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Up-regulation of neural indicators of empathic concern in an offender population

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ABSTRACT

Empathic concern has traditionally been conceived of as a spontaneous reaction to others experiencing pain or distress. As such, the potential role of more deliberate control over empathic responses has frequently been overlooked. The present fMRI study evaluated the role of such deliberate control in empathic concern by examining the extent to which a sample of offenders recruited through probation/parole could voluntarily modulate their neural activity to another person in pain. Offenders were asked to either passively view pictures of other people in painful or non-painful situations, or to actively modulate their level of concern for the person in pain. During passive viewing of painful versus non-painful pictures, offenders showed minimal neural activity in regions previously linked to empathy for pain (e.g., dorsal anterior cingulate cortex and bilateral insula). However, when instructed to try to increase their concern for the person in pain, offenders demonstrated significant increases within these regions. These findings are consistent with recent theories of empathy as motivational in nature, and suggest that limitations in empathic concern may include a motivational component.

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Empathy, a vicarious emotional response to another's emotional state, has long been thought to play an important role in motivating prosocial behavior and inhibiting antisocial behavior (e.g. Hoffman, 2001). Increasingly, research has focused on specific facets of empathy rather than on the overarching concept (e.g. Decety & Cowell, 2014). Empathic concern, feelings of compassion for others in distress, has been identified as the facet of empathy most likely to elicit prosocial behavior and inhibit antisocial behavior (Batson, Ahmad, Lishner, & Tsang, 2002). The extent to which one experiences empathic concern is influenced by a variety of personality and contextual factors, and unfortunately there are many instances in which people display limited levels of empathic concern. This may be particularly true for offender samples with elevated levels of antisociality (e.g. Pfabigan et al., 2014).

Several approaches have been attempted to increase empathic concern, such as weeks-long compassion training (Weng et al., 2013). Although sometimes successful, these approaches assume empathic concern is a spontaneous reaction to others' distress. However, this may obscure the role of motivation in producing this response. Other studies have examined the extent to which changes in neural activity underlying empathy for others could be deliberately increased (Kim et al., 2009; Meffert, Gazzola, Den Boer, Bartels, & Keysers, 2013). However, these studies have examined aspects of empathy other than empathic concern (compassion for sad facial expressions and vicarious touch, respectively). As such, no study has yet examined whether neural activity underlying empathic concern for others in pain can be brought under voluntary control.

With this in mind, the present study was designed to evaluate whether a sample of antisocial offenders recruited through probation/parole could increase their neural activity in regions linked to empathic concern for others' pain. An offender sample was utilized because this group is known to have difficulties with empathic concern (e.g. Pfabigan et al., 2014), providing a stronger test of the possibility that empathic concern is under voluntary control. We asked offenders currently on probation/parole to undergo functional magnetic resonance imaging (fMRI) as they completed an empathy modulation task, in which participants were asked to attempt to

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voluntarily modulate their concern for others in pain. In normative populations, viewing others in pain produces increased neural activity within a distributed neural network that includes bilateral anterior insula (AI) and dorsal anterior cingulate cortex (dACC) as central nodes (Lamm, Decety, & Singer, 2011). We thus hypothesized that our offender sample would show increased AI/dACC responses to images of others in pain following an instruction to up-regulate their level of concern.

Method

Participants

Participants were twenty-six adults (25 men) on probation/parole for crimes more severe than drunk driving/possession. All were between the ages of 23 and 53 (M = 33.52, SD = 8.62), had full-scale IQ scores > 70 (M = 104.69, SD = 12.17), and tested at a minimum of a 6th grade reading level. As a within-subjects design was utilized to afford comparison of offenders' baseline/modulated indicators of empathic concern, a non-offender group was not required.

Exclusion criteria included loss of consciousness for greater than 30 minutes, along with common contra-indicators for MRI. All participants were diagnosed for psychopathy via the Psychopathy Checklist - Revised (PCL-R; Hare, 2003), and for Axis I/Axis II disorders via the Structured Clinical Interview for DSM-IV disorders (SCID-I/P; First et al., 2002). Three participants who failed to follow task instructions (e.g. stay awake) were dismissed from the study before completing the task. One female participant was also not included, given well-established gender-related differences in antisociality and empathic concern. Thus, data from 22 men were included in analyses.

Empathy modulation task

The empathy modulation task was a modified version of a standard emotion-regulation paradigm (Ochsner, Silvers, & Buhle, 2012). Participants were presented with pictures of people in painful and non-painful situations, and were either asked to react naturally, or to increase /decrease their concern for the person in the picture. Each trial began with an instruction ("WATCH", "INCREASE", or "DECREASE") presented at the top of the screen for 2000 ms. A picture depicting a person in a painful or non-painful situation was then presented under the instruction for 6000 ms. Finally, participants were asked to rate the level of pain experienced by the person in the picture using a 4-point Likert scale. Following a jittered intertrial interval (2000 ms, 3500 ms, or 5000 ms) the next trial began (see supplementary Figure 1).

Picture Stimuli and Trial Types

The 72 picture stimulus set (from Jackson et al., 2005) included pictures depicting one individual's hands/feet in self-induced painful (n = 54) or non-painful (n = 18) situations. Participants were only asked to modulate their concern during painful pictures; thus, the task included four different trial types ($NoPain_{WATCH}$, $Pain_{WATCH}$, $Pain_{INCREASE}$, and $Pain_{DECREASE}$). Each trial type was presented 18 times in each of two runs.

Image processing

Whole-brain imaging data was obtained using a Siemens 3T TrioTim MRI scanner, with advanced SQ gradients (max slew rate 200 T/m/s) equipped with a 16 element head coil. The IPAT (parallel acquisition) EPI gradient-echo pulse sequence (TR/TE 2000/29 ms, flip angle 75°, FOV 24 × 24 cm, 64 × 64 matrix, 3.4 by 3.4 mm in plane resolution, 3.5 mm slice thickness, 33 slices) covers the entire brain (150 mm) in 2.0 seconds. Head motion was limited using padding and restraint.

Functional images were reconstructed offline and reoriented to approximately the anterior commissure/posterior commissure (AC/PC) plane. Functional image runs were motion corrected using an algorithm unbiased by local signal changes (INRIAlign; Freire & Mangin, 2001) as implemented in Statistical Parametric Mapping 5 (SPM5; Friston et al., 1994). All participants displayed head movement of less than 5 mm maximum displacement between volumes within a run. A mean functional image volume was constructed for each run from the realigned image volumes. The mean EPI image was normalized to the EPI template. The spatial transformation into standard MNI space was determined using a tailored algorithm with both linear and non-linear components (Friston et al., 1994). The normalization parameters determined for the mean functional volume were then applied to the corresponding functional image volumes for each participant. The normalized functional images were smoothed with a 9 mm full width at half-maximum (FWHM) Gaussian. High-pass (cutoff period 116 hz) filters were applied to remove low-frequency confounds.

Data analytic strategy

Instruction, picture, and rating period were all modeled with the standard hemodynamic response function in single-subject analyses, with instruction and picture modeled as the single event of interest with eight-second duration. Mean images were created for each trial type that depicted activity occurring during this eight-second period. Both whole-brain (FWE corrected, $p < .05$, 10 contiguous voxels) and region of interest ($p < .05$, FWE, corrected for small volume search space) approaches were utilized. An a priori regions of interest (ROIs) mask was created by defining 10 mm spheres around coordinates obtained from a meta-analysis examining empathy for pain (Lamm et al., 2011) within bilateral insula ($x = -40$, $y = 22$, $z = 0$; $x = 39$, $y = 23$, $z = -4$) and dorsal anterior cingulate ($x = -2$, $y = 23$, $z = 40$), and combining these three ROIs into a single image.

Results

Baseline reactivity to others' pain

Baseline reactivity to the pain pictures was assessed via the $Pain_{WATCH}$ > $NoPain_{WATCH}$ contrast. Whole-brain analyses identified several regions with increased activity to the pain pictures, including bilateral supramarginal gyri and left precentral gyrus (see supplementary materials). Supramarginal gyrus (SMG) has been linked to distinguishing between self and other (e.g. Silani, Lamm, Ruff, & Singer, 2013), while precentral gyrus is considered part of the mirroring system (Rizzolatti & Craighero, 2004). However, in this offender sample there was no evidence of increased activity in regions with theorized involvement in empathy for pain (AI/dACC).

Table 1. Regions showing increased activity during modulation of empathic concern ($p < .05$, $k = 10$, FWE corrected unless otherwise indicated).

$Pain_{INCREASE}$ > $Pain_{WATCH}$ contrast				
Region	Cluster size	L/R	Peak voxel (x,y,z)	*t*-score
Insula	545	**L**	**−48, 15, 0**	**6.98**
Anterior cingulate cortex	502	**L**	**−6, 15, 45**	**5.02**
Insula*	77	**R**	**36, 15, 3**	**3.85**
Supplement motor area	502	L	−6, 3, 66	7.87
Cerebellum	209	R	27–72 −24	6.31
Precentral gyrus	88	L	−42, 3, 48	6.01
Inferior parietal cortex	90	L	−51, −54, 45	5.82
Cerebellum	22	L	−39, −57, −30	5.65
Dorsomedial prefrontal cortex	51	L	−30, 42, 21	5.55

Bold = Within predefined ROIs
Asterisk = Small volume corrected

Up-regulation of reactivity to others' pain

Participants' neural reactivity on $Pain_{INCREASE}$ trials served as the primary measure of interest, and was investigated via the $Pain_{INCREASE}$ > $Pain_{WATCH}$ contrast. This analysis identified significant activity across several brain regions (see Table 1), including both AI and dACC ROIs (see Figure 1). Thus, despite showing limited responsivity in AI/dACC to others' pain under passive-viewing conditions, participants showed significantly increased activity within these regions when instructed to increase their concern for the person in pain. Of import, the magnitude of neural up-regulation showed no association to offenders' level of antisociality (measured via PCL-R interview scores; see supplementary materials).

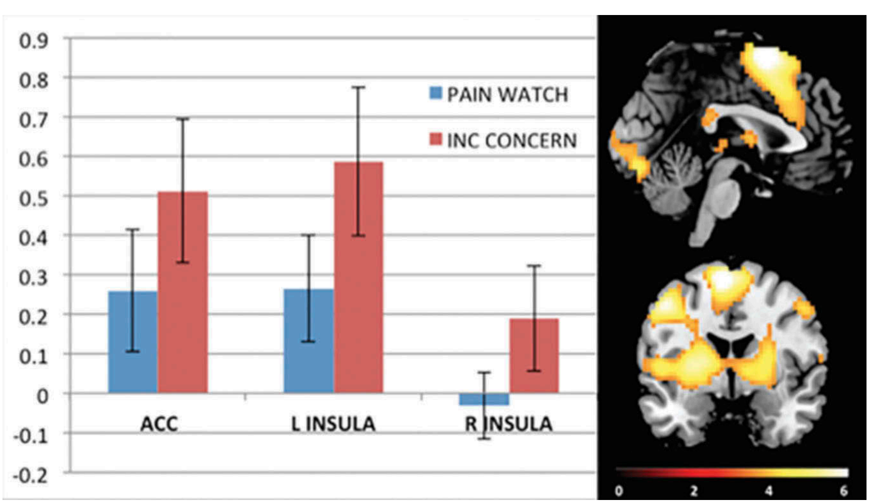

Figure 1. Neural activation and corresponding percent signal change for $Pain_{INCREASE}$ > $Pain_{DECREASE}$ trials. Y-axis represents percent signal change. Each condition is plotted against the corresponding $NoPain_{WATCH}$ average percent signal change for illustration purposes. Error bars represent standard errors. Neural activity displayed at $p < .001$ uncorrected for illustration purposes.

Top-down regulatory control processes

Separating neural activity associated with the generation versus regulation of emotions is a well-documented challenge (Ochsner et al., 2012). However, under the assumption that both up- and down-regulation of emotional responses require similar levels of top-down control, the $\text{Pain}_{\text{DECREASE}}$ condition was utilized as a control condition for top-down recruitment. To this end, the $\text{Pain}_{\text{INCREASE}} > \text{Pain}_{\text{DECREASE}}$ contrast revealed that activity within left AI and dACC ROIs was significantly greater on $\text{Pain}_{\text{INCREASE}}$ compared to $\text{Pain}_{\text{DECREASE}}$ trials (see supplementary materials). As effortful control was accounted for in this contrast, we interpret this increased AI/dACC response to represent the successful up-regulation of participants' empathic concern.

Discussion

The present study examined offenders' neural responses to pain and non-pain pictures under both passive- and instructed-viewing conditions. On passive-viewing trials, when participants were asked to watch the images as they normally would, they showed few areas of increased activity to others' pain and no increases in bilateral AI and dACC ROIs. In contrast, when participants were instructed to increase their concern for the person in pain, they showed significant increases in neural activity within several regions, including bilateral AI and dACC. These regions have previously been implicated in the generation of an empathy for pain response (e.g. Jackson et al., 2005), and may represent participants' ability to up-regulate their empathic concern for others' pain. Of import, up-regulation capacity appeared unrelated to offenders' level of antisociality, suggesting that even individuals with heightened PCL-R scores may be capable of voluntarily modulating their levels of empathic concern.

The present work expands on previous research demonstrating that empathy for vicarious touch (Meffert et al., 2013) and emotional facial expressions (Kim et al., 2009) are under voluntary control by extending this into the domain of empathic concern for others' pain. Additionally, research by Arbuckle and Cunningham (2012) has demonstrated that undergraduates scoring high on psychopathic traits behaved more altruistically when others were members of an in-group, rather than strangers. Together, these studies suggest that empathic concern may be at least partially under voluntary control, and provide a converging picture that deficits in empathic concern may include a motivational component. This is consistent with recent models of empathy, which have moved away from conceiving of empathy as solely an ability, and instead have emphasized the role of choice and motivation in producing an empathic response (e.g. Keysers & Gazzola, 2014; Zaki, 2014).

Although the present study sheds new light on the voluntary control of empathic concern, there are some limitations. First, controlling neural activity that has been linked to empathic concern does not necessarily equate with controlling empathic concern itself. Although reverse inference is common in social neuroscience, so too is the knowledge that it must be done cautiously (Poldrack, 2006). In the present study, a null result (no increased activity when directed to increase concern) would suggest an inability to control empathic concern; by rejecting the hypothesis that offenders lack this type of control, we take an initial step in determining that empathic concern is at least partially under voluntary control. Second, as we did not include a behavioral measure of empathic concern, it remains unknown how this increased neural response may relate to concern-related behavior. Finally, because we did not employ a non-offender comparison group, we cannot draw conclusions about the relative performance of offenders versus non-offenders. However, the fact that offenders - a population with low levels of concern - were capable of voluntarily controlling their neural activity underlying empathic concern provided a particularly strong test of our hypothesis.

In sum, the present study examined offenders' ability to up-regulate their emotional responses to others' pain, using neural activity previously linked to empathy for pain as our outcome measure. Offenders recruited through probation/parole showed little neural activity when passively viewing images of others' pain, but showed increased activation in regions previously linked to empathic processing (AI/dACC). These results suggest that empathic concern may include a voluntary component, and may be amenable to motivated control. Moreover, that offenders could increase these neural responses underlying concern for others suggests that even individuals with significant empathic deficits may be able to harness increased concern should motivation be sufficiently heightened.

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No potential conflict of interest was reported by the authors.

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References

Arbuckle, N. L., & Cunningham, W. A. (2012). Understanding everyday psychopathy: Shared group identity leads to increased concern for others among undergraduates higher in psychopathy. *Social Cognition*, *30*, 564–583. doi:10.1521/soco.2012.30.5.564

Batson, C. D., Ahmad, N., Lishner, D. A., & Tsang, J.-A. (2002). Empathy and altruism. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 485–498). New York, NY: Oxford University Press.

Decety, J., & Cowell, J. M. (2014). The complex relation between morality and empathy. *Trends in Cognitive Sciences*, *18*, 337–339. doi:10.1016/j.tics.2014.04.008

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B.W. (2002). Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Patient Edition. (SCID-I/P) New York: Biometrics Research, New York State Psychiatric Institute.

Freire, L., & Mangin, J.-F. (2001). Motion correction algorithms may create spurious brain activations in the absence of subject motion. *NeuroImage*, *14*, 709–722. doi:10.1006/nimg.2001.0869

Friston, K. J., Holmes, A. P., Worsley, K. J., Poline, J.-P., Frith, C. D., & Frackowiak, R. S. J. (1994). Statistical parametric maps in functional imaging: A general linear approach. *Human Brain Mapping*, *2*, 189–210. doi:10.1002/hbm.v2:4

Hare, R. D. (2003). The Hare Psychopathy Checklist – Revised (PCL-R) (2nd ed.). Toronto: Multi-Health Systems.

Hoffman, M. L. (2001). *Empathy and moral development: Implications for caring and justice*. Cambridge: Cambridge University Press.

Jackson, P. L., Meltzoff, A. N., & Decety, J. (2005). How do we perceive the pain of others? A window into the neural processes involved in empathy. *NeuroImage*, *24*, 771–779. doi:10.1016/j.neuroimage.2004.09.006

Keysers, C., & Gazzola, V. (2014). Dissociating the ability and propensity for empathy. *Trends in Cognitive Sciences*, *18*, 163–166. doi:10.1016/j.tics.2013.12.011

Kim, J., Kim, S., Kim, J., Jeong, B., Park, C., Son, A. R., … Ki, S. W. (2009). Compassionate attitude towards others' suffering activates the mesolimbic neural system. *Neuropsychologia*, *47*, 2073–2081. doi:10.1016/j.neuropsychologia.2009.03.017

Lamm, C., Decety, J., & Singer, T. (2011). Meta-analytic evidence for common and distinct neural networks associated with directly experienced pain and empathy for pain. *NeuroImage*, *54*, 2492–2502. doi:10.1016/j.neuroimage.2010.10.014

Meffert, H., Gazzola, V., Den Boer, J. A., Bartels, A. A. J., & Keysers, C. (2013). Reduced spontaneous but relatively normal deliberate vicarious representations in psychopathy. *Brain*, *136*, 2550–2562. doi:10.1093/brain/awt190

Ochsner, K. N., Silvers, J. A., & Buhle, J. T. (2012). Functional imaging studies of emotion regulation: A synthetic review and evolving model of the cognitive control of emotion. *Annals of the New York Academy of Sciences*, *1251*, E1–E24. doi:10.1111/j.1749-6632.2012.06751.x

Pfabigan, D. M., Seidel, E. M., Wucherer, A. M., Keckeis, K., Derntl, B., & Lamm, C. (2014). Affective empathy differs in male violent offenders with high- and low-trait psychopathy. *Journal of Personality Disorders*, *28*, 1–20.

Poldrack, R. A. (2006). Can cognitive processes be inferred from neuroimaging data? *Trends in Cognitive Sciences*, *10*, 59–63. doi:10.1016/j.tics.2005.12.004

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Review of Neuroscience*, *27*, 169–192. doi:10.1146/annurev.neuro.27.070203.144230

Silani, G., Lamm, C., Ruff, C. C., & Singer, T. (2013). Right supramarginal gyrus is crucial to overcome emotional egocentricity bias in social judgments. *Journal of Neuroscience*, *33*, 15466–15476. doi:10.1523/JNEUROSCI.1488-13.2013

Weng, H. Y., Fox, A. S., Shackman, A. J., Stodola, D. E., Caldwell, J. Z. K., Olson, M. C., … Davidson, R. J. (2013). Compassion training alters altruism and neural responses to suffering. *Psychological Science*, *24*, 1171–1180. doi:10.1177/0956797612469537

Zaki, J. (2014). Empathy: A motivated account. *Psychological Bulletin*, *140*, 1608–1647. doi:10.1037/a0037679