Distinct regions of right temporo-parietal junction are selective for theory of mind and exogenous attention

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Background:
In functional magnetic resonance imaging (fMRI) studies, a cortical region in the right temporo-parietal junction (RTPJ) is recruited when participants read stories about people’s thoughts (‘Theory of Mind’). Both fMRI and lesion studies suggest that a region near the RTPJ is associated with attentional reorienting in response to an unexpected stimulus. One recent study compared these activations using a region of interest (ROI) analyses, and found evidence consistent with a single common region. However, the apparent overlap may have been due to the low resolution of the previous technique. We sought to test this hypothesis using a high-resolution protocol, within-subjects analyses, and more powerful statistical methods.

Central Questions:
- In an fMRI study, what constitutes sufficient evidence to suggest a shared neural substrate between two different tasks?
- Is it safe to conclude from the evidence in right Temporo-Parietal Junction that the Exogenous Attention and Theory of Mind tasks have a common neural and psychological mechanism?

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Subjects:
21 right-handed, native English speakers (10 women, 11 men)
12-channel head coil, 3T Siemens MAGNETOM Trio
In-plane resolution of 1.6 x 1.6 mm

**Theory of Mind Experiment**
-50% false belief
-50% false photo

**Exogenous Attention Experiment**
-25 trials
-44% “valid”
-16% “invalid”

**Theory of Mind ROI**
invalid vs. valid:
t(20)=4.9,p<0.0001
99.9% confidence interval for the difference between the peaks within a sample: 6 - 10 mm

**Attention ROI**
belief vs. photo:
t(20)=3.8,p<0.001
Peak Position - Bootstrap:
Distance between peaks (mm)

Overlap: Group, Bootstrap, & Individuals

Subjects were influenced by the spatial cue:
RT(valid 445ms) > RT(invalid 408ms)
paired-samples t-test (t(20)=3.8,p<0.001)

Subjects faster on belief trials:
RT(belief 2.64s) > RT(photo 2.80 s)
paired-samples t-test (t(17)=2.7,p=0.015)

Conclusions
*Resolution limitations, group averaging, and spatial normalization all tend to bias fMRI results to show overlap.
*In comparison to previous studies, improvements in data acquisition and analysis helped mitigate these factors, and oppugn earlier claims of common neural mechanism.

Region of Interest analyses replicated previous findings (Mitchell 2007)
Activations compared at high-resolution both in individuals and with powerful group methods
-Peak voxels found to reliably differ by 10 mm in Z dimension
-Consistent with recent meta-analysis (Decety 2007)
-Overlap both in individuals and bootstrap samples estimated below 10%

Could not find strong evidence that Theory of Mind and Exogenous Attention tasks recruit a common region