



Impairments of 3D visual perception in posterior cortical atrophy: functional and anatomical characterization

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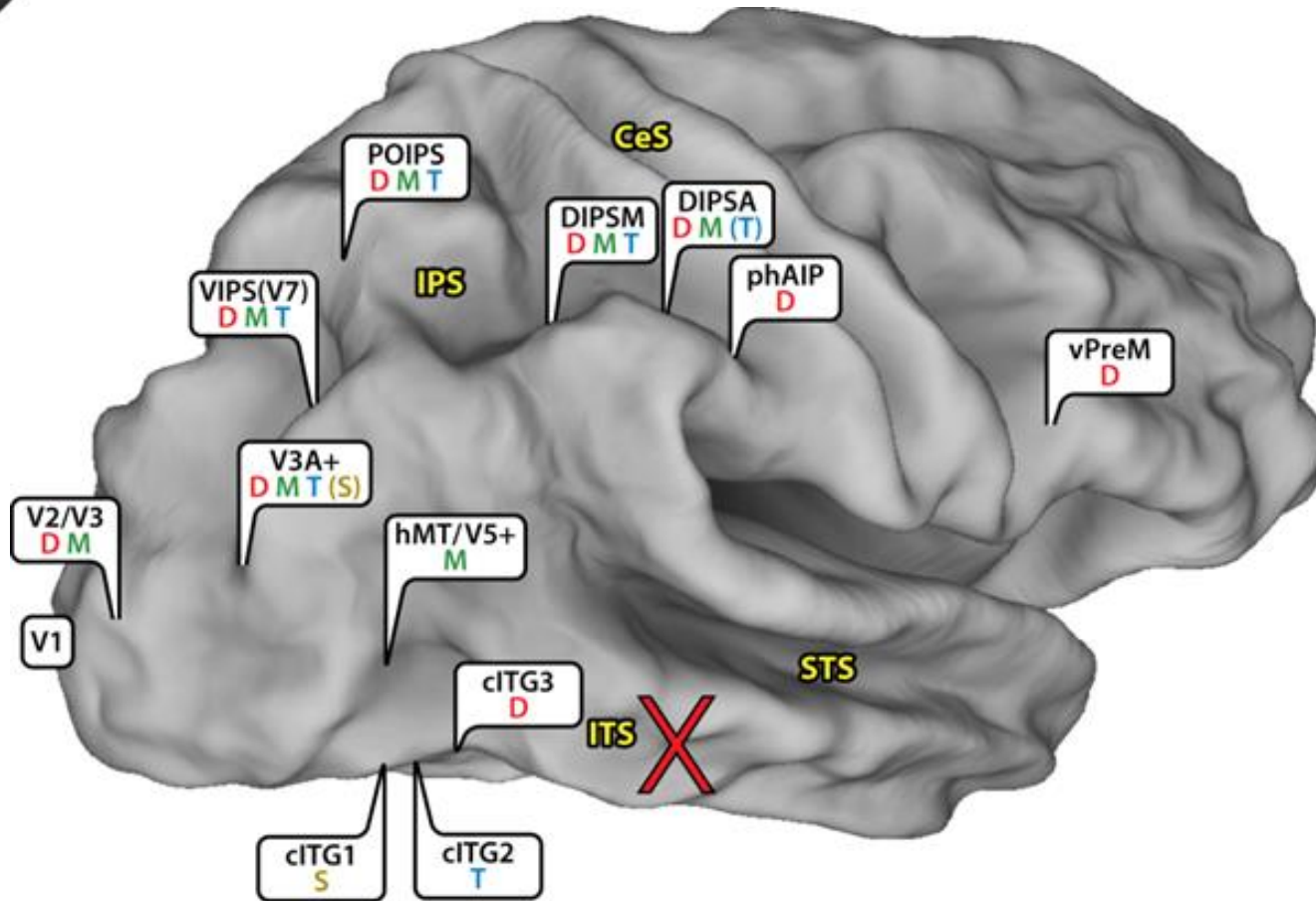
Introduction

- Posterior cortical atrophy (PCA) is a rare focal cortical syndrome that is most often caused by Alzheimer's disease
- Subjects become incapacitated because of the progressive visual dysfunction
- We applied modern visual neuroscience techniques in an attempt to analyze 3D shape perception in PCA

The network for 3D shape perception

Binocular cues: ocular disparity

Monocular cues: shading – motion – texture



Orban G.A., Annu Rev Neurosci 34, 361-388, 2011

Research question

1. Is 3D shape perception affected in posterior cortical atrophy?
2. Does this differ depending on the cue defining 3D shape?
3. Which structural or functional alterations underly 3D shape perceptual deficit?

Participants

- 12 patients with posterior cortical atrophy
- Patient controls: 9 patients with clinically probable Lewy Body Dementia
- 30 age-matched healthy controls in the behavioral and volumetric studies
- 18 age-matched healthy controls in the task-related fMRI experiment

	1	2	3	4	5	6	7	8	9	10	11	12
Age	68	67	56	63	52	51	57	65	54	61	71	53
Sex	F	M	M	F	F	F	F	F	F	M	F	F
Disease duration (yrs)	1.5	2	1	1.5	1.5	2	1	0.75	0.5	0.5	2	3.75
MMSE (/30)	27	28	22	26	19	24	19	21	20	17	26	22
A β biomarker	+	+	+		+	+						+

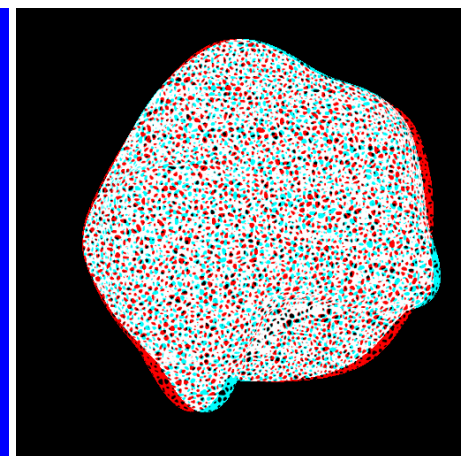
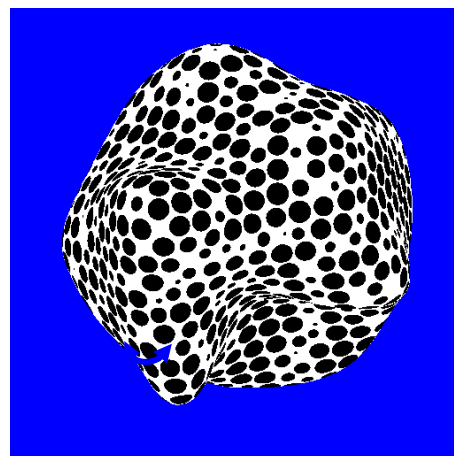
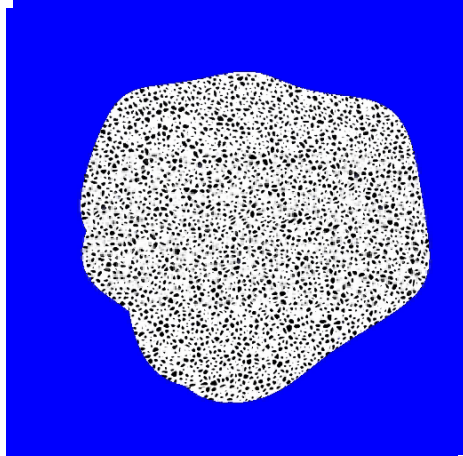
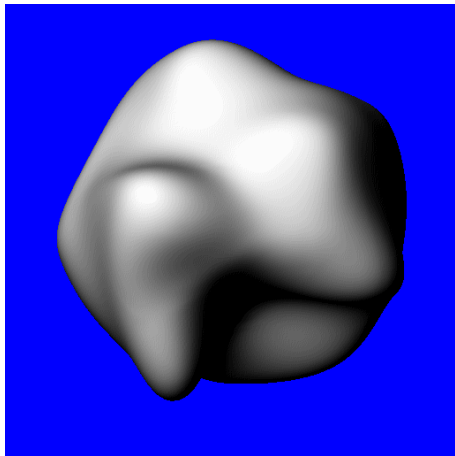
SHADING

MOTION

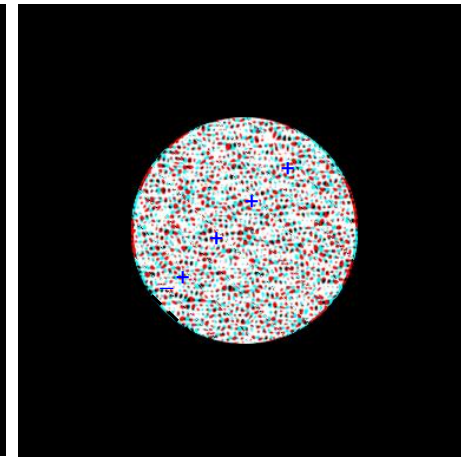
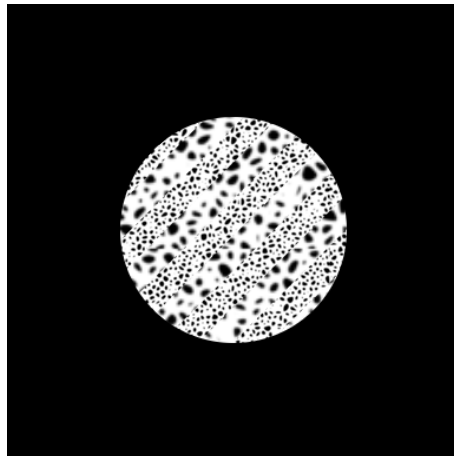
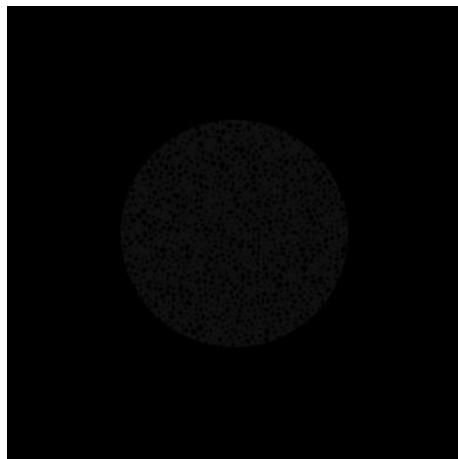
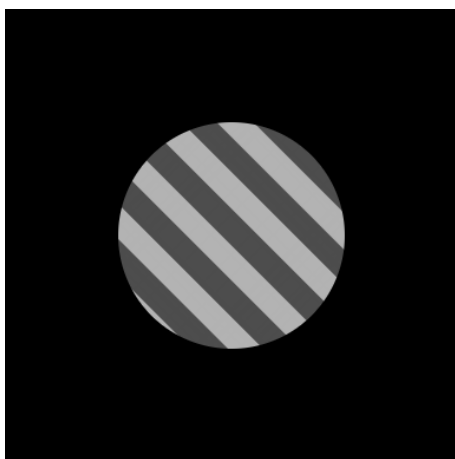
TEXTURE

DISPARITY

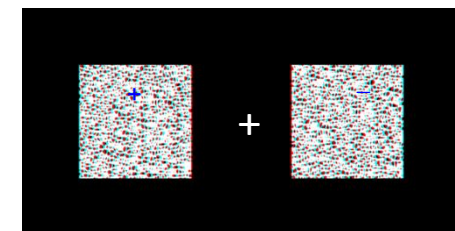
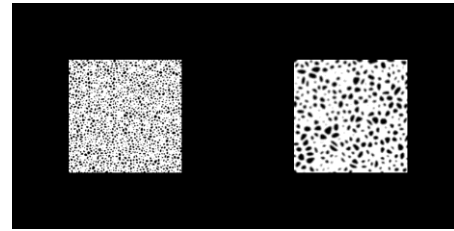
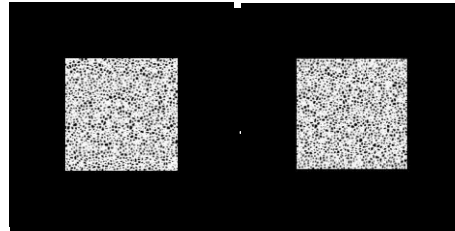
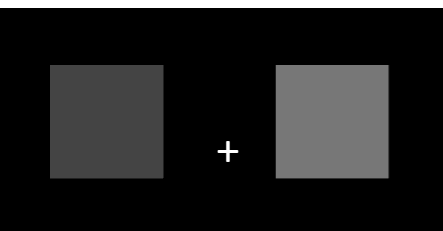
A. 3D shape

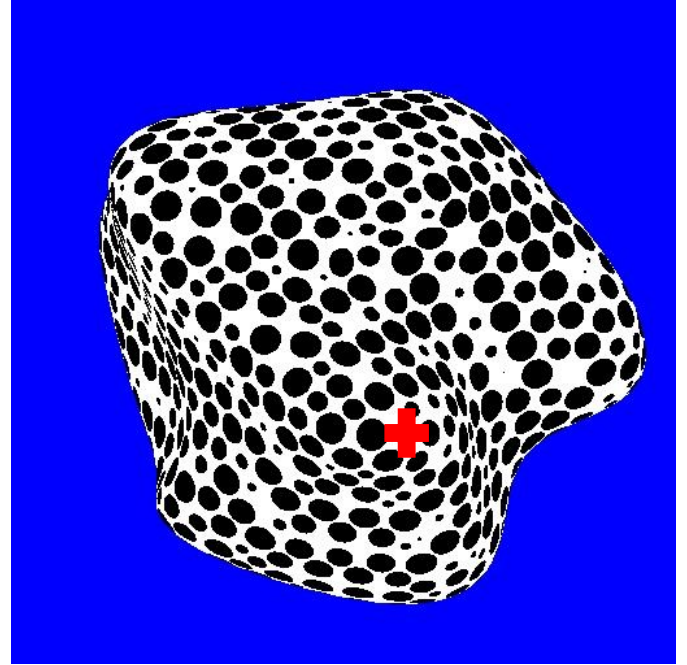
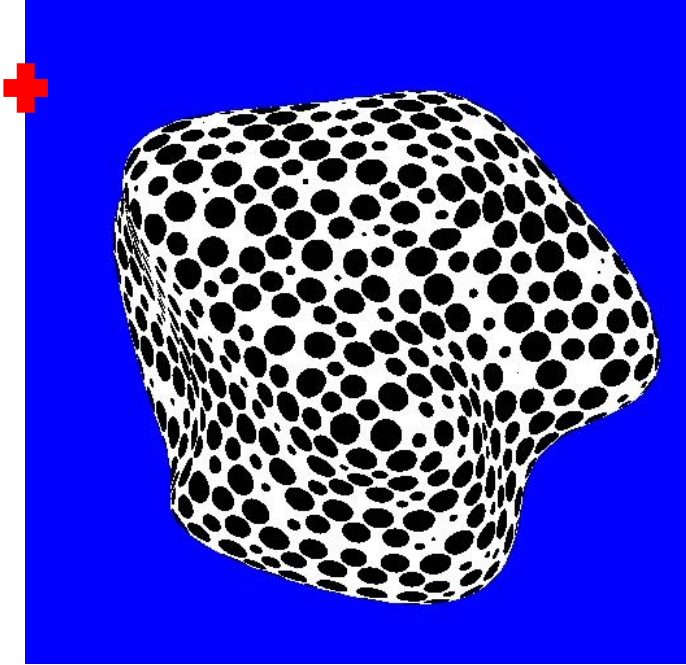


B. Orientation discrimination



C. Simultaneous same-different task



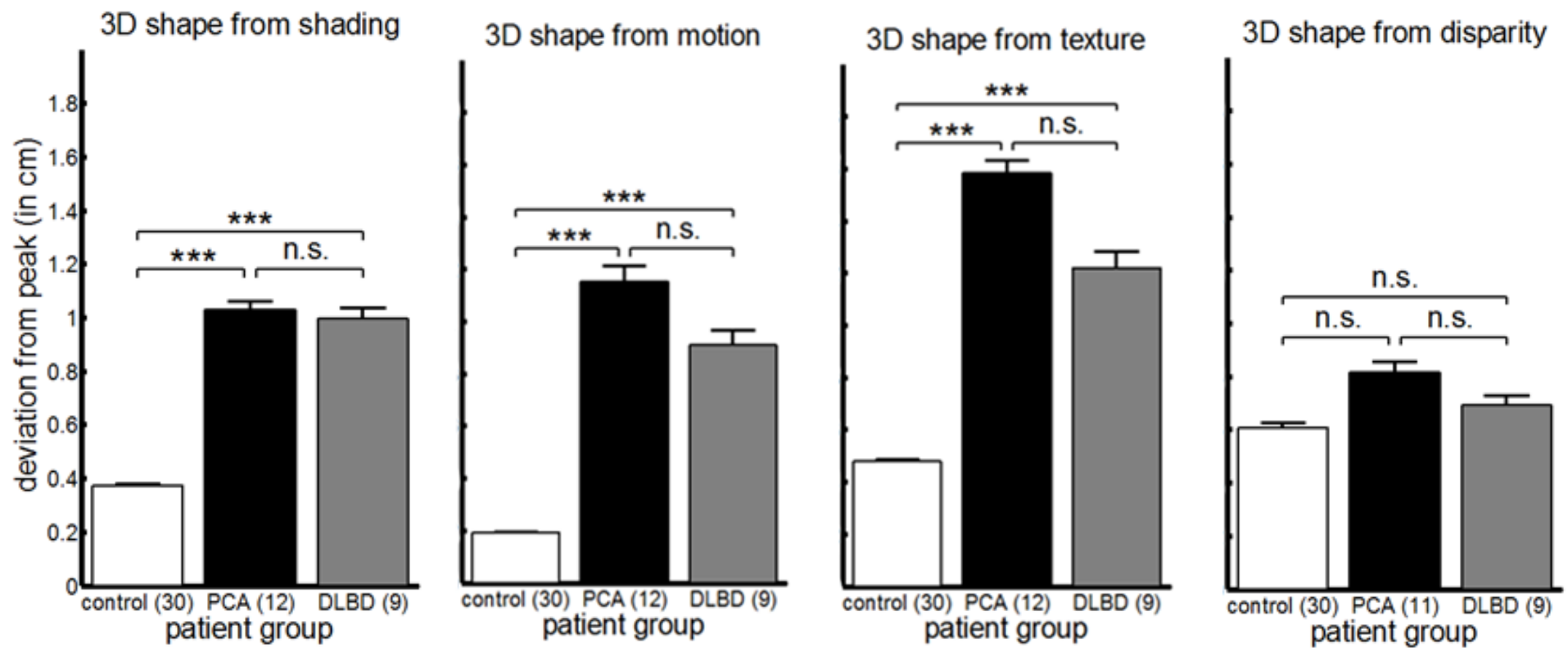


Outcome measures

- 3D shape perception: Distance from the peak for each of the cues
- Orientation discrimination: clockwise vs counterclockwise compared to 45 deg
- Elementary feature extraction: same-different judgment
- Adaptive procedure (QUEST)

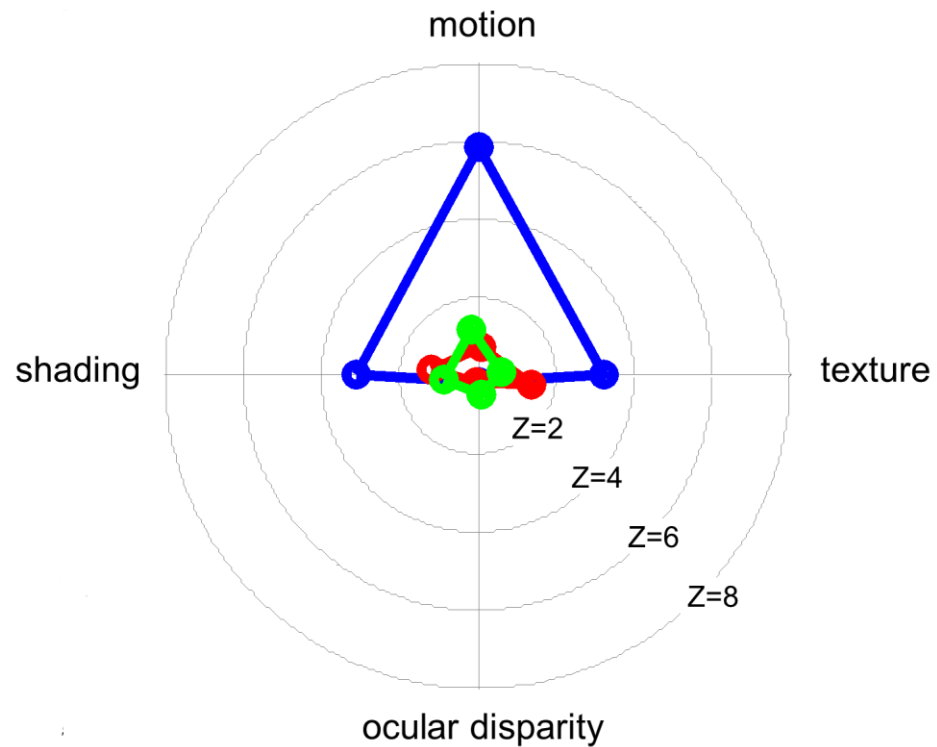
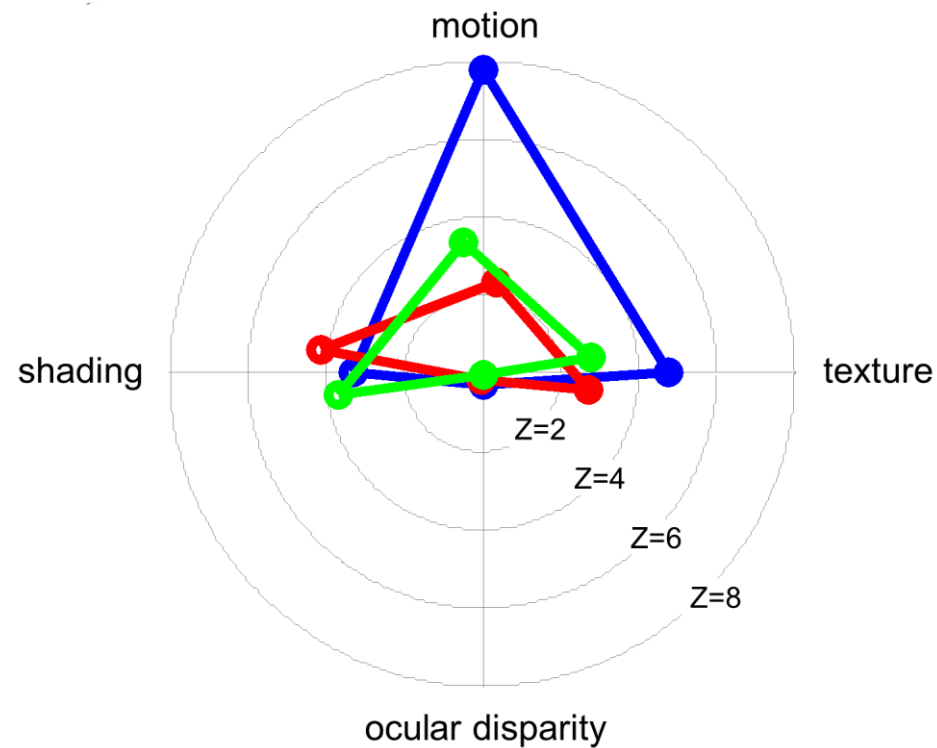
MRI

- Volumetric MRI, analysed using SPM8
 - Performance on the 3D tasks as covariate of interest
 - whole brain search volume at a corrected cluster level $P < 0.05$ with voxel-level at $P < 0.001$
- Functional MRI:
 - Passive viewing, 5 blocked conditions
 - 3D shape from shading and 3D shape from motion
 - 2D control conditions
 - *Georgieva et al., Cerebral Cortex, 18, 2416-2438, 2008*



POSTERIOR CORTICAL ATROPHY

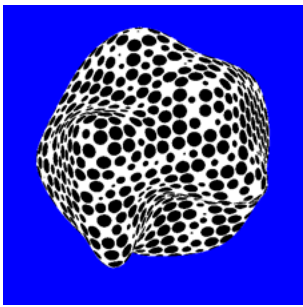
LEWY BODY DEMENTIA



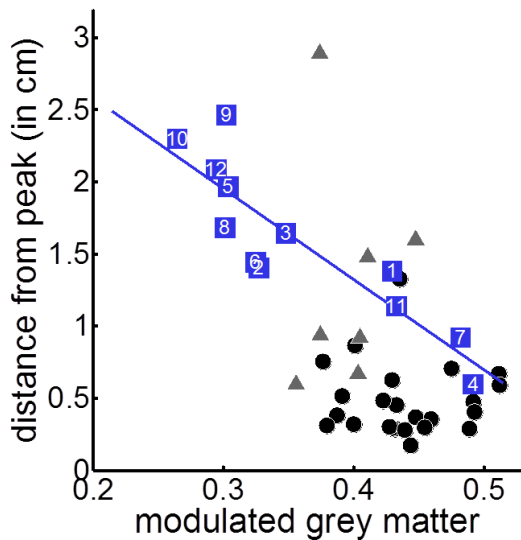
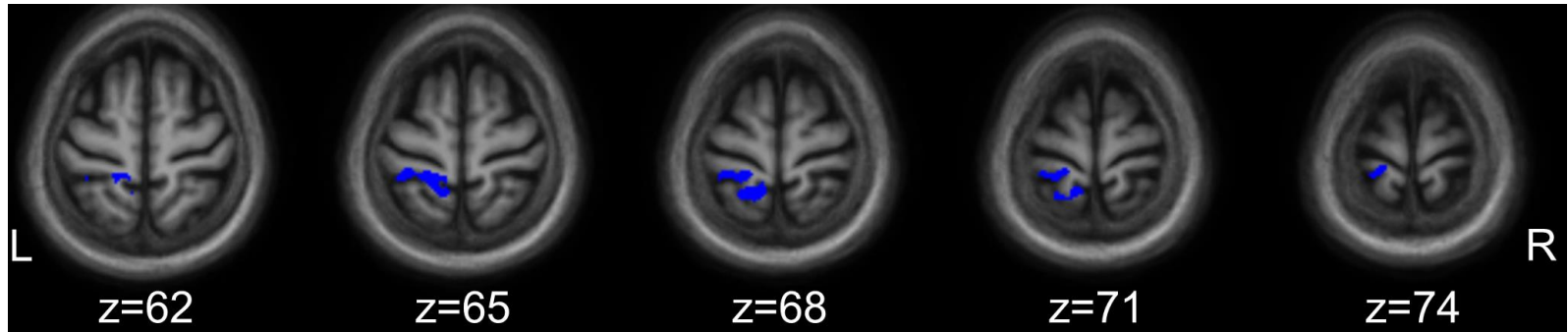
—●— 3D shape processing

—●— 2D shape processing

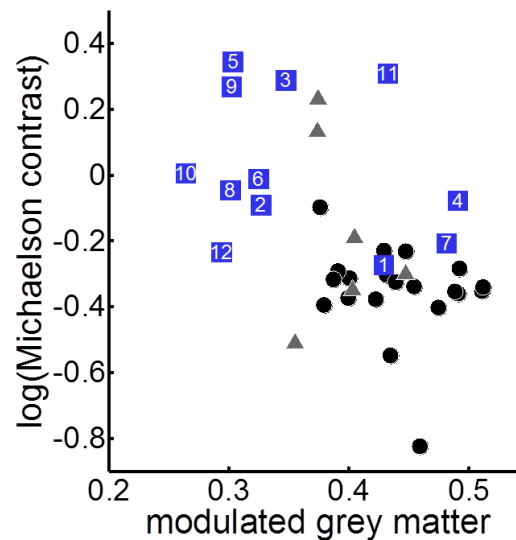
—●— feature extraction



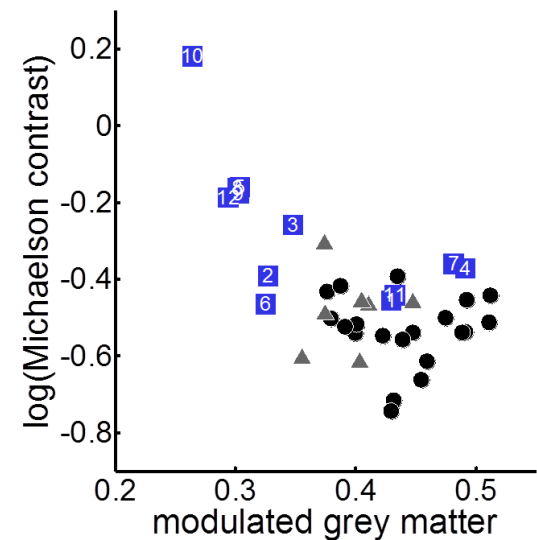
3D shape-from texture



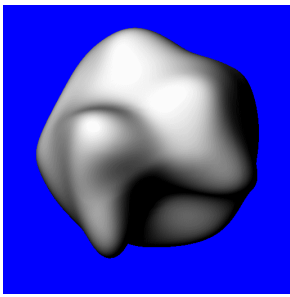
3D SHAPE
FROM TEXTURE



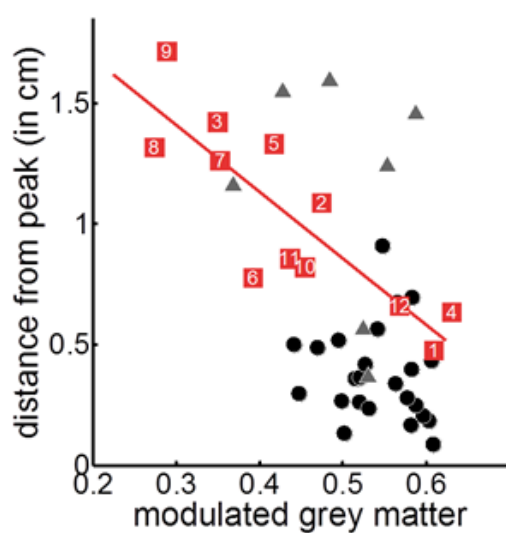
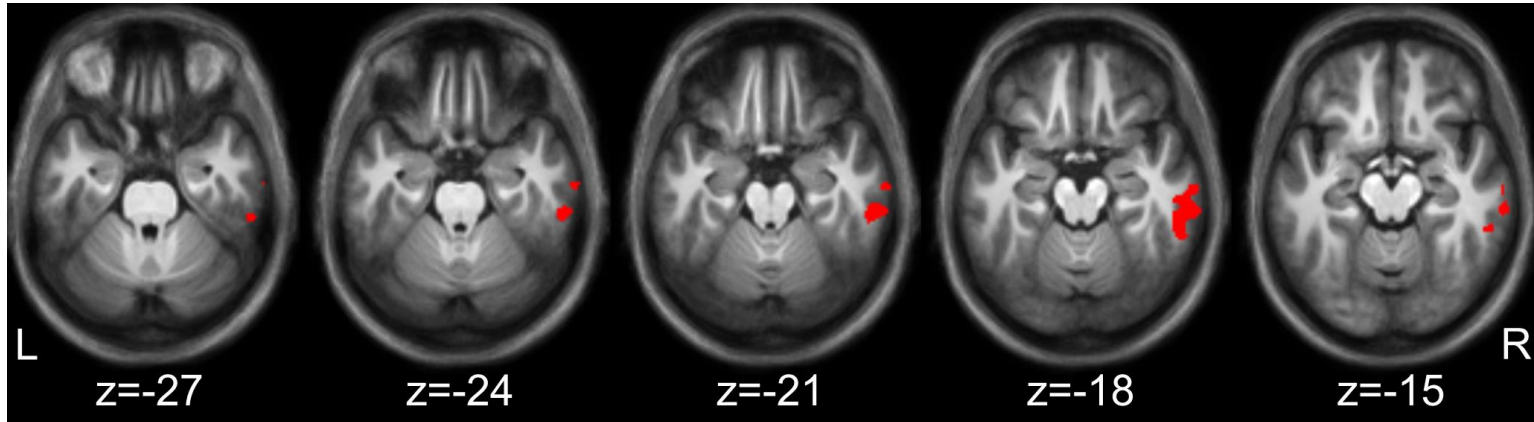
ORIENTATION
FROM TEXTURE



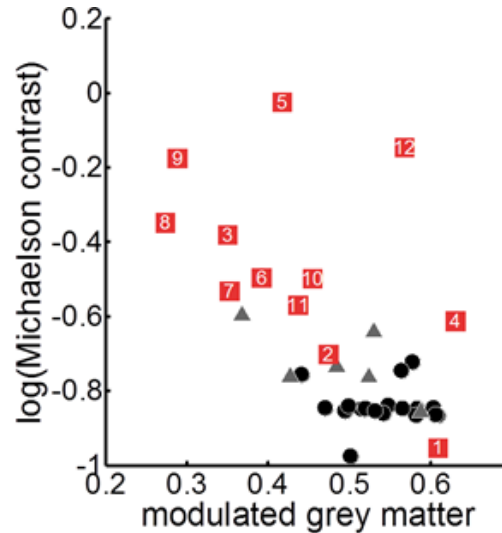
SAME-DIFFERENT
TEXTURE



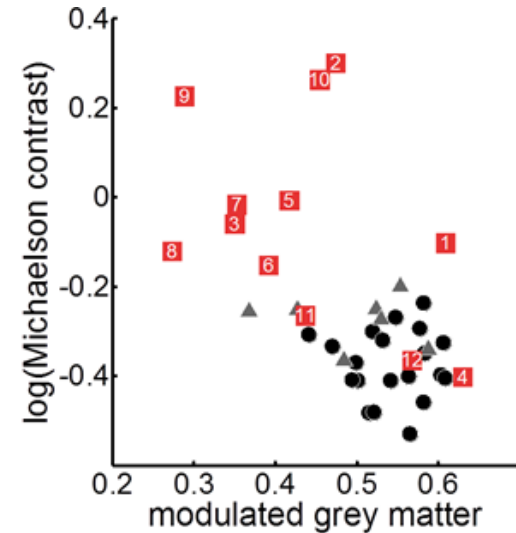
3D shape-from-shading



3D SHAPE
FROM SHADING



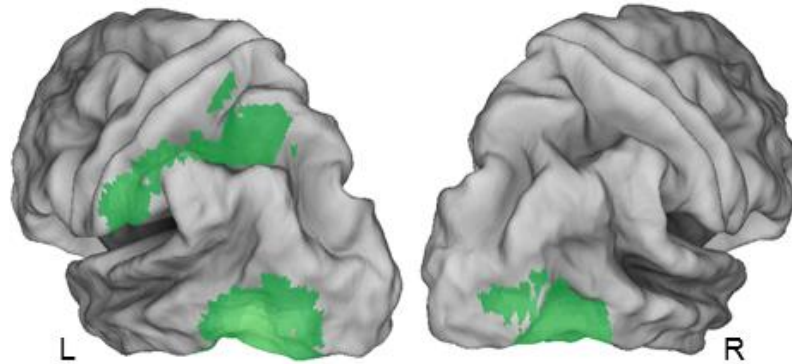
ORIENTATION
FROM SHADING



SAME-DIFFERENT
SHADING

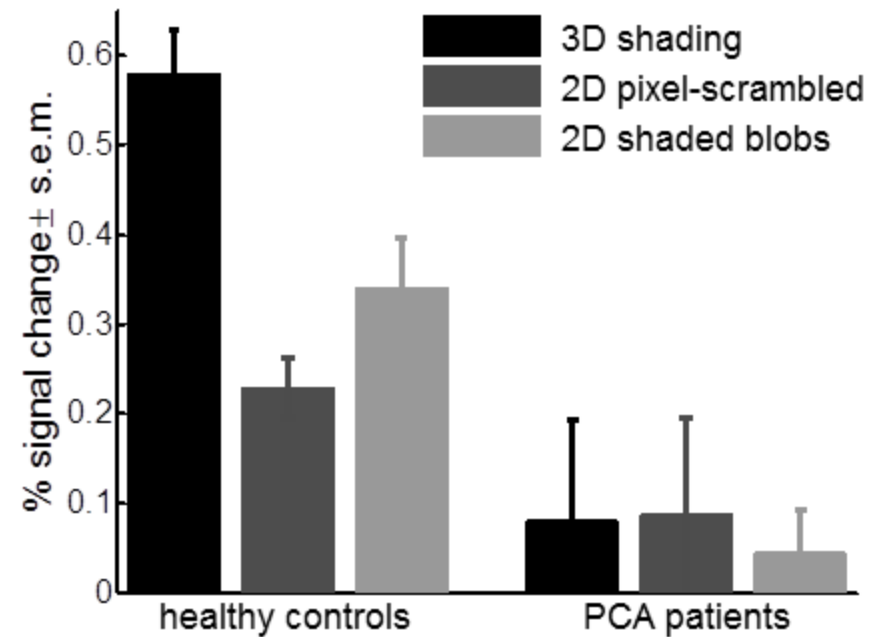
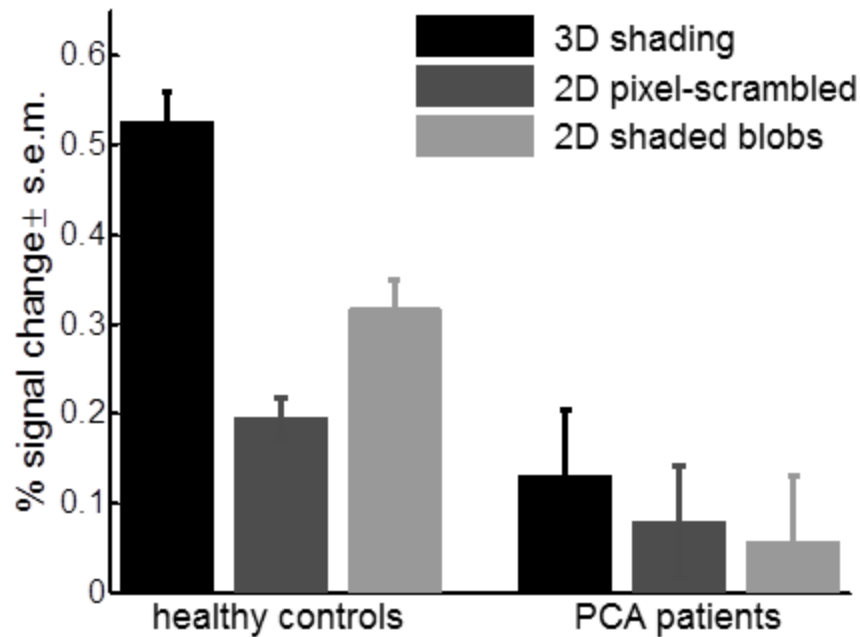
fMRI

3D from shading minus controls



left ITG

right ITG



Conclusion

- 3D shape perception is affected in PCA for all monocular cues with relative preservation of binocular disparity as a cue
- Inferior temporal volume loss is associated with a deficit in 3D shape-from-shading, superior parietal volume loss with deficit in 3D shape-from-texture
- The findings are in agreement with neurophysiological models of 3D shape perception