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Posterior Cortical Atrophy: An investigation of grasping.

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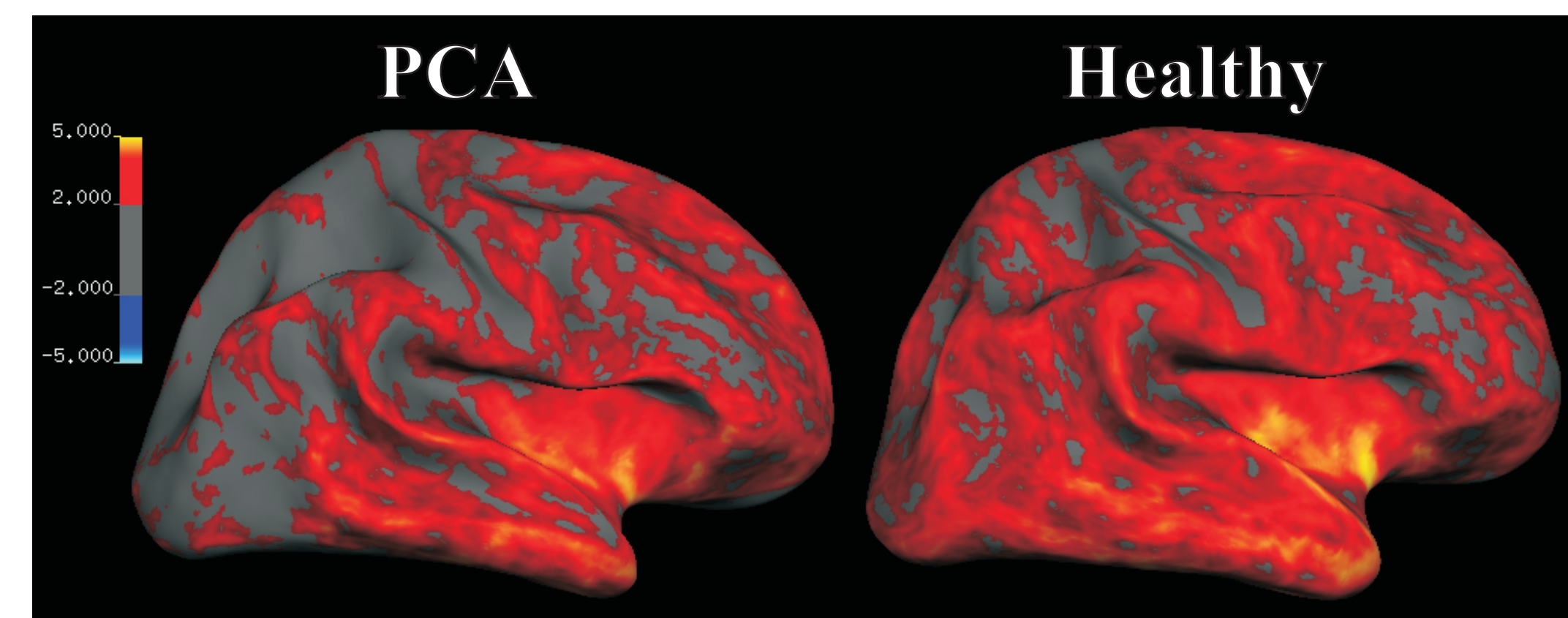
Introduction

Posterior cortical atrophy (PCA) is a rare progressive neurodegenerative disorder that can target the occipital, temporal and parietal lobes^{1,2}.

Often classified as a ‘visual variant of Alzheimer’s Disease’, PCA is characterized by impairments in higher level visual processing, while memory, language, and reasoning remain relatively intact until late in the disorder.

It has been suggested that PCA may exhibit two distinct varieties based on the focus of atrophy: dorsal PCA and ventral PCA³.

Cortical Thickness



Previous studies have suggested that a pure ventral stream syndrome is very rare⁴, but targeted investigations have yet to be carried out.

Patients

RB is a 75 year old, right-handed female who has been experiencing progressively worsening visual disturbances over the last 4 years. Her symptoms include severe face- and object-perception difficulties, colour hallucinations, and simultanagnosia. A talented artist, RB now struggles to copy even simple line drawings.

MTB is a 65 year old, right-handed female who began complaining of reading and visual difficulties 8 years ago. She suffers from moderately impaired face-perception and has difficulties counting multiple objects in an array.

PLH is a 61 year old, right-handed female who started to complain of “fuzzy” vision 4 years ago. She reports getting lost in familiar environments and struggles with face- and object-perception.

AP is a 77 year old, left-handed female who struggles with reading and getting dressed. She shows some misreaching as well as unilateral hemispatial neglect - bisecting lines to the right of center. AP also demonstrates simultanagnosia and is severely impaired in judgements of line orientation.

SS is a 64 year old, right-handed male who started getting lost in familiar places 3 years ago. He has trouble locating objects in front of him, doing simple calculations, reading, writing, counting objects, and perceiving faces and objects. He also demonstrates some misreaching and difficulty sequencing movements.

The authors would like to thank Dr. Paul Shelton (HSC) for his patient referrals.

Investigation

Using tests known to selectively tax the functions of the dorsal and ventral visual streams⁵, the current study explores the possibility of functionally distinct PCA variants.

Blake Shapes

Perceptual Judgement

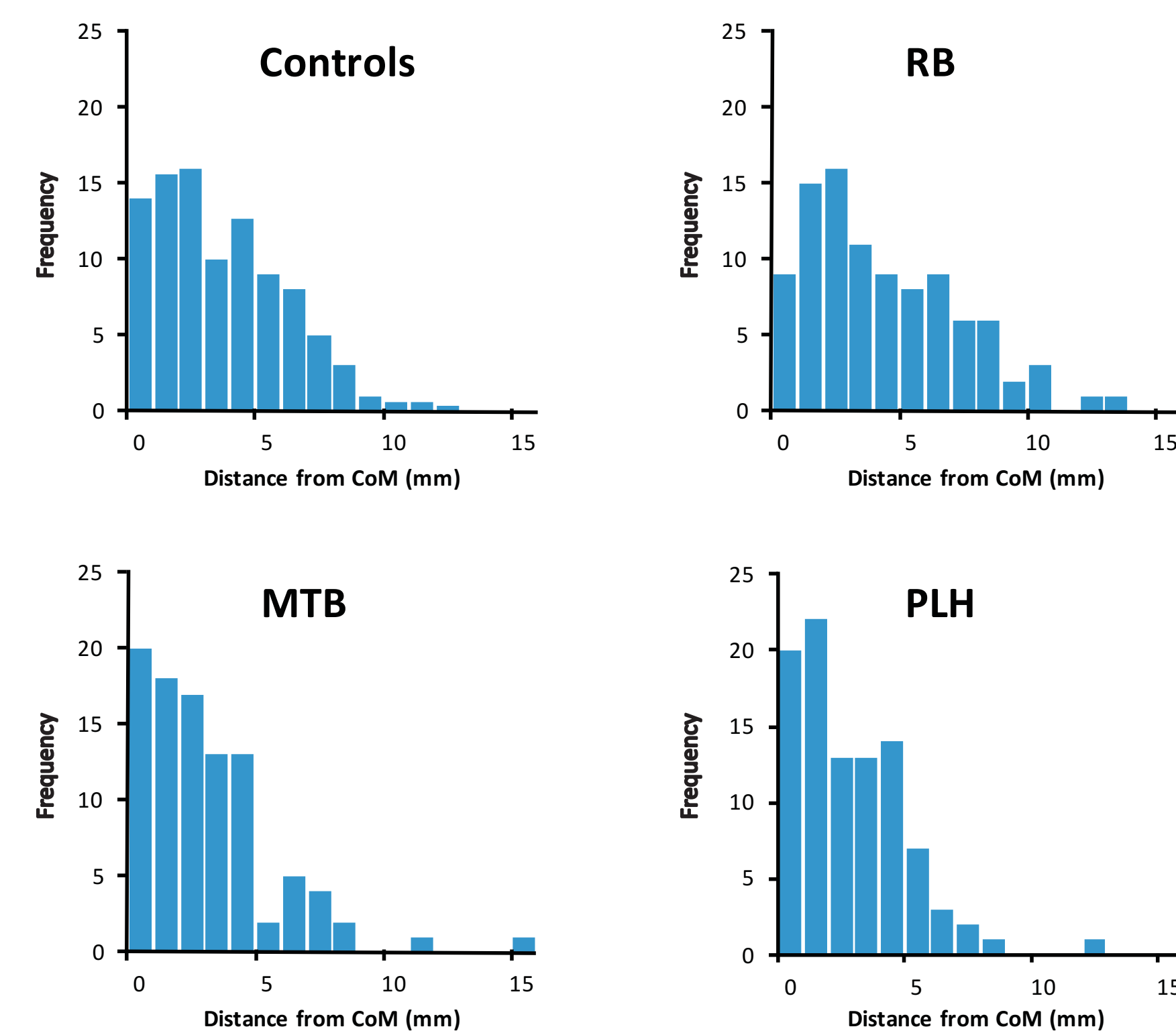
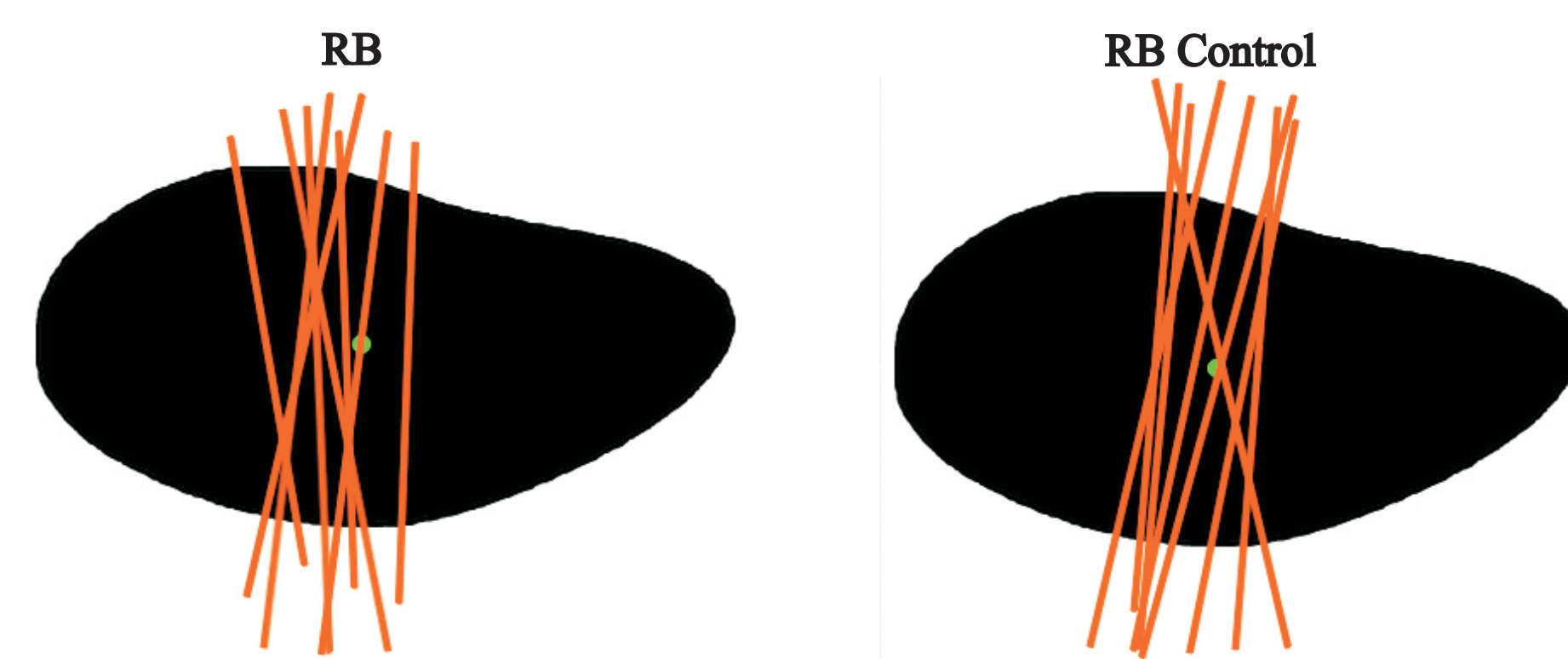
“Are these two objects the same, or different?”



	RB	MTB	PLH	Controls
% Correct	70.8	54.2	64.0	100.0

RB, MTB and PLH perform very poorly on a task requiring them to assess and compare the shape of two objects.

Grasping



Despite severe perceptual difficulties, RB, MTB and PLH execute accurate grasps to asymmetrical, irregularly-shaped objects.

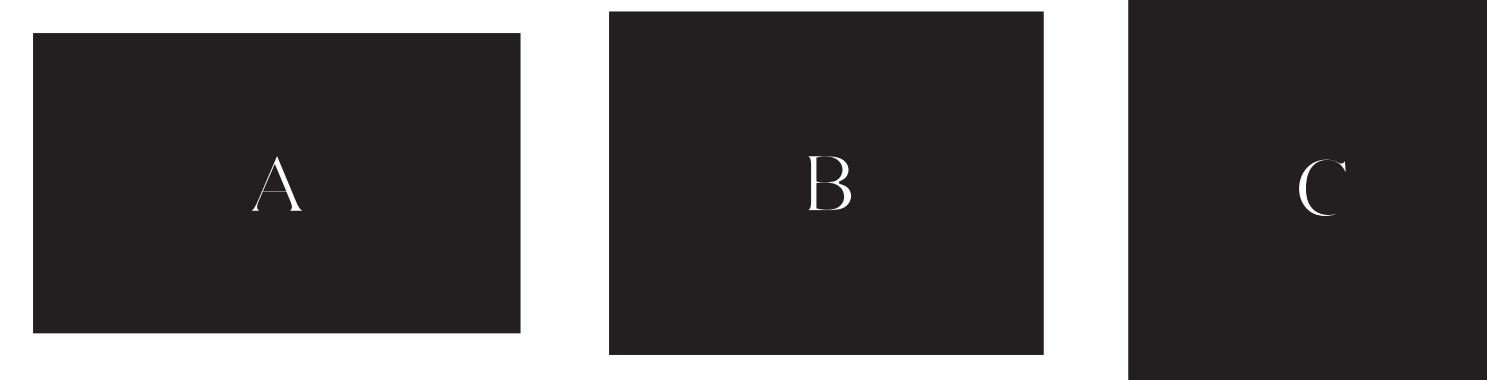
This indicates a preserved ability to evaluate the overall shape of an object, select stable grasp points, and guide their fingers to those locations.

AP and SS have not yet been tested on this task.

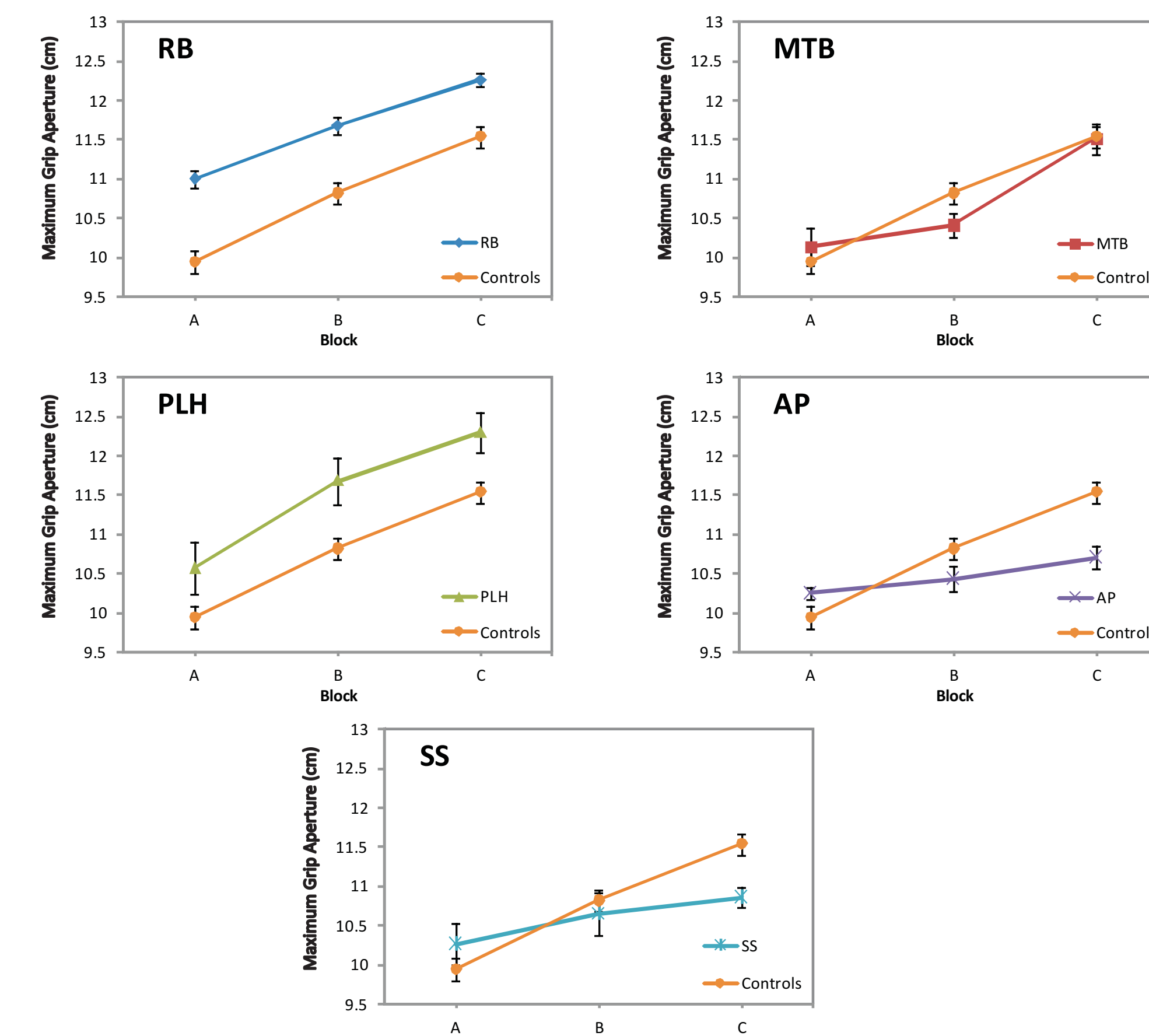
Grip Scaling

Grasping vs Estimation

Using only their index finger and thumb, subjects were required to either reach out and pick up one of four rectangular blocks or manually estimate its size.

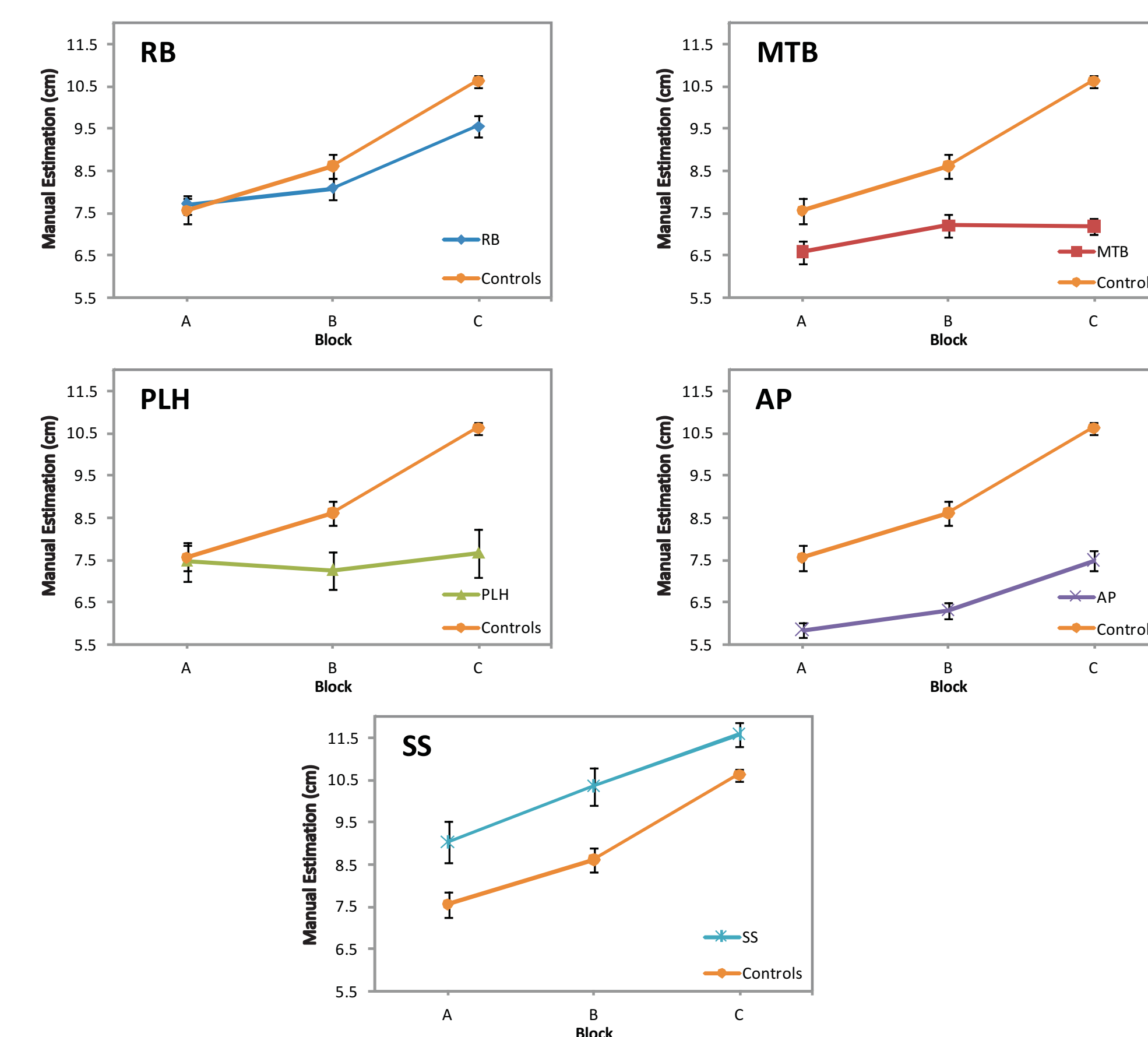


Grasping



All of our patients scale their grasps with regards to the size of the block ($p < 0.01$). However, RB, MTB and PLH show no difference in their scaling from that of controls, whereas AP and SS show a significant departure from normal scaling behaviour ($p < 0.05$).

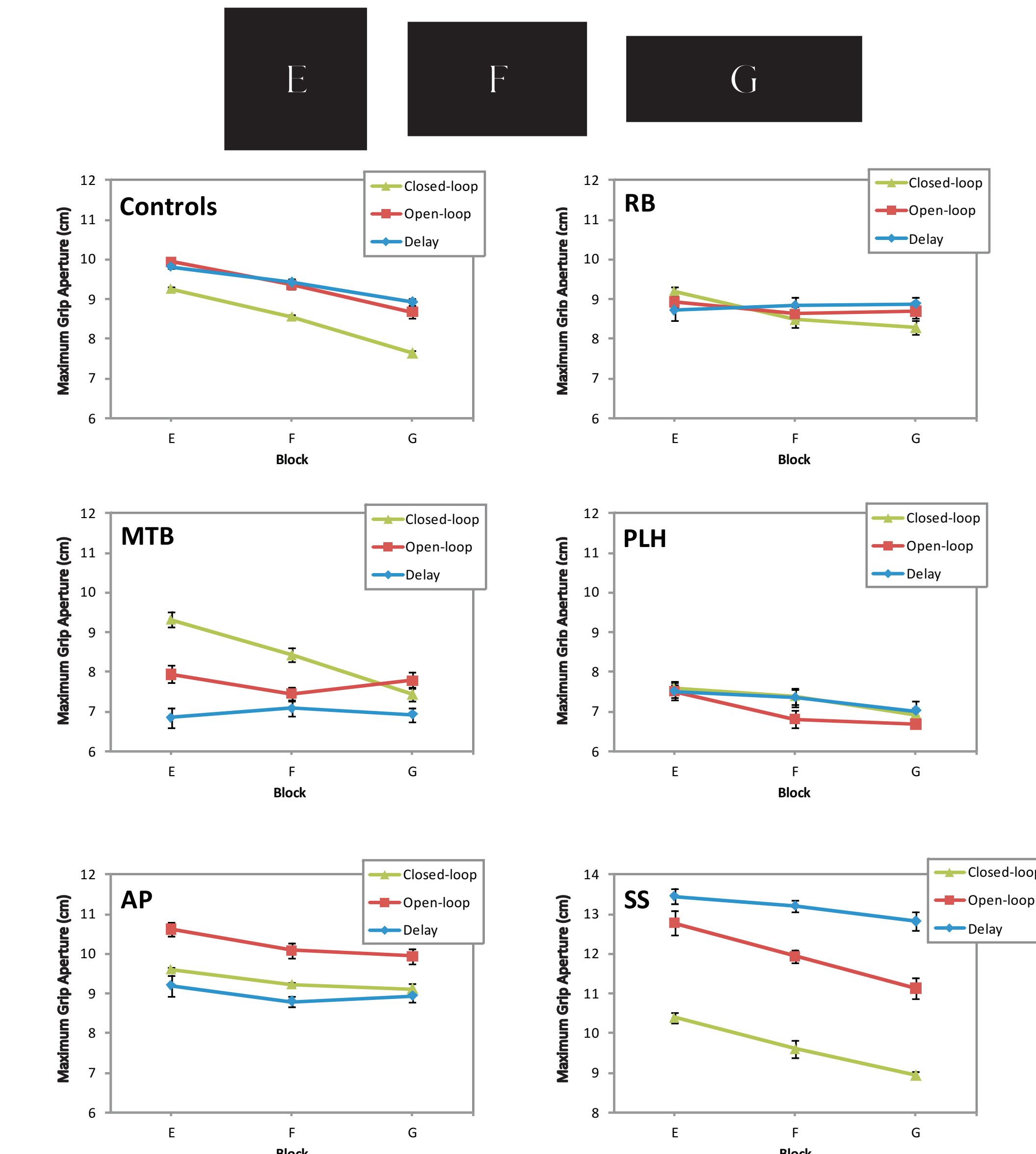
Estimation



RB, AP and SS demonstrate a preserved ability to provide a manual estimate of the size of an object, while MTB and PLH show a complete loss of this ability ($p < 0.05$).

Delayed Grasp

1. Closed-loop (visually-guided grasping)
2. Open-loop (3s viewing followed by no-vision grasping)
3. Delayed (3s viewing, 3s delay, no-vision grasping)



	Closed-loop	Open-loop	Delayed
RB	✓	✗	✗
MTB	✓	✗	✗
PLH	✓	✓	✗
AP	✓	✓	✗
SS	✓	✓	✓
Controls	✓	✓	✓

During visually-guided grasps, all patients demonstrate grip scaling in relation to the size of the blocks ($p < 0.05$). However, patients RB, PLH and AP struggle with this task, showing a reduced degree of scaling compared to controls ($p < 0.01$).

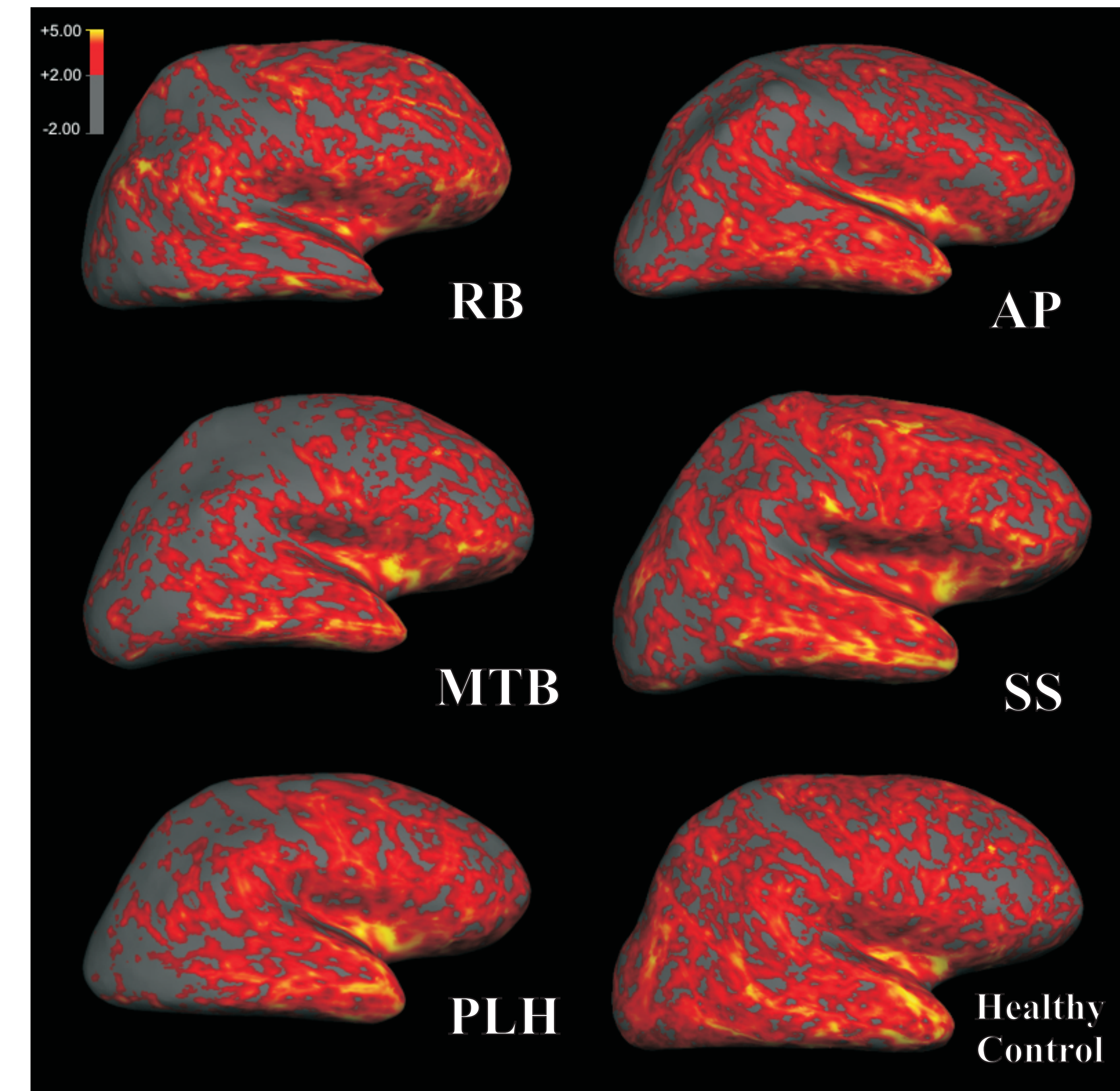
When vision is removed, RB and MTB immediately lose their ability to accurately scale their grip apertures ($p < 0.05$). AP’s scaling in this condition, though present, is weakened compared to controls ($p < 0.05$).

Finally, introducing a delay to the no-vision condition results in a loss of grip scaling for RB, MTB, PLH and AP ($p < 0.05$).

Our healthy, age-matched controls scale appropriately under all three conditions ($p < 0.01$).

Delayed grasping conditions force the visuomotor system to rely on a stored ‘percept’ of the target from the ventral stream⁵. Evidently, our patients lack the ability to form, or perhaps store, robust object representations, leading to their inability to perform accurate grasps in the open-loop conditions.

Cortical Thickness



Conclusions

It seems that a clear dissociation between pure dorsal and ventral variations of PCA is difficult to observe. Although some of our patients show relatively preserved visuomotor functioning in the face of severe perceptual deficits (e.g. RB, MTB and PLH), the others show a combination of symptoms indicative of more generalised atrophy. Even though it is tempting to classify some of our patients as ventral-PCAs, it is clear from their varied performance on our visuomotor tasks, and cortical thinning in occipitoparietal cortical regions, that their damage is not limited to the ventral stream.

References

1. Tang-Wai, D.F., et al. (2004). Clinical, genetic, and neuropathic characteristics of posterior cortical atrophy. *Neurology*, 63(7), 1168-1174.
2. Whitwell et al. (2006). Imaging correlates of posterior cortical atrophy. *Neurobiology of Aging*, 28(7), 1051-1061.
3. Aharon-Peretz, J., Israel, O., Goldsher, D., & Peretz, A. (1999). Posterior cortical atrophy variants of alzheimer’s disease. *Dementia and Geriatric Cognitive Disorders*, 10(6), 483-487.
4. McMonagle, P., Deering, F., Berliner, Y., & Kertesz, A. (2006). The cognitive profile of posterior cortical atrophy. *Neurology*, 66(3), 331-338.
5. Milner, A.D. & Goodale, M.A. (2006). *The visual brain in action*. 2nd edition. Oxford University Press: Oxford.

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