Theory of mind and grey matter volume in late childhood

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Introduction

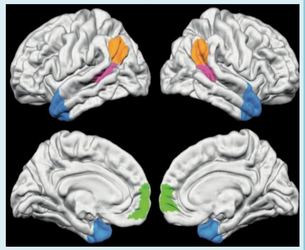
❖ **Theory of mind (ToM)**

- Ability to attribute mental states to oneself and others[1]
- Undergoes important development during childhood[1]
- Plays a crucial role in social adjustment[2]

❖ **Theory of mind and brain morphology**

Social brain

- In adults: identified by fMRI studies[3]
- In childhood: neural correlates of ToM remain unclear



Acquisition and practice of cognitive abilities
↓
Experience-dependent mechanisms of neuroplasticity
↓
Effect on brain morphology[4]

❖ **Hypothesis**

- Activation patterns more diffuse in children vs. adults?[5]
  → Additional cortices whose GMV correlates to ToM are expected
- Exact location of these regions not hypothesized a priori

❖ **Objective**

Investigate the associations between ToM performance in middle childhood and whole-brain GMV in late childhood.

Method

❖ **Participants**

58 children (25 boys)
Three assessments:

- T1 = 6 years (*M* = 6.07)
- T2 = 7 years (*M* = 7.14)
- T3 = 10 years (*M* = 10.47)

❖ **Measures**

Theory of mind (T1, T2)

- Second-order false-belief stories[1,6]
- Scores at T1 and T2 significantly correlated (*r* = .28, *p* = .03)
  - Average score retained for analyses

Grey matter volume (T3)

- MRI with standard 3D T1-weighted whole-brain protocol
- Scanner models: Siemens 3T Trio (n = 33) and Siemens 3T Prisma (n = 25)
- Preprocessing (CAT12, SPM12)
  - Pediatric templates[8]
  - 8-mm FWHM smoothing

❖ **Statistical analyses**

- Multiple regressions analyses to predict whole-brain regional grey matter volume from ToM abilities
- p < .001, uncorrected
- Extend threshold = 100 voxels
- Covariates: child age, sex, total intracranial volume, maternal education and scanner model

Results

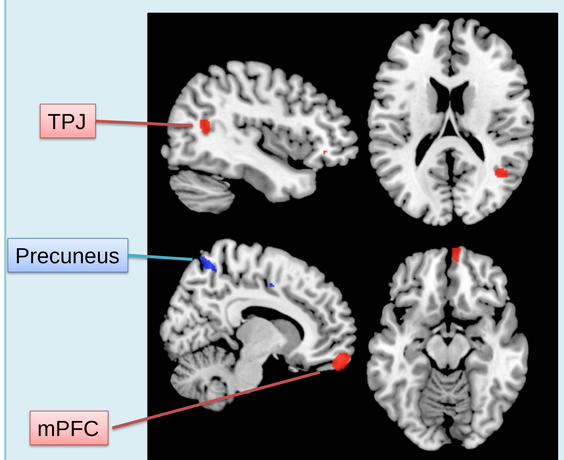
Higher performance on ToM tasks
↓↓↓
Larger GMV in the right medial prefrontal cortex (mPFC) and the temporo-parietal junction (TPJ)

Smaller GMV in the right precuneus

Table 1. *Associations Between Child Theory of Mind and Regional GMV in Late Childhood*

Cortical regions	BA	*k*	*T*	MNI coordinates
Positive associations				
Right mPFC	11	306	5.13	6, 62, −22
Right TPJ	39	142	4.18	42, −58, 14
Negative associations				
Right precuneus	7	216	4.05	9, −60, 64

Note. Results hold at *p* < .001, uncorrected, with an extend threshold of 100 voxels. BA = Broadman's area. *k* = number of voxels. *T* = peak T-value.



Conclusion

Superior ToM during childhood was related to the volume of neural structures that are essential for mentalizing abilities at a later age

❖ **TPJ, mPFC**

- Consistent with studies of adult populations[3]
- Involved in perspective taking, attributing mental states[3]

❖ **Precuneus**

- Role in ToM considered secondary[3]
- Involved in mental imagery[3]
- Negative associations : unexpected
  - Developmental considerations: inverted U-shape of GMV maturation [8]
  - Regional differences in the maturation process?

❖ **Additional observations**

- Children vs. adults: no additional neural structure was found
- Repeated MRIs necessary to confirm whether positive or negative associations reflect greater maturity

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