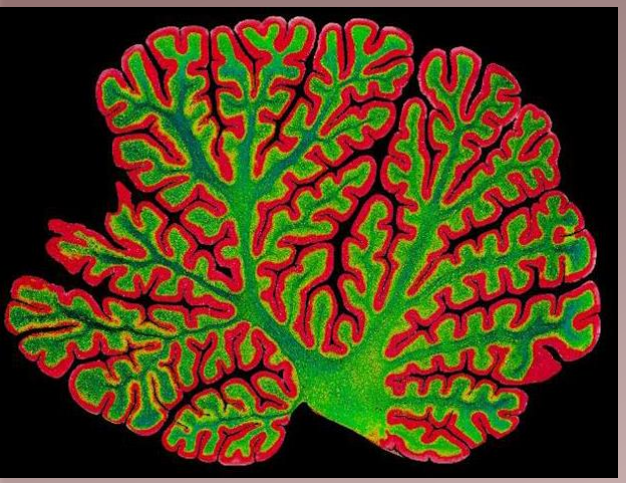


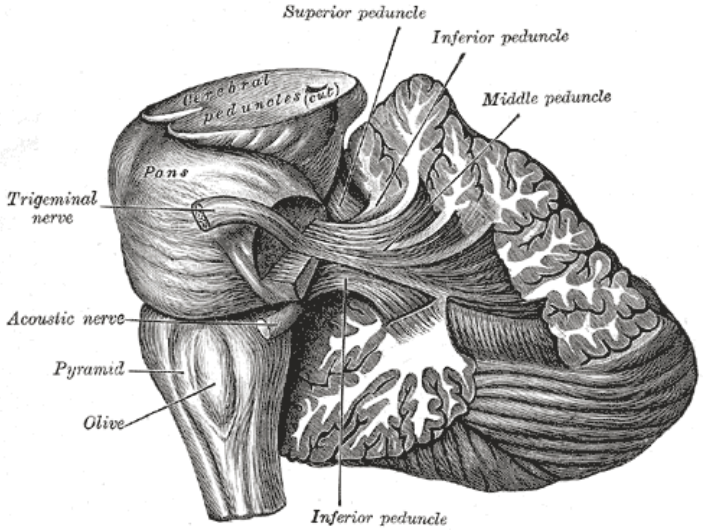
Effects Of Attention And Perceptual Uncertainty On Cerebellar Activity During Visual Motion Perception

Oliver Baumann & Jason Mattingley
Queensland Brain Institute
The University of Queensland

Key cerebellar functions

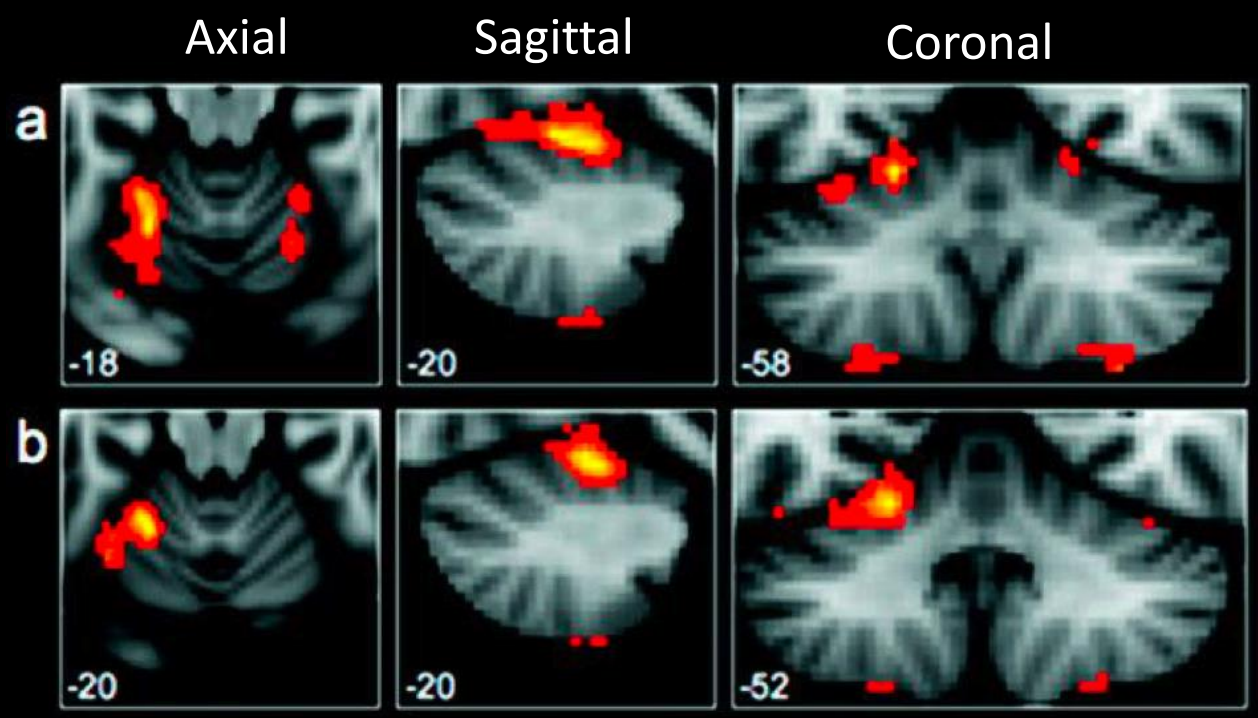
- Control and coordination of movements

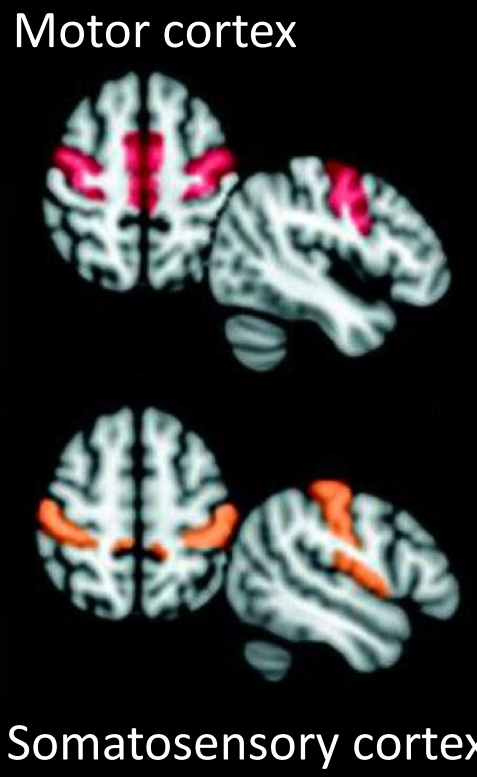
- <u>Example:</u> Ataxia = incoordinated and dysmeteric movements



Gait ataxia with “tandem” gait

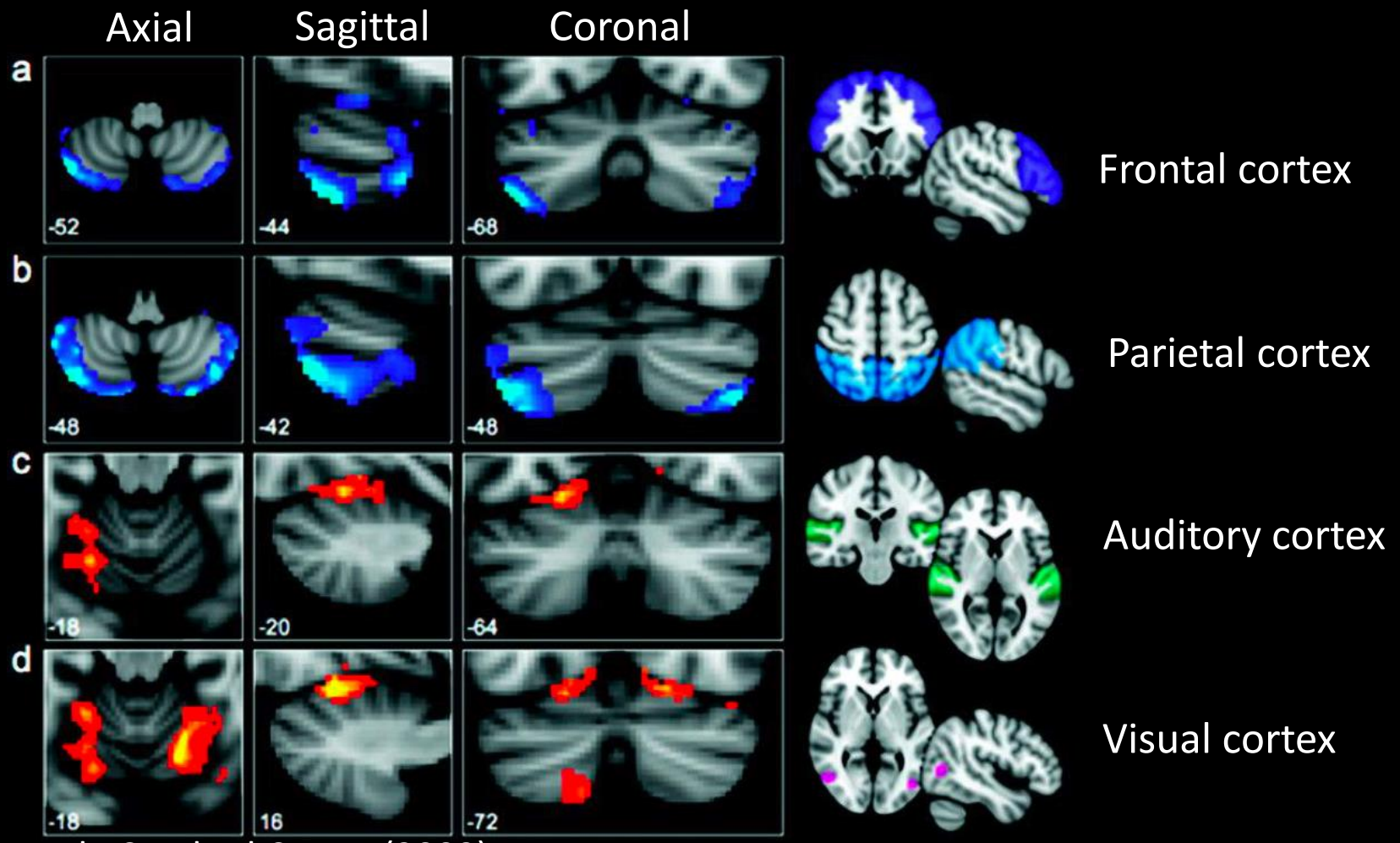
Connectivity of cerebellar sensorimotor regions





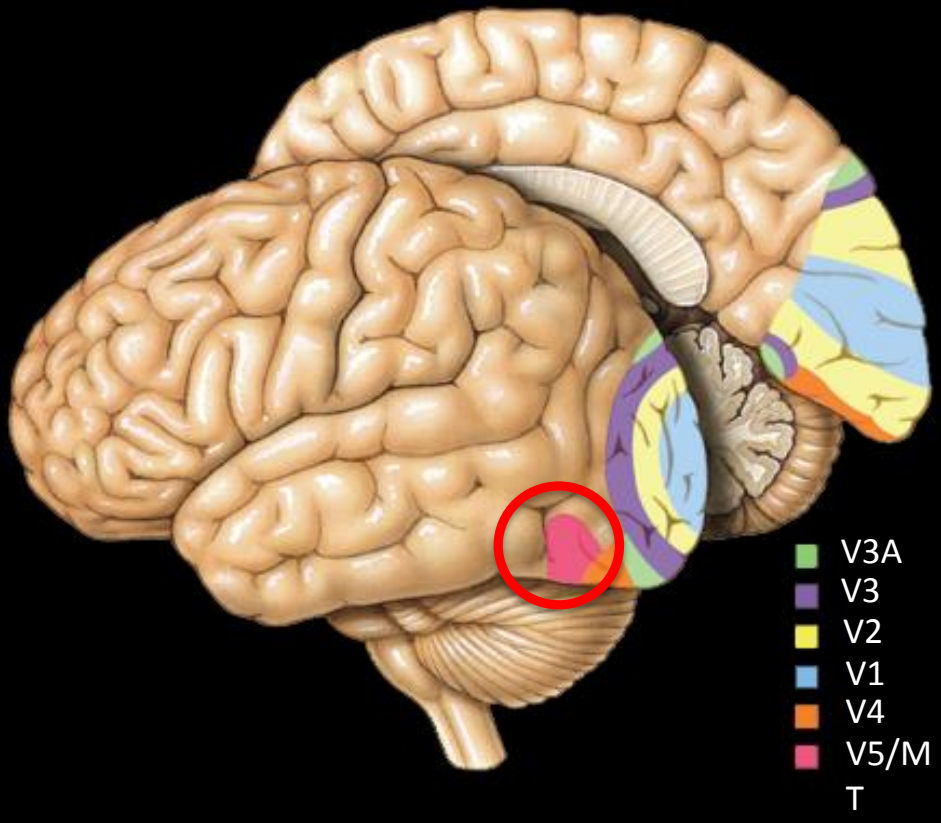
O'Reilly et al., Cerebral Cortex (2009)

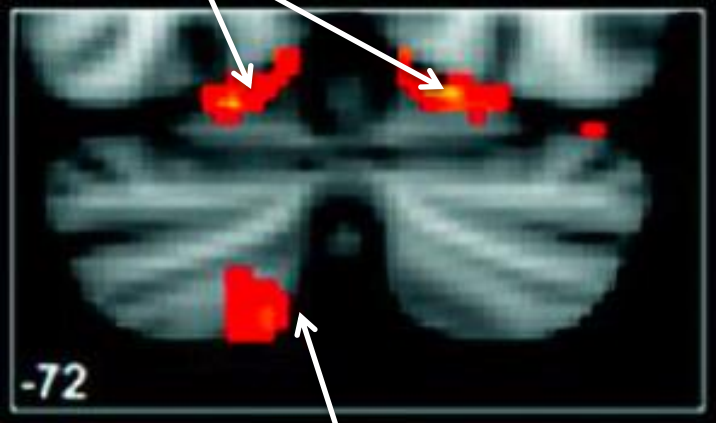
Connectivity of cerebellar non-motor regions



O'Reilly et al., Cerebral Cortex (2009)

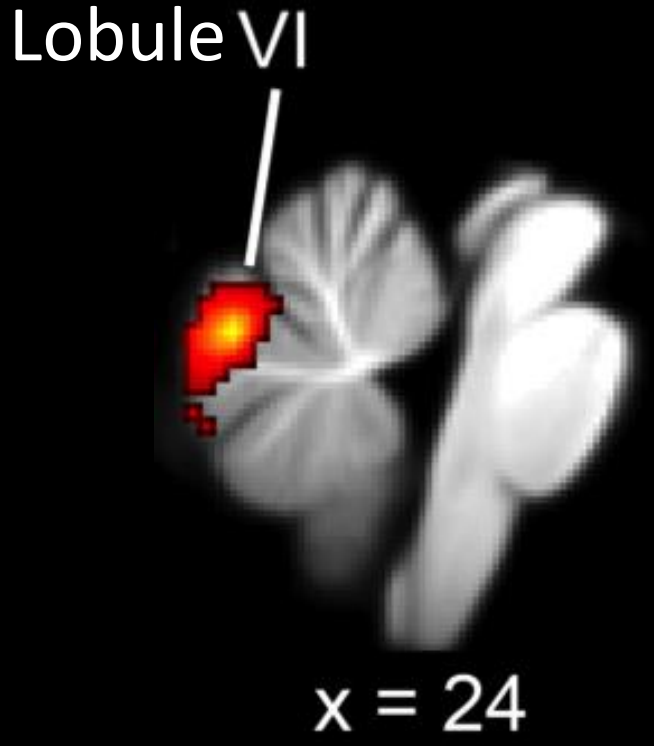
Resting-state connectivity between cerebellum and V5/MT

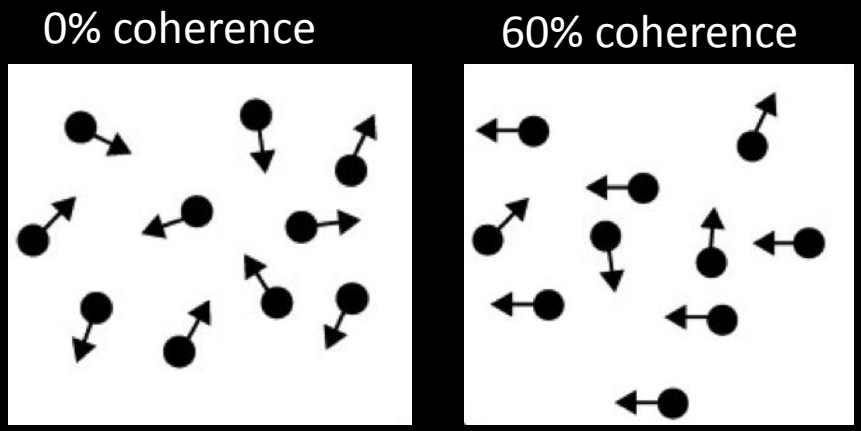




O'Reilly et al., Cerebral Cortex (2009)

Cerebellar fMRI activity during motion perception

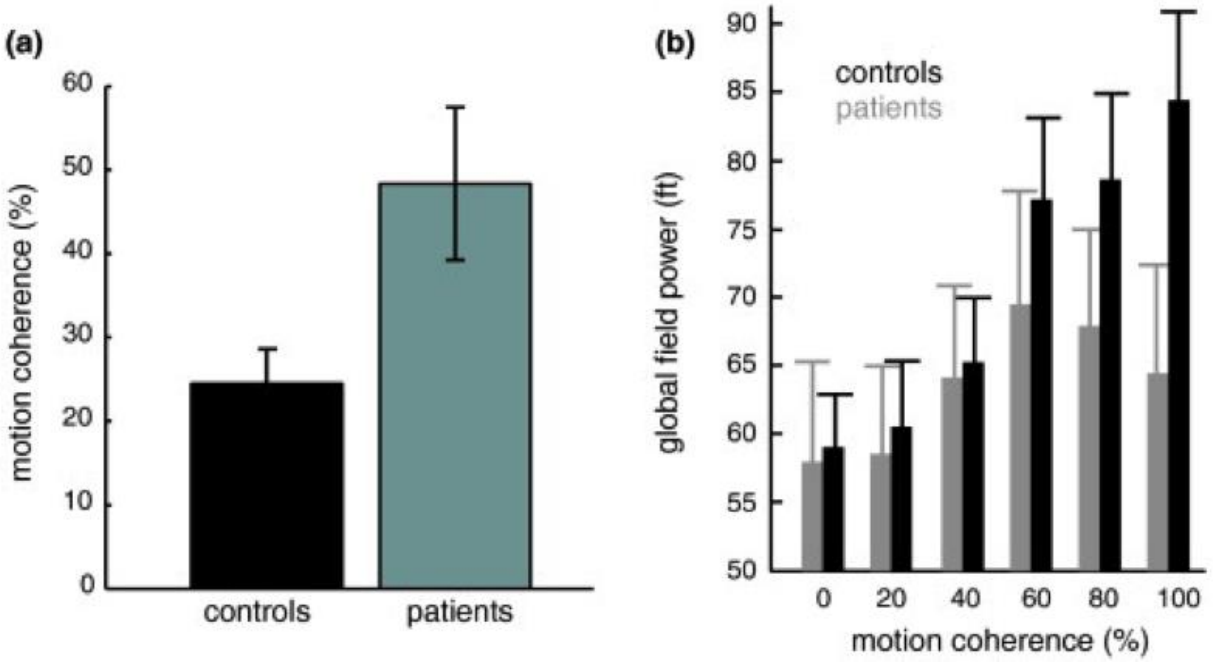




Coherent motion (in noise) detection task

Baumann & Mattingley, J Neurosci (2010)

Effect of cerebellar damage on visual motion detection and MEG responses in parieto-temporal cortex



Händel et al., J Neurosci (2009)

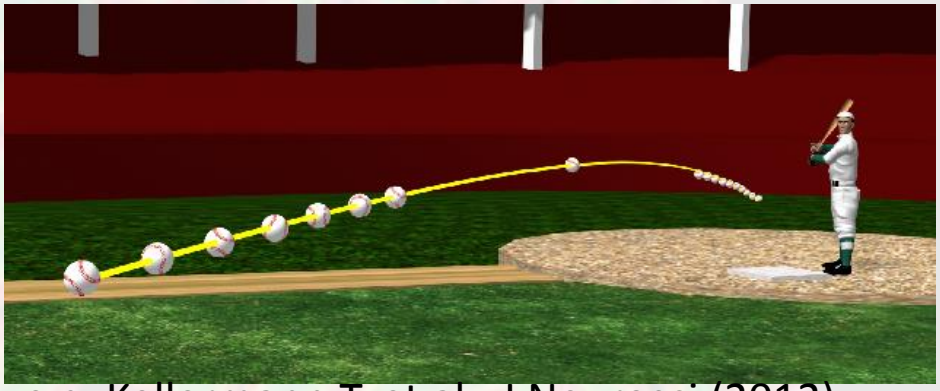
What is the role of the cerebellum in visual motion perception?

What is the role of the cerebellum in visual motion perception?

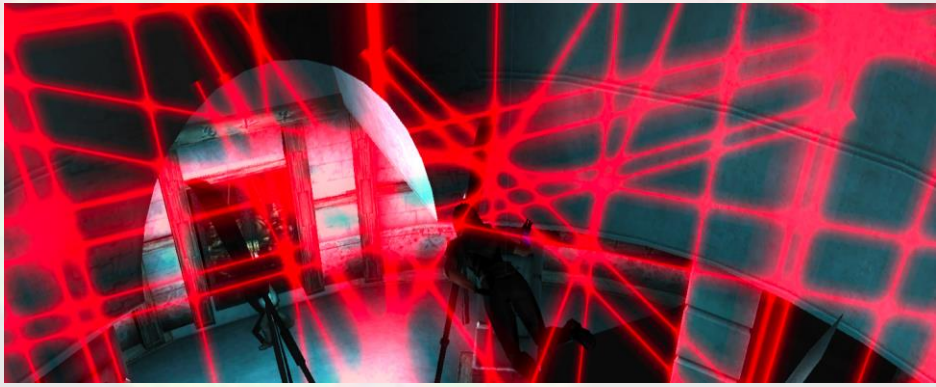
(1) Tracking?

and/or

(2) Detection?



e.g. Kellermann T, et al., J Neurosci (2012)



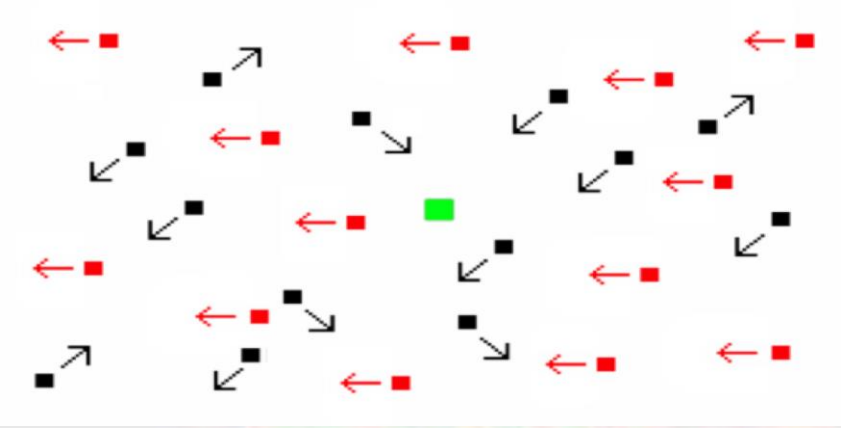
e.g. Baumann & Mattingley, J Neurosci (2010)

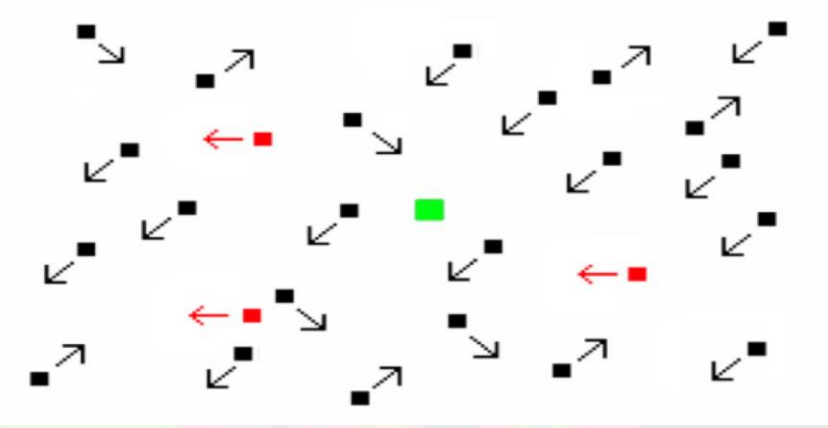
Experimental design

<u>Tracking</u>=
Low perceptual uncertainty
(i.e. high motion coherence)

vs.

<u>Detection</u>=
High perceptual uncertainty
(i.e. low motion coherence)





- **Motion task: "Detect and monitor the direction of the coherent motion signal"**
- **Colour-control task: "Monitor the colour of the fixation dot"**

Methods

- Random Dot Kinematograms:
  -400 dots with (0, 15 and 30% horizontal coherent motion)
  -sinusoidal velocity profile (0.2Hz, max speed 12.6°/s)
  -central fixation spot colour (green/yellow) alternates at 0.2Hz
  -variable stimulus duration (4.7, 8.5, 11.2, or 16s)

- Button response indicating the final direction (left/right) of coherent motion or final colour (green/yellow) of the central fixation dot

- 18 young healthy participants (12 female)

- Prescan fixation assessment and training (±0.3° criterion)

30% Motion Coherence

15% Motion Coherence

0% Motion Coherence

Experimental Factors

Attention: Colour vs. motion task

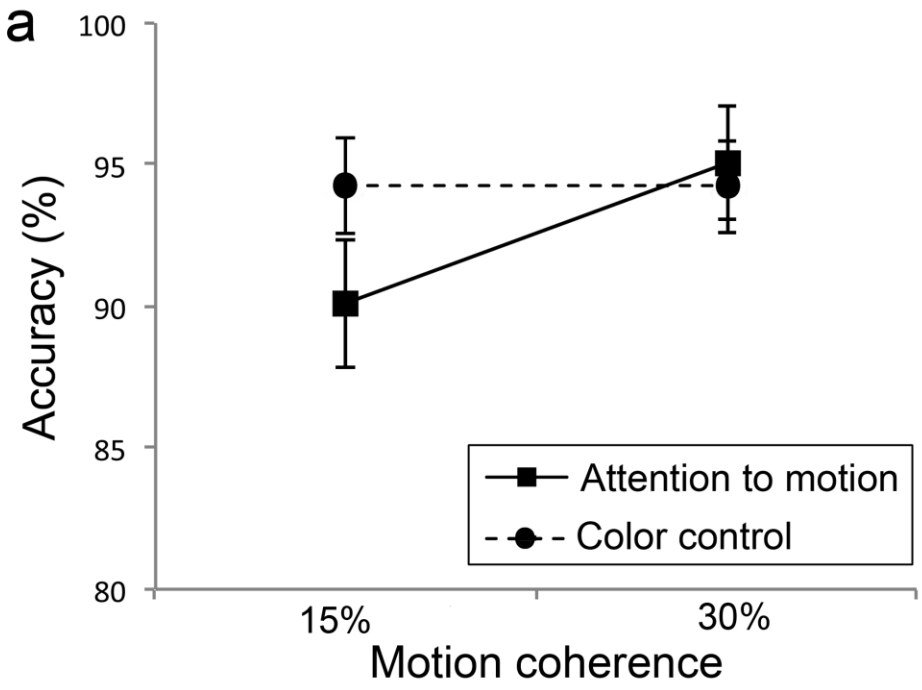
Perceptual uncertainty: 3 levels of perceptual uncertainty (i.e. motion coherence)

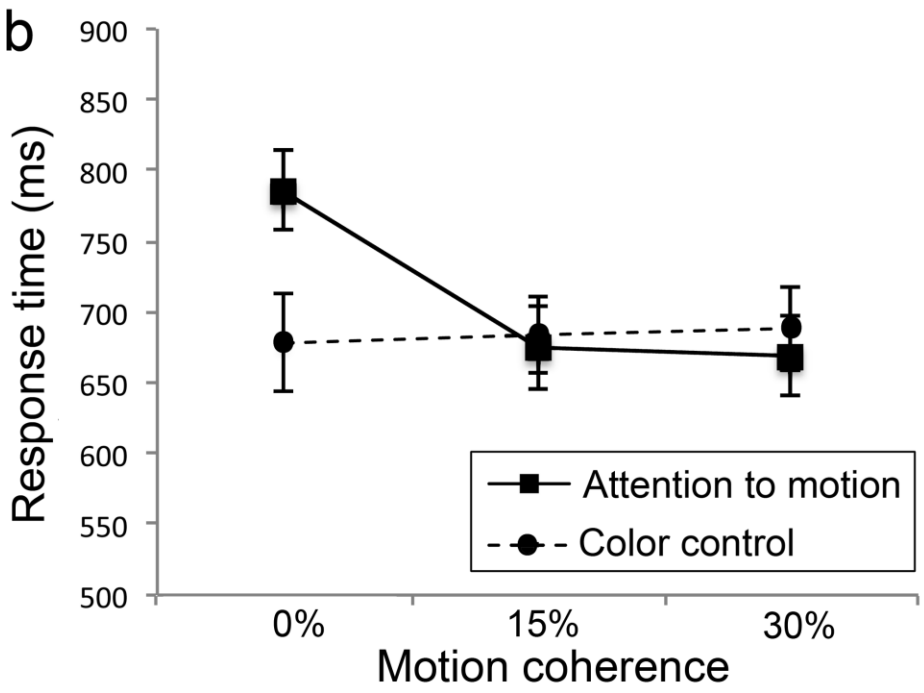
Attend motion - 0% coherence	Attend motion - 15% coherence	Attend motion - 30% coherence
Attend colour - 0% coherence	Attend colour - 15% coherence	Attend colour - 30% coherence

fMRI acquisition and analysis

- 3T MRI
- Voxel size 3.3 x 3.3 x 3.0 mm
- TR = 2.19 s; TE = 30 ms
- Correction for physiological effects
- Event-related GLM analysis (SPM8)
- 36 trials per condition
- Voxel-wise p = 0.05 (t-contrast analysis, FWE corrected for multiple comparisons)
- Cerebellum analysed in isolation (using individual masks derived from structural images)

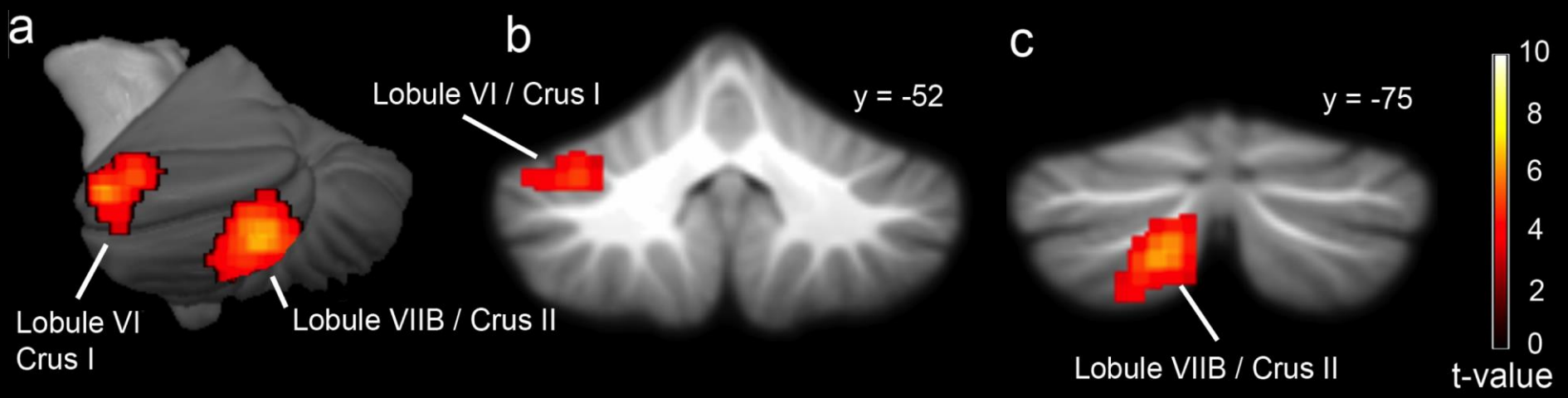
Mean accuracy rates and response times





- Motion coherence affected performance in the 'Attention to motion' condition.
- No effect of motion coherence on performance in the colour-control condition.
- Mean RT in 0% condition significantly greater than all other conditions ($p < 0.001$).

Effects of motion detection



0% coherent motion (high perceptual uncertainty) > color-control condition:

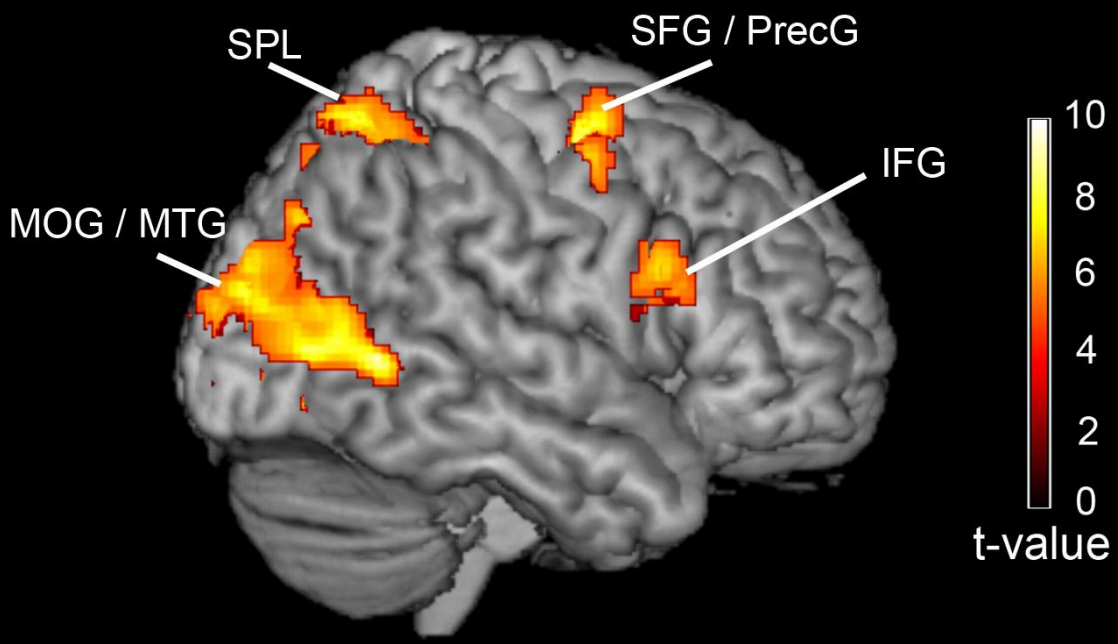
- Two left-hemispheric cerebellar activation clusters (p=0.05, FWE corrected)
- Reportedly connected to prefrontal, posterior parietal and visual cortices

Effects of motion tracking

Attention to suprathreshold motion (30%) > color-control condition:

- No significant effects in the cerebellum ($p>0.001$, uncorrected)

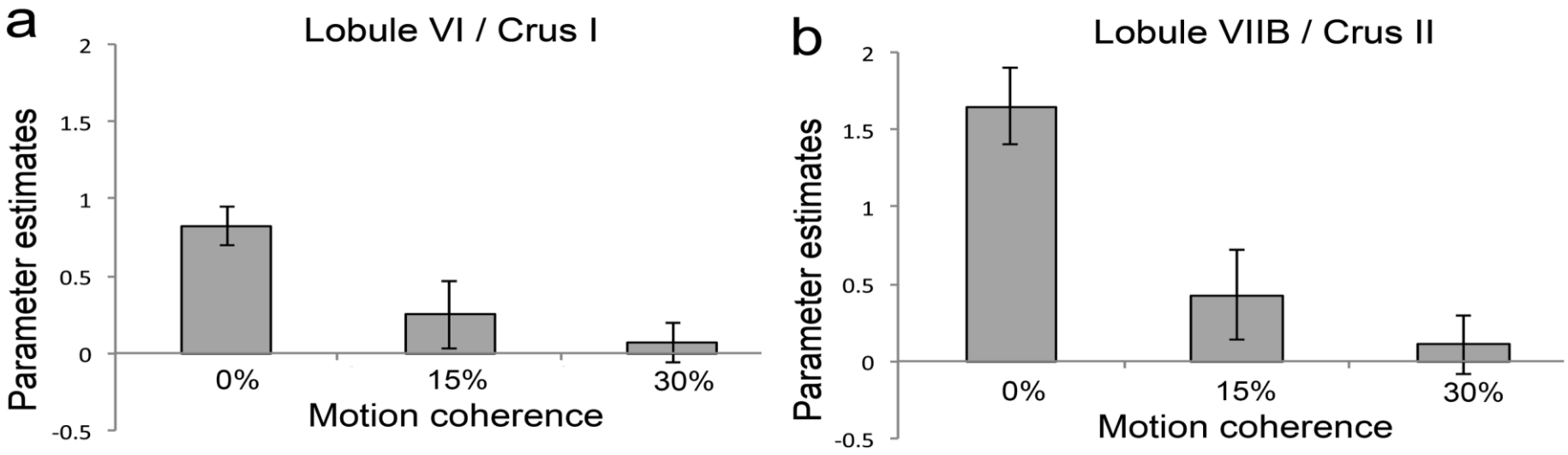
Effects of motion tracking



Attention to suprathreshold motion (30%) > color-control condition:

- No significant effects in the cerebellum ($p>0.001$, uncorrected)
- Significant effects ($p=0.05$, FWE corrected) in cortical areas underlying covert motion tracking (Culham et al. 1998, J Neurophysiol)

Region of interest analysis



Beta-values of contrast "*attend motion>attend color*" for three levels of coherence:

- High visual uncertainty (0%) = significant cerebellar activity
- Low visual uncertainty (30%) = no significant cerebellar activity

Key findings

- The cerebellum facilitates the detection of moving objects under conditions of high perceptual uncertainty.

- The cerebellum is not involved in sustained attentive tracking of salient motion stimuli.

Detailed results are reported in:

Cerebellum (2014) 13:46–54
DOI 10.1007/s12311-013-0519-2

ORIGINAL PAPER

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