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

pain

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25 **Abstract**

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

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

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59   **1. Introduction**

60   Social power is commonly defined as the ability to control or influence another's thoughts,

61   feelings, or behaviours (e.g., Keltner et al., 2003; Guinote, 2017). Empathy is commonly defined

62   as the ability to both share and understand the thoughts and feelings of others (e.g., Preston & de

63   Waal, 2002; de Waal & Preston, 2017; Rameson & Lieberman, 2009; Tremblay et al., 2018), and

64   is often distinguished between two types: affective empathy, which refers to the emotional sharing,

65   or "resonating", between the subject and object of empathy, and cognitive empathy, which refers

66   to a person's ability to engage in self-other processing such as being able to take the perspective

67   of others and/or "mentalize" (e.g., Tremblay et al., 2018). That there is some sort of relationship

68   between social power and empathy is captured succinctly by Lord Acton's (1887/1997) well-

69   known adage: "Power tends to corrupt and absolute power corrupts absolutely". And indeed,

70   current cultural tropes (at least amongst Western societies) often portray the powerful (e.g., CEOs,

71   politicians, bankers, etc.) as greedy and lacking in empathy.

72

73   Early work by Galinsky et al. (2006) corroborated this culturally-held stereotype. In one of their

74   experiments, participants were induced to states of high or low social power via the episodic recall

75   task, in which participants are induced into states of high, low, or neutral social power by recalling

76   and writing about a time when they felt powerful, powerless, or in the case of a neutral condition,

77   what they did the previous day. After the power manipulations, participants were instructed to

78   draw the letter "E" on their foreheads as quickly as they could. Within this task, participants could

79   either decide to draw the E in an other-oriented manner (where the "E" is drawn in the correct

80   direction relative to third-person observers) or in a self-oriented manner (where the "E" is drawn

81   in the correct direction relative to the drawer). Galinsky et al. (2006) report that participants in the

82 high social power condition were almost three times more likely to spontaneously draw the "E" in

83 a self-oriented manner compared to participants in the low social power condition. They took this

84 as evidence that perspective taking can be negatively affected in states of high social power.

85

86 Further corroboration is provided by Van Kleef et al. (2008). In their study, participants were

87 randomly paired with another participant, and participant took turns recounting a time that caused

88 them emotional suffering. Van Kleef et al. (2008) reported that participants with a higher sense of

89 power (measured via self-report) experienced less distress and less compassion during the

90 conversation (as compared to participants with a lower sense of power). In conjunction with

91 Galinsky et al.'s (2006) results, these studies seem to suggest that social power modulates both

92 affective (e.g., less distress and compassion during a conversation) and cognitive (e.g., perspective

93 taking indexed via the "E" task) empathy; specifically, high social power seems to diminish

94 empathy related processing.

95

96 Interestingly, and in contrast to Galinsky et al. (2006) and Van Kleef et al. (2008), Mast et al.

97 (2009) found that high social power can lead to better interpersonal sensitivity. In one of their

98 experiments, participants were induced to states of high, low, or neutral social power via the

99 episodic recall task. Immediately after this, participants completed the DANVA-2 Adult Facial

100 Expressions Test (Nowicki & Duke, 1994), which tests for emotional recognition/accuracy. They

101 found that participants in the high social power condition scored higher on the DANVA-2

102 compared to both the low social power and neutral conditions. The low social power and neutral

103 conditions did not significantly differ, suggesting that, while participants in the high social power

104 condition showed an increase in emotional recognition accuracy, participants in the low social

105   power condition did not show an equivalent decrease. Mast et al. (2009) speculated that inducing

106   their participants to a state of high social power led them to adopt a global cognitive style (i.e.,

107   more abstract thinking), which has been associated with increased interpersonal sensitivity (e.g.,

108   Ambady & Gray, 2002; Patterson & Stockbridge, 1998).

109

110   In addition to behavioural research, more recent neurophysiological research by Hogeveen et al.

111   (2014) has shown that inducing participants (via the episodic recall task) to a state of high or low

112   social power reduces or increases motor resonance, respectively, as indexed via TMS-induced

113   motor evoked potentials. Motor resonance refers to the automatic activation of the motor cortex

114   during observation of another person's actions. In so far as motor resonance relates to action

115   understanding as a result of action observation in the motor cortex (e.g., Rizzolatti & Luppino,

116   2001; but see Cook et al., 2014), Hogeveen et al. (2014) speculate that these results may suggest

117   that high or low social power individuals are less or more inclined to understand others,

118   respectively. In conjunction with Galinsky et al. (2006) and Van Kleef et al. (2008), these results

119   imply that states of high social power seems to attenuate empathic processing (also see Varnum et

120   al., 2016; Farwaha & Obhi, 2019).

121

122   The aim of the current study is to extend this line of research by exploring if and how social power

123   influences the event-related potential (ERP) components associated with empathy for pain. Fan &

124   Han (2008) were the first to report that both early (N1, P1, N2) and late (P3, LPP) components

125   were sensitive to pain vs. no pain observation, with the early components commonly thought to

126   index affective empathy (i.e., the emotional response to another's pain) and the later components

127   commonly thought to index cognitive empathy (i.e., the cognitive evaluation of another's pain).

128   However, it is important to note that this distinction and association between early-emotional and

129   late-cognitive processing is overly simplistic; for example, recent work by Hesse et al. (2016) and

130   Decety et al. (2018) suggest that early components can also reflect (and be influenced by) cognitive

131   factors during a pain observation task. A more recent meta-analysis and review by Coll (2018)

132   suggests that the most robust components are the N2, P3, and LPP, with the later components being

133   more reliably found compared to the early (Coll (2018) in fact found non-significant overall effects

134   of the N2; however, this may be due to the ambiguity of the direction of the effect, with some

135   studies finding more negative mean amplitudes, and others more positive, when comparing pain

136   vs. no-pain – see Galang et al. (2020) for a longer discussion of this point). With that said, follow

137   up studies have generally corroborated and extended Fan & Han's (2008) original findings (e.g.,

138   Li & Han, 2010; Sessa et al., 2014; Cui et al., 2016; Coll et al., 2017; Galang et al., 2020).

139

140   However, no study to date has explored whether social power can modulate these ERP

141   components. This research is needed as previous work seems to provide incongruent results – with

142   Galinsky et al. (2006), Van Kleef et al. (2008), and Hogeveen et al. (2014) showing that high social

143   power leads to an impairment of empathic processing, while Mast et al. (2009) show that high

144   social power accentuates empathic processing; as such, the results of this study may aid in

145   strengthening one of these two hypotheses. Furthermore, the results of this study will also show

146   whether the connection between social power and empathy can be seen at the neurophysiological

147   level of ERPs (i.e., automatic, and involuntary responses). Lastly, showing that social power does

148   indeed modulate these components will extend our growing understanding of how the ERP

149   components associated with empathy for pain are influenced by top-down factors.

150

151   To explore this issue, we employed the episodic recall task to induce our participants (primarily

152   female; see limitations section below) into either a state of high or low social power. Afterwards,

153   participants completed a pain recognition task (e.g., Fan & Han, 2008; Fabi & Leuthold, 2017;

154   Galang et al., 2020) to elicit the ERP components associated with empathy for pain. In this task,

155   participants observed either an image of a hand getting pricked by a needle (Pain) or being touched

156   by a Q-tip (No Pain). Participants had to categorize the images as either "Pain" or "No Pain" as

157   fast as they could. Furthermore, we showed these images shot from either a first-person or third-

158   person visual perspective, to explore whether visual perspective taking modulates how social

159   power interacts with pain observation.

160

161   We could make a number of predictions based on previous works. For example, given that Van

162   Kleef et al. (2008) found that a sense of high social power reduced distress and compassion towards

163   a suffering other and that Galinsky et al. (2006) found that inducing high social power led to lower

164   perspective taking, it might be expected that high social power will attenuate both the early and

165   late components of empathy for pain, and will diminish any influence of visual perspective.

166   Alternatively, the picture is somewhat complicated by Mast et al.'s (2009) findings that high social

167   power can also lead to *greater* interpersonal sensitivity, specifically in regard to emotional

168   recognition. This suggests that high social power could lead to an increase in later (or early-related)

169   cognitive components. Lastly, given both the novelty and exploratory nature of the current study,

170   it is possible that social power will not have any influence over the ERP components of empathy

171   for pain. In this case, we at least expect to corroborate previous ERP research on empathic pain

172   observation (i.e., differential effects of pain vs. pain observation in both the early and late

173   components).

174

175   As a final point, it should be noted that participants also completed the Interpersonal Reactivity

176   Index (IRI; Davis, 1980, 1983), the Sense of Power Scale (SOP Scale; Anderson et al., 2012), and

177   the Behavioural Inhibition/Activation System Scale (BIS/BAS Scale; Carver & White, 1994) at

178   the end of the experiment. The IRI consists of four subscales (Perspective Taking (PT), Empathic

179   Concern (EC), Fantasy Scale (FS), and Personal Distress (PD)) and is the most widely used self-

180   report measure of trait-levels of empathy. The SOP scale is a trait-level measure of feelings of

181   power, and the BIS/BAS scale is a trait-level measure of motivational (inhibition-

182   withdrawal/activation-approach) systems; these motivations systems have been related to states of

183   social power (e.g., Boksem et al., 2012; Li et al., 2016; Galang & Obhi, 2020). There were two

184   primary reasons these scales were included in this study: first, as exploratory measures to see if,

185   for example, trait-levels of empathy are associated with social power states; and second, as a

186   manipulation check to see whether random sampling did indeed provide us with unbiased groups

187   in each Social Power condition (i.e., to make sure that our effects were due to the episodic recall

188   task, rather than having one condition contain a large amount participants with high trait levels of

189   empathy, power, and/or BIS/BAS – for example, rather than high social power participants

190   showing attenuated responses in the late or early components, it may instead be due to having a

191   large number participants with low trait levels of empathy in that condition).

192

193   **2. Methods**

194   *2.1 Participants*

195   64 right-handed participants were recruited for course credit (n = 32 per social power condition;

196   Mean Age = 18.8; Males = 9; note that this gender imbalance is a limitation in this study, see

197   limitations). A simulation-based sensitivity analysis (via the SuperPower (ver. 0.0.3) R package,

198   Lakens & Caldwell, 2019) shows that, for a 2x2x2 mixed-model ANOVA (with 1 between-

199   subjects factor and 2 within-subjects factors) interaction effect, n = 32 (per between-subjects

200   group) is sensitive enough to detect *partial-eta* = ~0.12 at ~80% power. Furthermore, 1 participant

201   was removed from final analysis due to making too many errors during the pain categorization

202   task (>65% error rate; suggesting lack of attention to the stimuli). This left us with n = 63 (high

203   social power = 31; low social power = 32). Note that, even with 1 participant excluded, the

204   remaining sample size per condition generally matches what is found in the ERP literature (and, if

205   anything, is on the higher end; Coll, 2018). Furthermore, there was roughly the same number of

206   males in each social power condition (high social power = 5; low social power = 4) and participant

207   age did not significantly differ across conditions (high social power = 18.8 [SD = 3]; low social

208   power = 18.8 [SD = 2.5]; *p* > 0.92). Prior to participation, participants provided written informed

209   consent. This study was approved by the McMaster Research Ethics Board (MREB).

210

211   *2.2 Apparatus and Stimuli*

212   The experiment was programmed and presented using SuperLab ver. 5 (Cedrus Corporation, San

213   Pedro, CA, USA), and was run on a Lenovo P910 ThinkStation. Participants responded with their

214   right and left index fingers using a Cedrus RB series Response Pad. The visual stimuli consisted

215   of a picture depicting a male Caucasian hand either being pricked by a needle or touched by a Q-

216   tip from either the first-person perspective or third-person perspective (adapted from video stimuli

217   used by Avenanti et al., 2010). We manipulated visual perspective taking by presenting both

218   picture stimuli either upright to showcase a first-person perspective or inverted for a third-person

219   perspective (a similar method to manipulate visual perspective was used by Bucchioni et al., 2016

220   & Galang et al., 2020). The pictures were gray scaled to limit the influence of color in the tasks

221   (See Figure 1(a)). EEG was recorded using a 62 channel Neuroscan Quik-Cap throughout the

222   experiment. Participants also completed the Interpersonal Reactivity Index (IRI; Davis, 1980,

223   1983), the Sense of Power Scale (SOP Scale; Anderson et al., 2012), and the Behavioural

224   Inhibition/Activation System Scale (BIS/BAS Scale; Carver & White, 1994) at the end of the

225   experiment.

226

227   **FIGURE 1 ABOUT HERE**

228

229   *2.3 ERP Components*

230   While Fan & Han (2008) analyzed multiple components in their initial analysis, follow up studies

231   have not always examined the same components. For example, some studies have only replicated

232   the effects of pain observation in the P3/LPP (Lyu et al., 2014; Sessa & Meconi, 2015), while

233   others find only a subset of the early components (e.g., N1, P2 but no presence of the N2; Decety

234   et al., 2010). Furthermore, some studies split up the P3 into its ascending phase, peak, and

235   descending phase for separate analysis (e.g., Li & Han, 2010; Suzuki et al., 2015), while others

236   focus on the total P3/LPP waveform (Coll et al., 2017). As Coll (2018) points out, there is a danger

237   of increased analytical flexibility in the literature, thus potentially inflating Type 1 error rates. As

238   such, to help minimize Type 1 error inflation, we limit ourselves by using the same components,

239   time windows, and electrode schemes used in our previous study (i.e., Galang et al., 2020).

240

241   Specifically, we focus our analysis on the N2, P3, and LPP (the most reliably found components

242   in the literature; Coll, 2018). Following Galang et al. (2020), the N2 time window was determined

243   to be between 200ms-300ms, the P3 to be between 350ms-450ms, and the LPP to be between

244   500ms-800ms. The N2 was analyzed using the average waveforms from the Fz, F3, F4, FCz, FC3,

245   and FC4 electrodes ("Frontal-Central region") and the P3/LPP were analyzed using the average

246   waveforms from Cz, C3, C4, CPz, CP3, CP4, Pz, P3, and P4 electrodes ("Central-Parietal region");

247   note that Galang et al. (2020) based these regions of interest are on the electrode scheme originally

248   used by Fan and Han (2008).

249

250   *2.4 Design*

251   The experiment used a 2x2x2 mixed design, wherein Picture Valence (Pain, No-Pain (NP) and

252   Visual Perspective (1st Person (1P), 3rd Person (3P)) were the within-subjects factors, and Social

253   Power (High, Low) was the between-subjects factor. Participants were randomly assigned into the

254   Social Power conditions. The four stimuli making up the Picture Valence x Visual Perspective

255   factors (1P-Pain, 1P-NP, 3P-Pain, 3P-NP) were presented 60 times each, giving an overall trial

256   count of 240. The 2x2x2 mixed design was applied to the N2, P3, and LPP. We also report

257   correlations between the IRI, SOP, and BIS/BAS and these components.

258

259   *2.5 EEG Acquisition and Processing*

260   EEG was recorded using a 62 channel Neuroscan Quik-Cap. Impedance levels were below 15kΩ

261   before the start of the experiment. The EEG was sampled at 1000Hz and was online referenced to

262   an electrode near Cz. After data collection, the data was transferred to EEGLab (Delorme &

263   Makeig, 2004). In EEGLab, the data was down sampled to 250Hz, band-passed filtered at 0.1-

264   40Hz, and bad channels were identified and removed via the *clean_artifacts* function (all default

265   settings). The data was then re-referenced to the common average.

266

267   Independent Component Analysis (ICA) was then run on each dataset using EEGLab's *runica*

268   function (Infomax Extended). The ICLabel plugin (Pion-Tonachini et al., 2019) was then used to

269   automatically classify and subsequently remove components classified as artifacts (i.e., sources

270   coming from eye blinks, muscle movements, heart beats, line noise, and channel noise)[1].

271   Afterwards, removed channels were interpolated. The data was then epoched [-200ms 1000ms]

272   based on each condition (using the ERPLab plugin – Lopez -Calderon & Luck, 2014); epochs were

273   time locked to a photo-receptor marker for increased accuracy of stimulus onset. Epochs that

274   corresponded to bad behavioral trials (i.e., anticipatory responses (< 200ms), slow responses (>

275   1500ms), errors, or missing responses) were removed (less than 4% of trials on average). To check

276   whether the number of valid trials per condition did not significantly differ from one another, we

277   conducted a 2x2x2 mixed design ANOVA, with Picture Valence and Visual Perspective as the

278   within-subjects factor and Social Power as the between-subjects factor, on the total number of

279   valid trials. No significant results were found (all $p > 0.23$). The breakdown of the average number

280   of valid trials per condition is as follows: Pain_1P_High = 57.2 [SD = 4.5], NP_1P_High = 57 [SD

281   = 3.1], Pain_3P_High = 57.6 [SD = 3.8], NP_3P_High = 57.2 [SD = 4.4], Pain_1P_Low = 57.7

282   [SD = 2.3], NP_1P_Low = 57.5 [SD = 2.6], Pain_3P_Low = 58 [SD = 2.5], NP_3P_Low = 57.7

283   [SD = 2.8].

284

285   Using the ERPLab plugin, subject ERPs were created by averaging together epochs within each

286   condition (1P-Pain, 1P-NP, 3P-Pain, 3P-NP). Fz, F3, F4, FCz, FC3, and FC4 were averaged

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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.

287   together to create the "Frontal-Central" region for analysis of the N2 component, and Cz,C3, C4,

288   CPz, CP3, CP4, Pz, P3, and P4 were averaged together to create the "Central-Parietal" region for

289   analysis of the P3 and LPP components. Subject ERPs were then averaged together to create the

290   Grand Average ERPs used for visualization. Finally, ERPLab's ERP measurement tool was used

291   to obtain mean amplitudes between 200–300ms for the N2 in the Frontal-Central region and 350–

292   450ms/500–800ms for the P3/LPP components, respectively, in the Central-Parietal region.

293

294   *2.6 Procedure*

295   Participants first read over a letter of information going over the tasks in the study. If they were

296   comfortable with the procedures, they were asked to sign a consent form. Afterwards, participants

297   were fitted with a 62-channel EEG cap (Compuscan, Neuromedics). Once this was complete,

298   participants sat with their eyes open and closed alternating every two minutes for twelve minutes

299   – EEG data was collected during this time. Afterwards, participants completed the episodic recall

300   task using Microsoft Word to type their recollections – EEG data was also collected during this

301   time. It should be noted that the EEG data collected during the eyes open/closed baseline period

302   and the episodic recall task are meant for another project related to the use of Frontal Alpha

303   Asymmetry as an index of approach/withdrawal motivations (Boksem et al., 2012; Li et al., 2016;

304   Galang & Obhi, 2019). As this topic is not directly related to the current study's aims, we do not

305   report this data here. We merely mention this point for the sake of completeness in reporting our

306   procedures.

307

308   Participants were randomly assigned to either the High Social Power or Low Social Power

309   conditions. As described in the introduction, the episodic recall task requires participants to write

310   about a time when they felt powerful or powerless. Exact instructions were as follows (based on

311   Galinsky et al., 2003):

312

313   **High Social Power:** Please recall a particular incident in which you had power over

314   another individual or individuals. By power, we mean a situation in which you controlled

315   the ability of another person or persons to get something they wanted, or were in a position

316   to evaluate those individuals. Please describe this situation in which you had power – what

317   happened, how you felt, etc.

318

319   **Low Social Power:** Please recall a particular incident in which someone else had power

320   over you. By power, we mean a situation in which someone had control over your ability

321   to get something you wanted, or was in a position to evaluate you. Please describe this

322   situation in which you did not have power—what happened, how you felt, etc.

323

324   Participants were informed that they would have 10 minutes to complete the task, and that they

325   should write as much as possible within that time window. To keep the experimenter blind to the

326   participants' condition (to alleviate possible confounding effects of experimenter belief; Gilder &

327   Heerey, 2018), the Microsoft Word file was premade by another member of the lab (who did not

328   directly interact with the participants during the experiment). The Word file contained two pages;

329   the first stated that the participants should first wait for the experimenter to leave the room and to

330   scroll down afterwards, and the second contained the social power prompt. After the allotted time

331   limit was up, the experimenter came back into the room, asked the participant to save the file and

332   scroll back up to the first page (to make sure the experimenter remained blind). Note that the

333   experimenter was trained to interact with the participant in a neutral manner.

334

335   After the episodic recall task was completed, the SuperLab program containing the experiment

336   was played and the participant was presented with task instructions. The instructions were also

337   verbally explained by the experimenters: participants were instructed to press either the right or

338   left key if they saw a picture with someone in pain and to press the opposite key if they saw a

339   picture with someone not in pain. Key mappings of categories were counterbalanced between

340   blocks (after 120 trials); for example, if in one block the right button was assigned to painful

341   pictures, then in the next it was assigned to non-painful pictures. The order of the key mappings

342   (i.e., which button maps onto which category first) was counter balanced between participants. All

343   possible combinations of order were accounted for in our counter balancing. At the start of each

344   new key mapping, instructions were presented detailing the change. To make sure participants got

345   used to the key mappings, 20 practice trials were always provided at the start of each block. The

346   picture stimulus (1P-Pain, 1P-NP, 3P-Pain, 3P-NP) were randomly shown throughout the

347   experiment. Participants were given a self-paced break every 60 trials.

348

349   Each trial started with a 500ms inter-stimulus interval in the form of a black screen. A picture

350   stimulus then appeared for 200ms; however, the participant was instructed to press the button as

351   soon as they could correctly categorize the stimulus (up to 1500ms after the stimulus onset; see

352   Figure 1(b)). At the end of the computer task, the EEG cap was removed, and participants

353   completed the IRI, SOP, and BIS/BAS scales.

354

355   **3. Results**

356   *3.1 ERP Components*

357   *3.1.1 The N2 (200-300ms)*

358   The 2x2x2 mixed-design ANOVA yielded a significant main effect of Picture Valence [$F(1, 61)$

359    $= 33.8$, $p < 0.00001$, *partial-eta* $= 0.36$], such that participants showed larger (negative) mean

360   amplitudes when observing the Pain stimuli [$M = -7.3\mu V$, $SE = 0.36$] compared to No Pain [$M = -$

361    $6.7\mu V$, $SE = 0.34$]. All other effects were non-significant [all $p > 0.59$]. See Figure 2.

362

363   **FIGURE 2 ABOUT HERE**

364

365   *3.1.2 The P3 (350-450ms)*

366   The 2x2x2 mixed-design ANOVA yielded a significant main effect of Visual Perspective [$F(1,$

367    $61) = 11.4$, $p = 0.0013$, *partial-eta* $= 0.16$], such that participants showed a larger (positive) mean

368   amplitude when observing the picture stimuli from a First-Person Visual Perspective [$M = 3.84\mu V$,

369    $SE = 0.28$] compared to a Third-Person Visual Perspective [$M = 3.61\mu V$, $SE = 0.28$]; a significant

370   main effect of Picture Valence [$F(1, 61) = 11.15$, $p = 0.0014$, *partial-eta* $= 0.16$], such that

371   participants showed a larger (positive) mean amplitude when observing the Pain stimuli [$M =$

372    $3.84\mu V$, $SE = 0.28$] compared to No Pain [$M = 3.63\mu V$, $SE = 0.28$].

373

374   We also found a significant Visual Perspective x Social Power interaction [$F(1, 64) = 4.5$, $p =$

375   0.038, *partial-eta* $= 0.07$]. Follow-up *t*-tests (Holms-Bonferroni corrected) showed that

376   participants in the High Social Power condition showed larger (positive) mean amplitudes when

377   observing the stimuli from a First-Person Visual Perspective [$M = 3.62\mu V$, $SE = 0.38$] compared

378   to a Third-Person Visual Perspective [$M = 3.26\mu V$, $SE = 0.37$; $t(30) = 4.54$, $p = 0.00017$, $d = 0.82$].

379   However, no such difference between First-Person [$M = 4.05\mu V$, $SE = 0.42$] and Third-Person [M

380    $= 3.97\mu V$, $SE = 0.42$] Visual Perspectives was found for the Low Social Power condition [$t(31) =$

381   0.8, $p > 0.43$].

382

383   Crucially, we found a significant Picture Valence x Social Power interaction [$F(1, 61) = 5.02$, $p =$

384   0.029, *partial-eta* $= 0.076$]. Follow-up *t*-tests (Holms-Bonferroni corrected) showed that

385   participants in the High Social Power condition showed larger (positive) mean amplitudes when

386   observing the Pain stimuli [$M = 3.62\mu V$, $SE = 0.37$] compared to No Pain [$M = 3.27\mu V$, $SE = 0.39$;

387    $t(30) = 4.3$, $p = 0.0003$, $d = 0.8$]. However, no such differences between Pain [$M = 4.04\mu V$, $SE =$

388   0.43] and No Pain [$M = 3.97\mu V$, $SE = 0.41$] was found for the for the Low Social Power condition

389   [$t(31) = 0.73$, $p > 0.47$, $d = 0.13$]. See Figure 3 & 4.

390

391   **FIGURE 3 & 4 ABOUT HERE**

392

393   *3.1.3 The LPP (500-800ms)*

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

395

396   *3.1.4 Peak Latencies*

397   While previous research has primarily focused on mean amplitudes of the ERP components

398   associated with empathy for pain (with a minority of studies using peak amplitude or point-by-

399   point analyses; see Coll, 2018), we thought it may also be interesting to explore whether the peak

400   latency of these ERP components may be influenced by social power. Across all ERP components

401   (N2, P3, LPP), we only found a significant main effect of Picture Valence in the N2 [$F(1, 61) =$

402   6.6, $p = 0.013$, *partial-eta* $= 0.1$], which shows that the average N2 peak latency occurred faster as

403   a result of pain observation [M = 248ms, SE = 2.9] vs. no pain [M = 255ms, SE = 3]. All others

404   main effects and interactions, across all components, were not significant [all $p > 0.28$].

405

406   *3.2 Behavioural Results*

407   *3.2.1 Reaction Time*

408   The 2x2x2 mixed-design ANOVA yielded a significant main effect of Picture Valence [$F(1,61)$ =

409   18.2, p = 0.00007, *partial-eta* = 0.23], such that participants showed faster reaction times for the

410   Pain stimuli [M = 549ms, SE = 11.2] compared to No Pain [M = 561ms, SE = 11.2]. All other

411   effects were non-significant [all $p > 0.051$].

412

413   *3.2.2 Errors*

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

415

416   *3.3 Correlations with ERP Components*

417   Given the significant main effect of Picture Valence, for the N2, we correlated each subscale of

418   the IRI (Perspective Taking (PT), Empathic Concern (EC), Fantasy Scale (FS), and Personal

419   Distress (PD)), the SOP and the BIS/BAS scales with the difference (of mean amplitudes) between

420   Pain and No Pain conditions. We found a significant correlation between the N2 [Pain – No Pain]

421   and PD [r = 0.38, p = 0.005], such that larger N2 effects correlated with larger PD scores. Note

422   that this result remains significant even after correcting for multiple correlations [x7 scales; p =

423   0.035].

424

425   We follow the same procedures for the P3. However, given we found a two-way interaction in this

426   component, we correlated each scale to the difference between Pain and No Pain conditions, across

427   Social Power conditions. For the High Social Power condition, we found no significant

428   correlations [all $p > 0.1$]. For the Low Social Power condition, we also found no significant

429   correlations [all $p > 0.25$].

430

431   *3.4 Manipulation Checks*

432   To check that trait differences (in empathy, power, motivational tendencies) did not systemically

433   bias one Social Power group over the other, we entered participant scores on the IRI, SOP, and

434   BIS/BAS scales to an independent samples *t*-test with Social Power as the primary factor of

435   interest. For the IRI subscales, the *t*-test did not yield any significant effects [PT: $p > 0.32$; EC: p

436   > 0.42; FS: $p > 0.37$; PD: $p > 0.82$]. No significant difference was also shown for the SOP scale [p

437   > 0.15]. Lastly, neither the BIS [$p > 0.39$] nor BAS [$p > 0.15$] scales showed significant differences

438   between Social Power conditions.

439

440   To check that participants did indeed follow the instructions of the episodic recall task, we had

441   two blind coders assess the contents of each essay on two dimensions: Social Power ("How much

442   power did the participant hold in the essay? From -3 (least power) to +3 (most power)") and

443   Emotion ("How strong was their description of emotion in the essay? From -3 (most negative

444   valence) to +3 (most positive valence)"). Following previous work (e.g., Hogeveen et al., 2014),

445   if the episodic recall task was successful, then the High Social Power essays ought to be scored

446   higher on both perceived power and emotional valence compared to Low Social Power essays.

447   Furthermore, we should find a positive correlation with Social Power and Emotional Valence (as

448   predicted by the approach-inhibition theory of social power; Keltner et al., 2003).

449

450   First, we found that the two coders showed strong agreement with one another [Social Power: $r =$

451   0.82, $p < 0.0001$; Emotion: $r = 0.72$, $p < 0.0001$]. As such, the average rating in each dimension

452   was used for analysis. These average ratings were then entered into an independent samples t-test

453   (with Social Power as the main factor of interest). The t-test showed that raters did indeed rate

454   essays in the High Social Power condition [Social Power: $M = 1.68$, $SE = 0.16$; Emotion: $M = 0.71$,

455    $SE = 0.28$] higher compared to essays in the Low Social Power condition [Social Power: $M = $ -

456   2.05, $SE = 0.14$; Emotion: $M = -1.97$, $SE = 0.15$] [Social Power: $t(61) = 17.9$, $p < 0.00001$, $d = 4.5$;

457   Emotion: $t(61) = 8.5$, $p < 0.00001$, $d = 2.15$]. Lastly, we also found a significant correlation

458   between Social Power and Emotional Valence [$r = 0.82$; $p < 0.00001$].

459

460   **4. Discussion**

461   The aim of the current study was to explore if and how Social Power influences the early (N2) and

462   late (P3, LPP) components ostensibly related to empathy for pain. We did not find evidence to

463   suggest that Social Power influences the N2 (although we did find the expected Picture Valence

464   main effect of the N2 – both with mean amplitudes and peak latencies) or LPP (no significant

465   effects); however, our results do suggest that Social Power influences the P3. In the P3, we found

466   the expected main effect of Picture Valence, such that participants showed a larger mean amplitude

467   in the P3 during Pain observation compared to NP. Crucially, this main effect was qualified by a

468   two-way interaction between Picture Valence and Social Power. This interaction effect shows that

469   it is solely the High Social Power condition that is driving the Pain vs. NP effect, as follow-up t-

470   tests in the Low Social Power condition do not provide evidence of a Pain vs. NP effect in the P3.

471

472   Note that, without a neutral power group to compare to, we cannot conclude that the High Social

473   Power condition is somehow *increasing* the P3 pain observation effect, as it is unclear whether the

474   reported P3 effects would be significantly larger when compared to a neutral group. As such, our

475   results can only be interpreted as a difference between social power conditions: participants in the

476   High Social Power condition demonstrated a significant P3 pain observation effect while those in

477   the Low Social Power condition did not. To consider this finding in more detail, we must rely on

478   previous findings to guide our interpretations of these results. Given that the Low Social Power

479   condition did not produce the pain-related P3 enhancement effect often found in the literature, it

480   is possible that inducing states of Low Social Power somehow impairs cognitive empathy (i.e., the

481   cognitive evaluation of the observed pain) relative to a baseline state, as indexed by the P3. This

482   interpretation is somewhat consistent with Mast et al.'s (2009) results which showed that High

483   Social Power, rather than Low Social Power, leads to greater interpersonal sensitivity. In their

484   study, interpersonal sensitivity was measured using a variety of tasks that essentially involved

485   emotion recognition. As such, the comparison to our study is apt given our use of the pain

486   recognition task. Furthermore, previous studies have also reported that being in a sad mood

487   impaired emotion recognition of faces compared to a neutral condition (Chepenik et al., 2007).

488   Given the tight correlation that we observed between feeling powerless and negative emotional

489   valence, it is possible that inducing a state of powerlessness can also lead to attenuated emotional

490   recognition, or at least regarding pain recognition as indexed by the P3 (it is also possible that the

491   Social Power manipulation induced negative emotional valence, rather than feeling powerless per

492   se; see the limitation section below). Ultimately, more work will be needed to determine the

493   veracity of these interpretations.

494

495   In addition to a significant Social Power x Picture Valence interaction effect in the P3, we also

496   found a significant interaction between Social Power and Visual Perspective. The results show

497   larger mean amplitude of the P3 for first-person images (compared to third-person) exclusively in

498   the High Social Power group. These results may suggest that when in a Low Social Power state,

499   individuals might *not* discriminate between self (first-person) vs. other (third-person) related

500   stimuli, whereas individuals in a high social power state may be more sensitive to first person

501   depictions of pain. This finding fits well with previous work on perspective taking and power. In

502   particular, the high social power state has been linked to an ego-centric perspective (i.e, looking at

503   things from the view of the "self"; Galinksy et al, 2006). In our study, such an ego-centric focus

504   could lead to greater processing of first person stimuli as these are more similar to what would be

505   seen if the self were being stimulated.

506

507   We also found a tight correlation between the N2 and the PD subscale of the IRI. It is important

508   to note that empathy is often theorized to require the ability to distinguish between the self and

509   other, such that one can distinguish between one's emotional state vs. another (e.g., Bird & Viding,

510   2014). However, personal distress suggests that one is focusing on the self, rather than the other.

511   As such, it is possible that the N2, rather than being an index of empathy during a pain

512   categorization task, may instead be a general index of emotional valence and arousal – this

513   interpretation is appropriate as the N2 is treated as such in the wider affective neuroscience

514   literature (e.g., Olofsson et al., 2008).

515

516   Lastly, with regard to our ERP results not involving social power, we did not find a significant

517   interaction between Visual Perspective and Picture Valence in the N2, P3, nor the LPP. This is at

518   odds to the results reported in Galang et al. (2020) in which a similar paradigm was employed in

519   the absence of any power manipulations. One possible explanation for this discrepancy is that the

520   current study has no neutral power group, which would have been the state Galang et al.'s (20020)

521   participants were presumably in during that experiment. It is possible then that inducing states of

522   power (both high and low) somehow mitigates the interaction between Visual Perspective and

523   Picture Valence and future studies should consider adding a neutral power group to test this

524   possibility.

525

526   The behavioural results from the current study were consistent with previous findings.

527   Specifically, we found that participants were faster to respond when observing Pain stimuli

528   compared to No Pain stimuli. This corroborates previous work on reaction time and pain

529   observation (e.g., Morrison et al., 2007; Fabi & Leuthold, 2017; Han et al., 2017; Galang et al.,

530   2017; Galang & Obhi, 2020; Galang et al., 2020), which suggests that empathy for pain may

531   motivate action (regardless of the action's utility). Han et al. (2017) suggest that such motivation

532   for action may be a mechanism for relieving self-distress. This behavioural finding may also be

533   related to our peak latency results in the N2 (earlier peak latency after pain observation compared

534   to no pain), which may suggest faster processing of the pain stimuli vs. no pain (perhaps due to

535   the emotional content of the pain stimuli), which facilitated faster categorization of the stimuli.

536   However, as the latency of responses to pain is not commonly analyzed in this literature, more

537   work will be needed before strong interpretations are made.

538

539   *4.1 Limitations*

540   There are a number of important limitations to bear in mind pertaining to this study. In particular

541   it has been suggested that social priming studies can be hard to replicate (Molden, 2014) and while

542   we reviewed a number of studies showing the efficacy of the episodic recall task used here, we

543   would be remiss to not mention cases where it does not influence the primary measures of interest

544   (e.g., Heller & Ullrich, 2017; Zhang & Smith, 2018). Of particular relevance is recent work by

545   Gilder & Heerey (2019) showing that social power effects can be confounded with experimenter

546   beliefs; that is, participants in their studies showed effects congruent with the social power

547   condition to which the experimenters *believed* the participant was assigned, rather than to the

548   actual social power condition itself. To alleviate this possible confound, and to better control for

549   extraneous factors outside of the episodic recall task, we implemented a number of controls.

550

551   First, we implemented an experimenter-blind procedure of the episodic recall task (see procedures

552   section). As such, our experimenters were completely unaware of which Social Power condition

553   each participant was assigned to – thereby making sure that experimenter belief cannot influence

554   our results. Second, to account for potential differences in participants recruited to the two power

555   conditions, we had participants complete a number of self-report inventories measuring trait-levels

556   of empathy (IRI), power (SOP), and motivational tendencies (BIS/BAS). In all cases, groups did

557   not significantly differ on these scales. Thus, systematic trait differences in these factors cannot

558   explain our results. Lastly, to make sure participants completed the episodic recall task

559   appropriately, we had two coders, blinded to the experimental design, hypotheses, and social

560   power condition assignments, evaluate each essay on two dimensions: power and emotional

561   valence. We found that High Social Power essays were indeed coded as more powerful and

562   positively valenced than Low Social Power essays.

563

564   Relatedly, another limitation is the lack of distinction between the effects of social power vs.

565   emotion. According to the approach-inhibition theory of power (Keltner et al., 2003), social power

566   and emotional valence are closely connected (also evident in the strong correlation between power

567   and emotion scores of the power essays by our blind coders). However, this leads to a problem of

568   causation: what caused the differences in our results, feeling powerful/powerless or feeling

569   happy/sad? Very few studies in the social power literature have attempted to pick apart these two

570   factors (e.g., Mast et al., 2009; Hogeveen et al., 2014). And indeed, it may be possible that these

571   two factors cannot be separated in any meaningful sense (e.g., maybe feeling powerless necessarily

572   involves negative emotional valence). The results of the current study are interpreted following

573   previous work using the episodic recall task (i.e., as an effect of social power). However, we note

574   that there is a rich literature showing that the N2 and P3 are both sensitive to emotional processing

575   (Olofsson et al., 2008). More work will be needed to tease apart the causal roles that power and

576   emotion may have on these effects.

577

578   Another major limitation is that we did not pre-register this study – this is particularly problematic

579   given the rather large number of ROIs, time-windows, ERP components, etc. that have been used

580   in previous ERP research on empathy for pain (as discussed above). This of course can lead to

581   increased analytical flexibility due to the researchers' ability to essentially pick and choose which

582   electrodes, time-windows, components, etc. to add to one's analyses (Coll, 2018). To help combat

583   this, we made it explicit that we opted to perform data analyses on the same ROIs, time-windows,

584   and ERP components that were analyzed in our own previous study (Galang et al., 2020), with the

585   ROIs (Frontal and Central-Parietal) created by pooling electrodes based on Fan & Han's (2008)

586   original electrode scheme. As such, by grounding our EEG parameters on our previous study, we

587   mitigate the use of post-hoc criteria in our analysis (and also simplifies our models for analysis,

588   i.e., not having *each* electrode as a level of a factor, which could increase type 1 error rates, as

589   previous work has done). Nevertheless, we concede that this *a priori* selective analysis plan is still

590   problematic, and that it would have been better to pre-register these parameters. Future ERP

591   studies should strive to not only pre-register their EEG parameters but also consider using more

592   sophisticated techniques that do not require *a priori* parameters (e.g., time windows) to be selected

593   (e.g., Monte Carlo permutation tests with bootstrapping, e.g., Naccache et al., 2005; Manly et al.,

594   2006; Ibanez et al., 2013).

595

596   Another major limitation is the fact that our sample consists of primarily female participants; and

597   indeed, previous research has shown that gender can affect ERP components associated with

598   empathy for pain (e.g., Han et al., 2008; Gonzales-Liencres et al., 2016). Given the resource and

599   time constraints involved with running an EEG study on university students (e.g., equipment/room

600   availability, trained RAs, number of available and interested participants throughout the school

601   year, etc.), we opted to simply collect data without balancing gender to obtain enough participants

602   per social power condition. It should also be re-iterated that we used the same needle/Q-tip picture

603   stimuli throughout this experiment. The reason we did so was that we were successful in getting

604   strong effects of the N2 and P3 in our previous work (Galang et al., 2020) using the same stimuli

605   and experimental task as described in this study. And as we are exploring the effects of social

606   power on these components, we thought it best to keep the stimuli/task the same, as doing so means

607   that we ought to find the ERP effects of Pain vs. NP observation (even if Social Power did not

608   interact with this factor). While this study did find robust effects of both the N2 and P3, it is

609   nevertheless the case that this study primarily contained female participants observing male hands

610   get pricked by a needle. As such, future work will be needed, using a more gender-balanced sample

611   and diverse stimuli set, to see if these results can generalize beyond the specific context of the

612   current study.

613

614   Furthermore, and as already discussed, the lack of a neutral comparison group in this study

615   provides a major limitation in interpreting the results. As with our gender limitation, we chose not

616   to collect a neutral social power group due to resource and time constraints involved with running

617   an EEG study on first-year university students (e.g., equipment/room availability, trained RAs,

618   number of available and interested participants, etc.) and thought it better to maximize sample

619   sizes, rather than obtaining smaller sample sizes across three social power groups. Nevertheless,

620   future work including a neutral power group will be needed to better illuminate the results of this

621   study; however, the current results should be helpful in providing some background on the

622   expected size and direction of these effects.

623

624   Lastly, it should be noted that the lack of a significant Social Power x Picture Valence or Social

625   Power x Picture Valence x Visual Perspective interaction effect in the N2 may have been due to

626   our experimental procedures, as the N2 is measured at precisely the same time the picture stimulus

627   disappears from the screen. Although we nevertheless found a robust main effect of the N2 on pain

628   vs. no pain observation, it is still possible that a different experimental design, using longer

629   stimulus display latencies, may yield different results (although note that this explanation cannot

630   account for our lack of Picture Valence x Visual perspective interaction, as Galang et al., 2020

631   report such an interaction using the same experimental parameters used in this study).

632

633   *4.2 Conclusion*

634   The aim of the current study was to explore if and how Social Power influences the early (N2) and

635   late (P3, LPP) components ostensibly related to empathy for pain. Our results show that Social

636   Power seems to exclusively influence the P3 during pain observation, such that high social power,

637   but not low social power groups, exhibited a P3 enhancement when viewing a pain stimulus. When

638   considered in conjunction with previous research, this finding suggests that low social power may

639   lead to an impairment of the cognitive evaluation of someone else in pain. We also note a number

640   of important limitations to our study. These limitations should not be ignored, and the reported

641   results should be interpreted with care. As with all novel demonstrations, future research will be

642   required to further interrogate the ideas put forward here.

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656 **Acknowledgements**

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661 **Conflicts of Interest**

662 The authors declare no conflicts of interest.

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