**Macro- and micro-structural cerebellar and cortical characteristics of cognitive empathy towards fictional characters in healthy individuals**

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ROI-based VBM

At an uncorrected level of significance (puncorr < 0.001), Fantasy IRI subscale was positively associated with the left precuneus. A positive uncorrected association (puncorr < 0.001) was also found between Personal Distress and left somatosensory cortex. Negative uncorrected associations (puncorr < 0.001) were found between Perspective Taking and two clusters in right supplementary motor area and left somatosensory cortex (Supplementary Table 1).

Whole-brain VBM

At an uncorrected level of significance (puncorr < 0.001) the Fantasy subscale was positively associated with right cerebellar lobule 4-5, right frontal inferior pars triangularis, right cuneus, right lingual gyrus, right hippocampus, and with left precuneus. Other positive uncorrected associations (puncorr < 0.001) were found between Personal Distress subscale and volumes in left temporal superior gyrus. Negative uncorrected associations (puncorr < 0.001) were found between Perspective Taking and volumes in right supplementary motor area, right precentral gyrus, right frontal superior gyrus and right frontal inferior pars opercularis, and in left postcentral gyrus. No significant associations were found between Empathic Concern subscale and GM volumes (Supplementary Table 1).

The volumetric modifications found to be associated to empathic abilities are consistent with literature data. Namely, the volumes of inferior frontal gyrus, somatosensory cortex, precuneus, and cuneus are consistently associated with the individual differences in cognitive empathy (Avenanti et al., 2009; Keysers and Gazzola, 2006), while the volume of temporal superior gyrus is associated with the individual differences in affective empathy (Mackes et al., 2018). These findings support the evidence for cognitive and affective empathy being represented by cortical correlates.

**References**

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**Table 1S| Regional gray matter Volumes (ROI-based analyses) and IRI subscales**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Label for peak** | **Side** | **Extent (n voxels)** | **t** | ***p*** | **equivZ** | **x,y,z (mm)** |
| **Fantasy** |  |  |  |  |  |  |
| **Precuneus** | **L** | **63** | **4.04** | **0.058** | **3.81** | **-10, -57, 24** |  |  |  |
| **Perspective Taking** |  |  |  |  |  |  |
| **Supplementary Motor Area** | **R** | **116** | **3.90** | **0.057** | **3.68** | **3, -12, 52** |
| **Supplementary Motor Area** | **R** | **96** | **3.71** | **0.093** | **3.52** | **14, -18, 67** |
| **Somatosensory Cortex** | **L** | **257** | **4.11** | **0.053** | **3.86** | **-52, -12, 31** |
| **Personal Distress** |  |  |  |  |  |  |
| **Somatosensory Cortex** | **L** | **64** | **3.76** | **0.126** | **3.57** | **-34, -13, 42** |

**Abbreviations:**

***P* = significance (uncorrected) at the cluster level**

**L = left**

**R = right**

**Coordinates are in Montreal Neurological Institute (MNI) space.**

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**Table 2S| Regional gray matter Volumes (Voxel Based Morphometry) and IRI subscales**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Label for peak** | **Side** | **Extent (n voxels)** | **t** | ***p*** | **equivZ** | **x,y,z (mm)** |
| **Fantasy** |  |  |  |  |  |  |
| Cuneus | R | 279 | 4.39 | 0.402 | 4.10 | 15, -78, 25 |
| Inferior Frontal Gyrus, Pars Triangularis | R | 60 | 4.25 | 0.892 | 3.99 | 42, 33, 3 |
| Precuneus | L | 52 | 4.04 | 0.909 | 3.81 | -10, -57, 24 |  |  |  |
| Lingual Gyrus | R | 76 | 3.96 | 0.856 | 3.74 | 21, -66, -2 |
| Hippocampus | R | 92 | 3.79 | 0.817 | 3.59 | 34, -9, -14 |
| Cerebellum lobule 4-5 | R | 69 | 3.65 | 0.872 | 3.47 | 16, -43, -9 |
| **Perspective Taking** |  |  |  |  |  |  |
| Postcentral gyrus | L | 308 | 4.11 | 0.342 | 3.86 | -52, -12, 31 |
| Supplementary Motor Area | R | 116 | 3.90 | 0.757 | 3.68 | 3, -12, 52 |
| Precentral Gyrus | R | 128 | 3.80 | 0.725 | 3.60 | 22, -18, 67 |
| Superior Frontal Gyrus | R | 75 | 3.69 | 0.861 | 3.51 | 20, 0, 55 |
| Inferior Frontal Gyrus, pars opercularis | R | 67 | 3.48 | 0.880 | 3.33 | 46, 9, 10 |
| **Personal Distress** |  |  |  |  |  |  |
| Superior Temporal Gyrus | L | 114 | 3.90 | 0.762 | 3.69 | -57, -31, 12 |

Abbreviations:

*P* = significance (uncorrected) at the cluster level

L = left

R =right

Coordinates are in Montreal Neurological Institute (MNI) space.

**FIGURE 1S | Association between whole-brain grey matter volumes and IRI subscales.**



**FIGURE 1S. Association between whole-brain gray matter volumes and IRI subscales.** Fantasy and Personal Distress subscales showed positive associations, while Perspective Taking subscale showed negative associations. Coordinates are in Montreal Neurological Institute (MNI) space. Z above colorbar indicates normalized t-values. In figure left is left.