, components, etc. to add to one’s analyses (Coll, 2018). To help combat this, we made it explicit that we opted to perform data analyses on the same ROIs, time-windows, and ERP components that were analyzed in our ownprevious study (Galang et al., 2020), with the ROIs (Frontal and Central-Parietal) created by pooling electrodes based on Fan & Han’s (2008) original electrode scheme. As such, by grounding our EEG parameters on our previous study, we mitigate the use of post-hoc criteria in our analysis (and also simplifies our models for analysis, i.e., not having *each* electrode as a level of a factor, which could increase type 1 error rates, as previous work has done). Nevertheless, we concede that this *a priori* selective analysis plan is still problematic, and that it would have been better to pre-register these parameters. Future ERP studies should strive to not only pre-register their EEG parameters but also consider using more sophisticated techniques that do not require *a priori* parameters (e.g., time windows) to be selected (e.g., Monte Carlo permutation tests with bootstrapping, e.g., Naccache et al., 2005; Manly et al., 2006; Ibanez et al., 2013).

Another major limitation is the fact that our sample consists of primarily female participants; and indeed, previous research has shown that gender can affect ERP components associated with empathy for pain (e.g., Han et al., 2008; Gonzales-Liencres et al., 2016). Given the resource and time constraints involved with running an EEG study on university students (e.g., equipment/room availability, trained RAs, number of available and interested participants throughout the school year, etc.), we opted to simply collect data without balancing gender to obtain enough participants per social power condition. It should also be re-iterated that we used the same needle/Q-tip picture stimuli throughout this experiment. The reason we did so was that we were successful in getting strong effects of the N2 and P3 in our previous work (Galang et al., 2020) using the same stimuli and experimental task as described in this study. And as we are exploring the effects of social power on these components, we thought it best to keep the stimuli/task the same, as doing so means that we ought to find the ERP effects of Pain vs. NP observation (even if Social Power did not interact with this factor). While this study did find robust effects of both the N2 and P3, it is nevertheless the case that this study primarily contained female participants observing male hands get pricked by a needle. As such, future work will be needed, using a more gender-balanced sample and diverse stimuli set, to see if these results can generalize beyond the specific context of the current study.

Furthermore, and as already discussed, the lack of a neutral comparison group in this study provides a major limitation in interpreting the results. As with our gender limitation, we chose not to collect a neutral social power group due to resource and time constraints involved with running an EEG study on first-year university students (e.g., equipment/room availability, trained RAs, number of available and interested participants, etc.) and thought it better to maximize sample sizes, rather than obtaining smaller sample sizes across three social power groups. Nevertheless, future work including a neutral power group will be needed to better illuminate the results of this study; however, the current results should be helpful in providing some background on the expected size and direction of these effects.

Lastly, it should be noted that the lack of a significant Social Power x Picture Valence or Social Power x Picture Valence x Visual Perspective interaction effect in the N2 may have been due to our experimental procedures, as the N2 is measured at precisely the same time the picture stimulus disappears from the screen. Although we nevertheless found a robust main effect of the N2 on pain vs. no pain observation, it is still possible that a different experimental design, using longer stimulus display latencies, may yield different results (although note that this explanation cannot account for our lack of Picture Valence x Visual perspective interaction, as Galang et al., 2020 report such an interaction using the same experimental parameters used in this study).

*4.2 Conclusion*

The aim of the current study was to explore if and how Social Power influences the early (N2) and late (P3, LPP) components ostensibly related to empathy for pain. Our results show that Social Power seems to exclusively influence the P3 during pain observation, such that high social power, but not low social power groups, exhibited a P3 enhancement when viewing a pain stimulus. When considered in conjunction with previous research, this finding suggests that low social power may lead to an impairment of the cognitive evaluation of someone else in pain. We also note a number of important limitations to our study. These limitations should not be ignored, and the reported results should be interpreted with care. As with all novel demonstrations, future research will be required to further interrogate the ideas put forward here.

**Acknowledgements**

This work was supported by an NSERC-PGS awarded to CMG and an NSERC Discovery grant, along with infrastructure funding from the Canada Foundation for Innovation (CFI), held by SSO. We also thank Audrey Kern for helping with data collection.

**Conflicts of Interest**

The authors declare no conflicts of interest.

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1. Components were categorized as an artifact if ICLabel assigned it a >90% probability of its source coming from eye blinks, muscle movements, heart beats, line noise, or channel noise. [↑](#footnote-ref-1)