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ORIGINAL RESEARCH

Social class affects neural empathic responses

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Abstract The present study tested whether socioeconomic status (SES) was linked to differences in the strength of neural empathic responses. Following previous research we measured fronto-central P2 responses to images of neutral faces and faces expressing pain. As predicted we found that higher SES was linked to diminished neural empathic responses. Interestingly, higher SES was positively correlated with self-reported trait empathy, suggesting that those higher in status may not realize that they are actually lower in empathy. Implications and future directions for research on empathy, altruism, and prosocial behavior are discussed.

Keywords SES · Social class · Empathy · ERP · P2

Is high socioeconomic status (SES) linked to less empathy? An emerging literature suggests this may be the case. People who are lower in SES appear to be more attuned to others. For example, Kraus et al. (2010) have shown that low SES is associated with better accuracy at determining others emotional states. Low SES is also associated with greater self-reported compassion for others and more pronounced heart rate deceleration in response to videos of others in compassion inducing situations (Stellar et al. 2012). In addition low SES is associated with more charitable and prosocial behavior (Piff et al. 2012, 2010). Taken together this work suggests that empathy may be negatively related to a person's SES. Yet to some extent the previous studies have used relatively indirect and downstream measures of empathy.

In the present work we tested the association of SES and empathy using a neural marker in an ERP paradigm, namely heightened fronto-central P2 in response to

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images of others in pain. This response is reliably elicited by others' expressions of pain and images of others experiencing painful events (i.e. scissors appearing to cut a hand) (Fan and Han 2008; Sheng and Han 2012; Sheng et al. 2013), and to correspond with judgments of whether another person is in pain as well as self-report ratings of distress in response to viewing such images (Fan and Han 2008). We predicted that this empathy-related P2 response would be negatively correlated with SES, such that those higher in status should show reduced neural empathic responses.

Methods

64 participants (36 m, 28 f, age $M = 21.36$, $SD = 5.00$) took part in what they were told was an EEG study on face processing and compensated with $20. Because previous work has demonstrated a racial bias in empathy (e.g. Sheng et al. 2013), we attempted to recruit only European Americans who were US born. Due to experimenter error three participants took part in the study that did not meet these criteria. These subjects were excluded leaving 61 participants (35 m, 26 f, age $M = 21.36$, $SD = 5.12$). Finally, in order to obtain a reliable measure of the P2 empathy effect, each subject was required to have at least 25 trials in each of the pain and no-pain face conditions. This excluded 3 more participants resulting in a final N of 58 participants (32 m, 26 f, age $M = 21.24$, $SD = 5.18$). The key results were not substantially affected by the exclusion of these six participants.

Self-report measures

SES was measured using three key measures previously used in research on SES and Mu-suppression (Varnum et al. 2015). These were the MacArthur scale of subjective social status, which asks participants to indicate their social class rank on a ladder with 10 rungs (Adler et al. 2000), 6-point scales measuring mother's and father's education (1 = "did not complete high-school," 6 = "PhD, MD, or JD"), and self-reported family income assessed using a scale with slider bars (minimum = $0, maximum = $500,000). As in Varnum et al. (2015), these 3

Table 1 Descriptive statistic for self-report scales

	M (SD)		M (SD)
MacArthur SSS	5.71 (1.78)	SCS: IND	5.07 (.60)
Highest parental EDU	3.98 (1.37)	SCS: INT	4.72 (.58)
Income	120.28 (101.57)	CRS	1.73 (1.49)
5-point class: current	3.03 (.82)	IRI: avg	2.31 (.48)
5-point class: childhood	3.16 (.79)	IRI: FS	2.60 (.77)
		IRI: EC	2.51 (.63)
		IRI: PT	2.55 (.68)
		IRI: PD	1.58 (.83)

measures (subjective social status, income, and highest parental education of whichever parent had the highest level of educational attainment) were standardized and averaged to form a composite index of SES ($\alpha = .73$).

As exploratory measures we also included: two scales measuring current and childhood social class using 5-point scales (1 = "lower class," 5 = "upper class"), the 28-item IRI, a self-report trait-level measure of empathy (Davis 1983), the 30-item self-construal scale (Singelis 1994), and Cohen's R scale, a measure of religiousness (Cohen et al. 2006).The IRI was added after the first 7 participants completed the study. A total of 51 participants in the final sample completed the IRI. Descriptive statistics for all scales are provided in Table 1.

Procedure

Participants completed demographic questions online before coming to the lab for the EEG session. Data were collected for the other questionnaires in the lab post-EEG session.

Stimuli

Participants completed an oddball task in which the targets were scrambled faces in the form of spirals (see Fig. 1) and the distractors were faces with either neutral expressions or facial expression indicating pain. The face stimuli were the European-American faces previous used in Sheng et al. research on neural empathic responses (2012, 2013). In previous work on neural empathic responses, participants have been asked to make judgments of whether or not the faces they viewed were of people in pain. In our study we sought to assess spontaneous neural responses to pain, thus we did not ask participants to make explicit pain judgments.

The faces were from 16 individuals: eight males and eight females. Each one appeared neutrally or in pain yielding 32 unique stimuli. There were also 4 unique spirals in the experiment; two rotating counterclockwise (as in Fig. 1) and two

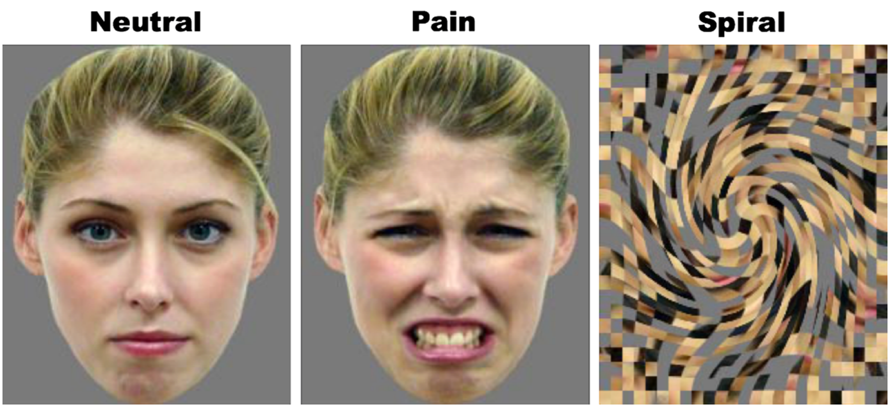

Fig. 1 Stimuli used in the EEG portion of the study

rotating clockwise. Each stimulus was presented 8 times in the experiment, yielding a standard:oddball ratio of 8:1 (12.5 % oddballs). Subjects were shown all four spiral images prior to the experiment and informed of the correct response. In total, there were 288 trials: 32 oddball images, 128 neutral images, and 128 pain images. These images were randomly divided into four 72-trial blocks separated by a 1–2 min break. Each trial was presented for 200 ms followed by a fixation cross for 1000–1600 ms, in increments of 100 ms, during which time participants could make their response. Thus, the interval between images ranged from 1200 to 1800 ms.

EEG recording and pre-processing

The EEG was recorded using a 32-channel cap with the average of the left and right mastoid electrodes as a reference on a NeuroScan Synamps RT system at 1000 Hz band-pass filtered from 1 to 100 Hz. The data were resampled offline to 250 Hz and band-pass filtered from 0.5 to 30 Hz. Data were time-locked to the onset of the face and epoched from −200 to 600 ms and baseline corrected to the first 200 ms pre-stimulus. Finally, trials which had a ±50 μV deviation across a 60 ms wide window moving in increments of 20 ms in any channel were considered artifacts and removed from analysis.

Results

Following Sheng et al. (2012, 2013) we analyzed data at frontal and central sites (F3, FZ, F4, FC3, FCZ, FC4, C3, CZ, and C4) in the time window 128–188 ms post-stimulus. We computed the difference score between responses to pain versus neutral faces, and consistent with previous findings we observed significantly greater P2 responses at all 9 electrode sites in response to pain versus neutral faces, $t(57)$'s ranging from 2.24 to 4.12, all p's < .03 (Fig. 2).

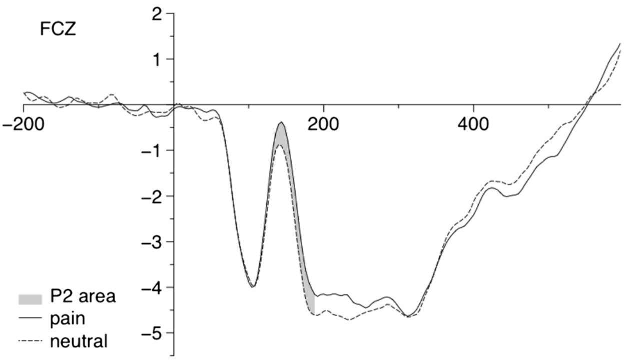

Fig. 2 Stimulus-locked event-related potentials to faces depicting pain (*solid line*) versus neutral faces (*dashed-line*). The *gray region* displays the P2 as defined by Sheng et al. (2013)

After examining our data, however, we observed that the 128–188 ms window used by Sheng et al. (2013) may have over estimated the latency for the peak P2 in our sample. Thus, to ensure that we had the peak P2—and presumably the best estimate of their empathy—for each of our subjects we identified the peak P2 amplitude within the 128–188 ms window across all face trials. Next, we computed the mean amplitude over the 50 ms window centered on that peak for each of the pain and no-pain conditions. Finally, the difference between these conditions was considered to be the subjects' P2 empathy effect (Fig. 3).

Consistent with our key prediction, composite SES was negatively correlated with neural empathic responses (pain–neutral difference scores) at F4 ($r = -.27$, $p < .04$), and FC4 ($r = -.28$, $p = .03$). Composite SES was also negatively correlated with neural empathic responses at the other fronto-central sites, however these effects were at trend level (r's ranging from $-.08$ to $-.21$, *ns*).The relationship between composite SES and neural empathic responses at F4 ($\beta = -.32$, $p = .03$), and FC4 ($\beta = -.34$, $p < .03$) remained significant in multiple regression analyses when IRI scores, age, and gender were simultaneously entered as predictors. Using a fixed window from 128 to 188 ms post-stimulus (Sheng and Han 2012; Sheng et al. 2013) yielded highly similar correlations. Composite SES was negatively correlated with neural empathic responses (pain–neutral difference scores) at F4 ($r = -.26$, $p = .05$), and FC4 ($r = -.27$, $p = .04$) (Fig. 4). Composite SES was also negatively correlated with neural empathic responses at the other fronto-central sites, however these effects were at trend level (r's ranging from $-.06$ to $-.19$, *ns*).

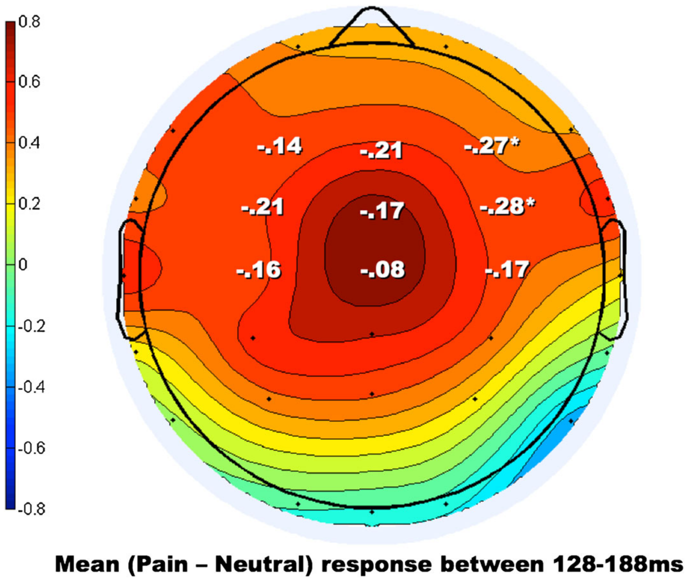

Fig. 3 Scalp map showing the mean amplitude of the empathy response (pain–neutral) across the scalp between 128–188 ms (after Sheng et al. 2012, 2013). Centered on the decimal place are the correlations between the standardized SES score and each of the electrodes of interest for the per-subject P2 amplitude computed as described in the text. *$p < .05$

The relationship between composite SES and neural empathic responses at F4 ($\beta = -.26$, $p < .09$), and FC4 ($\beta = -.27$, $p = -.08$) remained marginally significant in multiple regression analyses when IRI scores, age, and gender were simultaneously entered as predictors.

Scores on the MacArthur subjective social status ladder were significantly correlated with reduced neural empathic responses at FZ ($r = -.27$, $p = .04$), F4 ($r = -.27$, $p = .04$), FC4 ($r = -.26$, $p < .05$), and marginally at FCz ($r = -.24$, $p < .07$); they were negatively correlated with neural empathic responses at the other 5 electrodes but not significantly so (*r's* ranging from −.13 to −.21, *ns*). Parental education was also negatively correlated with neural empathic responses at F4 ($r = -.29$, $p < .03$) and FC4 ($r = -.28$, $p = .03$); parental education was negatively correlated with neural empathic responses at the other 7 electrodes but not significantly so (*r*'s ranging from −.05 to −.21, *ns*). Income was not significantly correlated with neural empathic responses (*r*'s ranging from −.14 to .07, *ns*).

Using a fixed window from 128 to 188 ms post-stimulus yielded similar results. Scores on the MacArthur subjective social status ladder were marginally correlated with reduced neural empathic responses at FZ ($r = .23$, $p = .08$), F4 ($r = .24$, $p = .07$) and FC4 ($r = .03$, $p < .09$); they were negatively correlated with neural empathic responses at the other 6 electrodes but not significantly so (r's ranging from −.10 to −.18, *ns*). Parental education was also negatively correlated with neural empathic responses at F4 ($r = -.27, p = .04$) and FC4 ($r = -.25, p = .05$); parental education was negatively correlated with neural empathic responses at the other 6 electrodes but not significantly so (*r*'s ranging from −.03 to −.19, *ns*). Income was not significantly correlated with neural empathic responses (*r*'s ranging from −.16 to .03, *ns*).

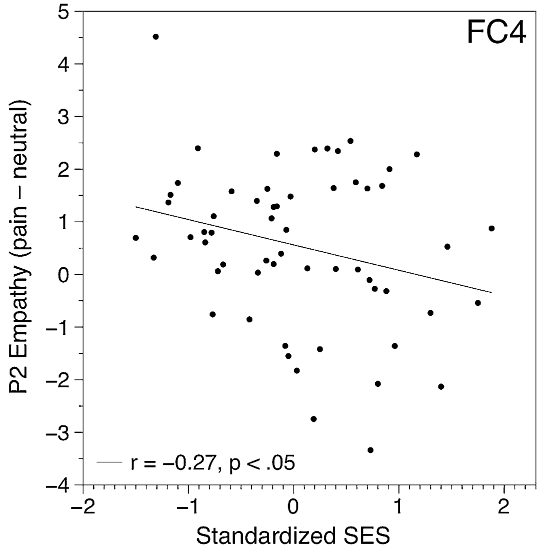

Fig. 4 Scatterplot showing the relationship between the empathic P2 response at FC4 and composite SES

Current subjective SES as measured on the 5-item scale was also negatively correlated with neural empathic responses at FZ ($r = -.22$, $p < .1$), F4 ($r = -.25$, $p = .06$), FC3 ($r = -.26$, $p = .05$), and C3 ($r = -.23$, $p = .08$).At the remaining 5 fronto-central sites the correlations were negative but non-significant (*r's* ranging from $-.09$ to $-.21$, *ns*). Childhood subjective SES was negatively correlated with neural empathic responses at all 9 fronto-central sites (*r*'s ranging from $-.05$ to $-.22$, *ns*), however only at FC3 did this effect approach significance ($r = -.22$, $p = .09$).

Using a fixed window from 128 to 188 ms post-stimulus yielded similar results. Current subjective SES as measured on the 5-item scale was also negatively correlated with neural empathic responses at all 9 electrodes (*r*'s ranging from $-.08$ to $-.21$), however only at F4 ($r = -.22$, $p = .09$) and FC3 ($r = -.22$, $p = .09$) did this relationship approach significance. Childhood subjective SES was negatively correlated with neural empathic responses at all 9 fronto-central sites (*r*'s ranging from $-.04$ to $-.23$), however only at FC3 did this effect approach significance ($r = -.23$, $p = .09$).

Interestingly, composite SES was positively correlated with IRI scores ($r = .27$, $p < .06$). Neither IRI scores, nor the R-scale, nor the Independent and Interdependent self-construal subscales were significantly correlated with neural empathic responses (pain-neutral) at any of the 9 fronto-central electrode sites ($|r\text{'s}| < .14$, *ns*), similar results were found using a fixed window from 128 to 188 ms post-stimulus ($|r\text{'s}| < .13$, *ns*). The R-scale ($r = .04$, *ns*), and interdependent ($r = .18$, *ns*) and independent ($r = -.06$, *ns*) self-construal subscales were also not correlated with composite SES.

The IRI consists of 4 subscales. The fantasy ($r = .28$, $p = .04$),and empathic concern subscales ($r = .29$, $p = .04$) of the IRI were positively correlated with composite SES. The fantasy ($r = .40$, $p = .004$), empathic concern ($r = .42$, $p = .002$), and personal distress subscales ($r = .32$, $p < .02$) were positively correlated with Interdependence. The fantasy subscale was positively correlated with neural empathic responses (as indexed by the individualized window) at CZ ($r = .30$, $p = .03$), and C4 ($r = .28$, $p < .05$). The fantasy subscale was also positively correlated with income ($r = .41$, $p = .003$), and marginally correlated with the 5-point subjective class measure ($r = .27$, $p < .08$). The empathic concern subscale was marginally correlated with scores on the MacArthur ladder, income, and the 5-point subjective class measure (*r*'s $> .24$, *p*'s $< .08$). The fantasy subscale was positively correlated with empathic concern ($r = .55$, $p < .001$), and personal distress ($r = .33$, $p < .02$). The empathic concern subscale was positively correlated with perspective taking ($r = .30$, $p = .03$), and personal distress ($r = .42$, $p = .002$). The perspective taking subscale was positively correlated with empathic concern ($r = .30$, $p = .03$), and marginally negatively correlated with personal distress ($r = -.23$, $p < .1$).

Women scored higher on the personal distress than did men ($r = .34$, $p = .01$), and marginally higher on empathic concern ($r = .24$, $p = .09$). Women had marginally stronger neural empathic response at FC3 when the window was calculated on an individual basis ($r = .24$, $p = .07$). There were no significant correlations between gender and self-construal or the CRS.

Discussion

Our results show that people who are higher in socioeconomic status have diminished neural responses to others' pain. These findings suggest that empathy, at least some early component of it, is reduced among those who are higher in status. These findings are broadly consistent with previous research showing that SES affects the degree to which people appear to be neurally attuned to others, including research showing that higher SES is associated with weaker Mu-suppression (a putative index of activation of the mirror neuron system) in response to others' motor movements (Varnum et al. 2015), and less activation in the mentalizing network when presented with images of others in social situations (Muscatell et al. 2012). They are also broadly consistent with previous behavioral research on the effects of SES on empathy and altruism (e.g. Kraus et al. 2010; Piff et al. 2010; Stellar et al. 2012).

Interestingly, we found a positive correlation when examining the relationship between a self-report measure of trait empathy and SES. This divergence suggests that in essence, higher status people perceive themselves to be more empathic (or at least present themselves in that fashion), but in fact may experience weaker empathic responses to others' pain. This would also be consistent with research demonstrating that the better-than-average-effect is stronger among those higher in SES (Varnum 2015), as are levels of narcissism (Piff 2014). Given this disconnect, it would also be interesting to test the extent to which neural markers of empathy might be better predictors of altruistic or prosocial behavior than self-reported measures of empathic tendencies. Future research should explore this possibility. In addition, it would be interesting to see if giving high SES participants feedback about their neural empathic responses might shift their self-views in this regard, or motivate them to actually become more attuned to others' suffering.

That said our study had a number of limitations. The magnitudes of the correlations between SES and neural empathic responses were small; however, they are comparable to the effect sizes found in previous social psychological research linking greater SES to greater empathy. Converting effect sizes into correlation coefficients from Stellar et al.'s (2012) studies yielded an average effect of $r = -.28$ (see Varnum 2013 for details). Nonetheless, the fact that the effects were fairly small and only significant for the composite SES index at 2 of the 9 sites (though results were somewhat more consistent for the MacArthur subjective social status measure) suggests that the present results should be interpreted with some caution. However it is worth noting that these results were fairly robust when controlling for IRI scores, age, and gender. Further, when examining individual markers of SES (subjective social status and parental education), significant or marginally significant correlations were seen at a larger number of electrode sites.

The present study did not assess or manipulate perceptions of the SES of the targets. We believe that this would be an interesting future direction. It may be that if the targets varied in terms of perceived SES we might observe intergroup phenomena, such that empathy was stronger for those whose SES was similar to that of the participants. It might also be the case that both high and low SES participants tend to assume others in general (in the absence of information regarding status) are of relatively lower (as opposed to higher status), which would have implications for why default differences in empathy may be observed as a function of participants' SES. Although these questions should be addressed in the future,we believe that the current study represents an important step in furthering our understanding of how SES affects empathy.

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