The Neural Correlates of Sensorimotor Attenuation

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Introduction

- The sensory consequences of voluntary actions are typically perceived as weaker than the same sensory events that are externally generated.
- Sensorimotor attenuation has been suggested to be mediated by a prediction mechanism, whereby an 'efference copy' of the motor command is used to predict its sensory consequences.
- Predicted sensory signal is removed from the perceived sensation following one's own action, enhancing the relative intensity of externally produced sensory events.
- Previous studies suggested sensorimotor attenuation relies on brain signals related to preparation for action, originating from areas upstream to primary motor cortex.

What are the brain areas related to sensorimotor attenuation?

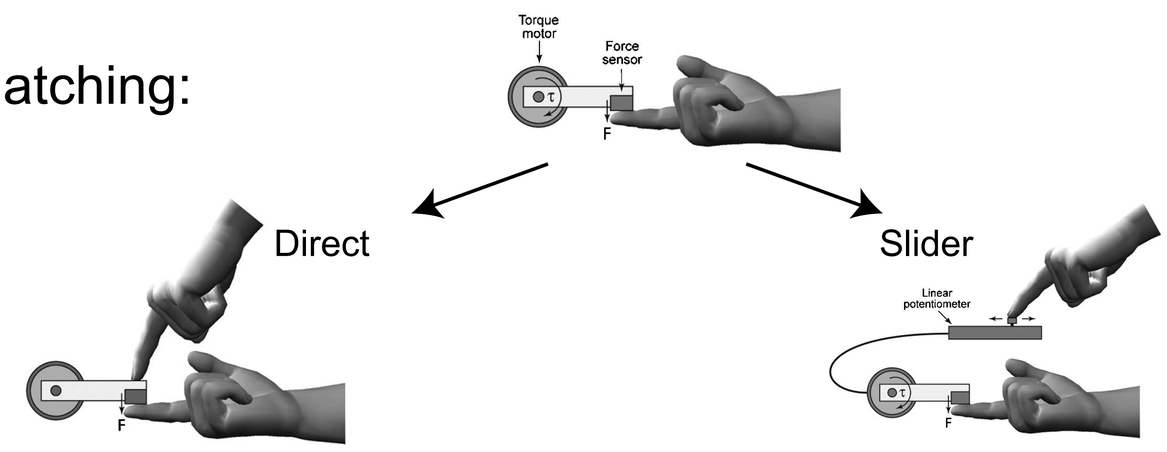
Methods

Subjects: n=146, aged 18-90 (55±19)

MRI: Siemens Trio 3T

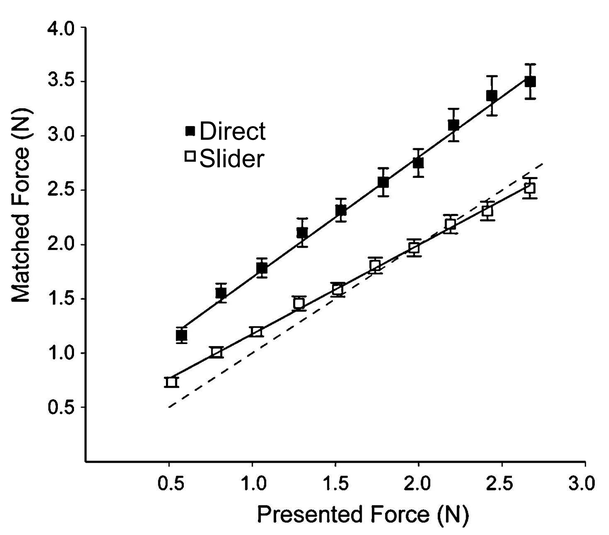
MPRAGE; 1 mm isotropic for
Voxel-Based Morphometry with SPM8

Force Matching:

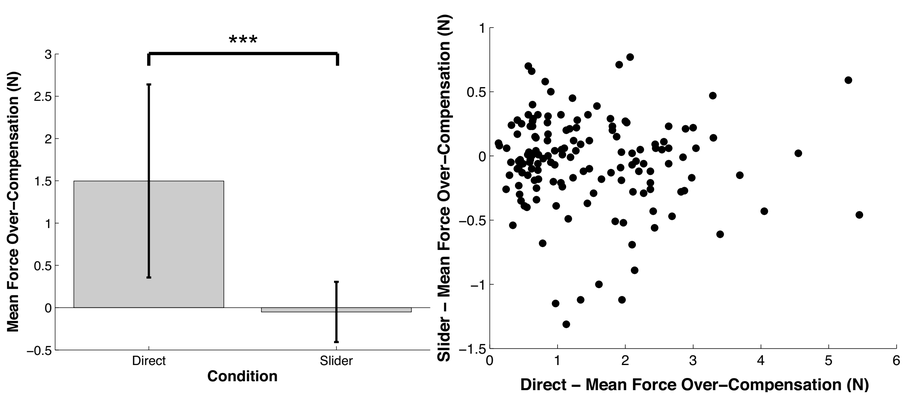


Results

Typical individual subject data



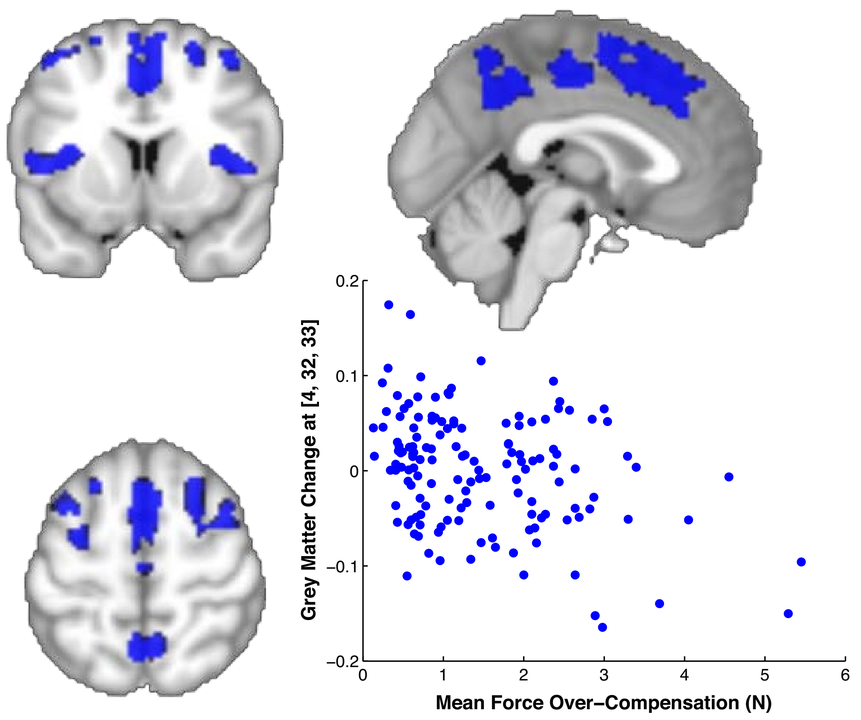
Group mean over-compensation



t_{145}=15.27, p=5.53x10^{-32}

Association with grey matter

Negative correlation between force over-compensation in the Direct condition and grey matter volume in the premotor cortex, SMA, pre-SMA, bilareral insula, operculum and precuneus

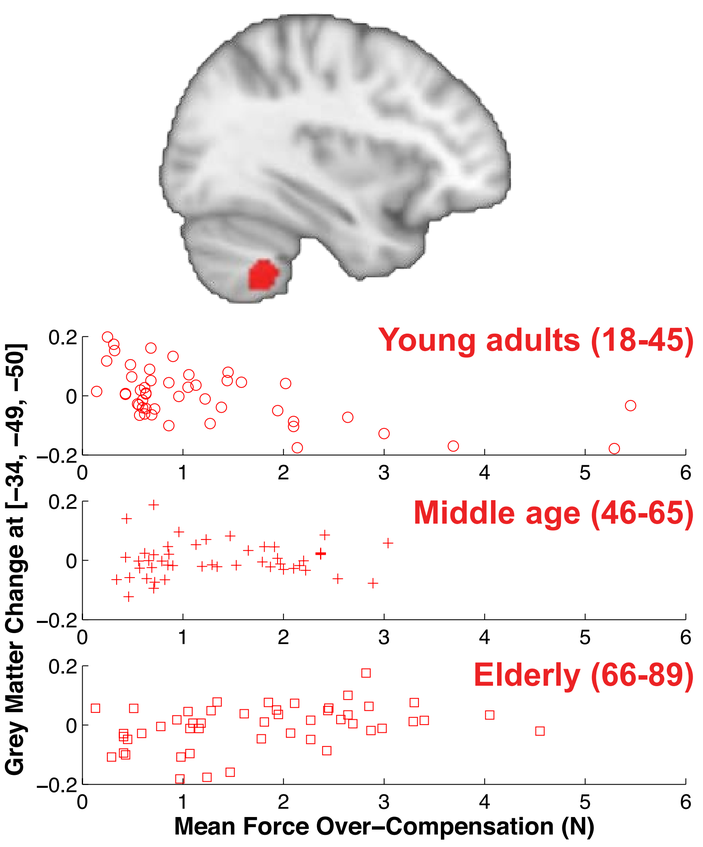


r=-0.09, p=0.279

p<0.05, FWE cluster corrected

Age-dependent association

Positive interaction between Direct force over-compensation and grey matter volume in the cerebellum



p<0.05, FWE corrected

p<0.05, FWE corrected

Conclusions

- The areas associated with sensorimotor attenuation, particularly the pre-SMA and insula, are repeatedly implicated in preparation for voluntary movement and awareness of action.
- The results support previous accounts that the pre-SMA and insular cortex process efference copies of motor commands.
- The cerebellum is proposed to generate forward models, and compare predicted and actual sensory feedback.
- Cerebellar contribution to sensorimotor attenuation is changed with age, possibly due to the differential effects of ageing on the cerebellum and cortex.

References

Task and typical subject figures from Teufel et al. (2010) *Neuropsychologia*
Bays et al. (2006) *PLoS Biology*
Shergill et al. (2003) *Science*
Voss et al. (2005) *Nature Neuroscience*

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