Dr. Temple Grandin: A Neuroimaging Case Study

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INTRODUCTION

Dr. Temple Grandin, internationally renowned scientist with autism, has generously provided science with many insights into the mind of individuals with autism. She has a unique mind, exceptional memory, and savant visuospatial abilities. She graciously allowed us to study her brain to understand better how brain structure and function are related to outstanding ability and disability within the same brain.

OBJECTIVE

The objective was to elucidate the neuroanatomical and functional basis of Dr. Grandin's cognitive strengths and weaknesses.

PARTICIPANTS

- Dr. Grandin's data were compared to those from three female control participants.
- Controls were matched to Dr. Grandin on age (Dr. Grandin 61.3 years; controls: mean 62.3 years, range 59.1-67.9 years.); two controls have advanced degrees, one did not complete college.

METHODS

- Anatomical, diffusion tensor, and functional magnetic resonance imaging (MRI, DTI, and fMRI) was performed at 3-Tesla on Dr. Grandin and the three control participants.
- MP-RAGE, T2-weighted anatomical, 12-direction DTI, and BOLD fMRI (resting state, visual language, auditory language, and music) data were collected from all participants.
- Measures analyzed were total and regional brain volume, cortical thickness, white matter microstructure (DTI), and functional (fMRI BOLD signal) differences.
- FreeSurfer was used for volumetric and cortical thickness analyses and visualizations.
- The functional analyses were done with MATLAB and SPM8 (Wellcome Trust Centre for Neuroimaging).
- All analyses used a whole-brain voxel-wise comparison approach.
- This case study is similar to past savant neuroimaging case studies (see Gonzalez-Garrido *et al*., 2002; Boddaert *et al*., 2005; Bor *et al*., 2007; Wallace *et al*., 2009; and Sevik *et al*., 2010).

RESULTS

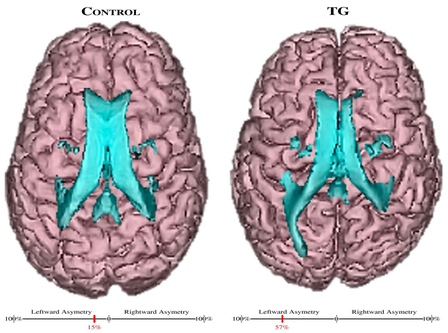


Figure 1.
Ventricular Volume Asymmetry
Dr. Grandin's left lateral ventricle was 57% larger than her right, whereas the control mean was only 15% leftward volumetric asymmetry .

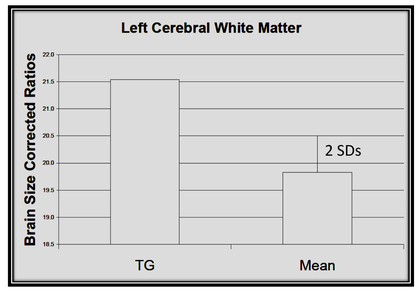
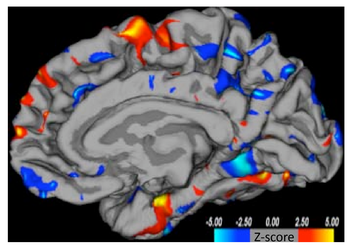


Figure 2.
Left Cerebral White Matter Volume
Dr. Grandin's left cerebral whitematter volume was > 2 SDs greater than the control mean.

Figure 3.
Cortical Thickness
Dr. Grandin's cortical thickness was 2 SDs > control mean in her entorhinal cortex and supplementary motor area. Her fusiform gyrus thickness was 2 SDs < control mean.



yellow = 2 SDs > control mean; cyan = 2 SDs < control mean

In addition to significantly increased left lateral ventricular volume and intracranial volume, Dr. Grandin had significantly increased volumes of the left cingulate, bilateral amygdala, and bilateral entorhinal cortex.

RESULTS (cont.)

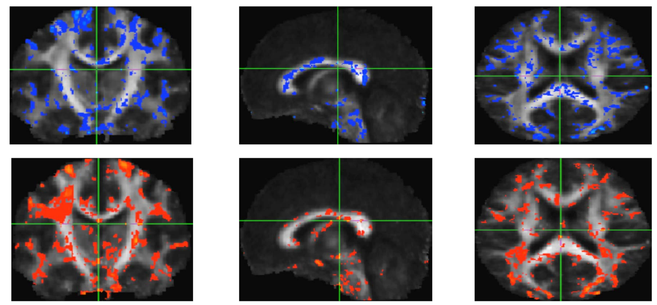
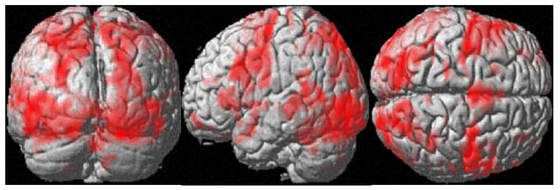


Figure 4. DTI Fractional Anisotropy (FA)
Dr. Grandin's FA was 2 SDs > control median in her left posterior/superior parietal region and corpus callosum, and 2 SDs < control median in her temporal stem, superior temporal gyrus, and arcuate fasciculus (blue = TG greater FA, red = control greater FA).

Figure 5. BOLD fMRI: Visual Language Task
Unlike in the controls, Dr. Grandin's brain activity was increased (q<0.05, FDR) in her bilateral parietal cortices during the visual language task, compared to resting state brain activity.



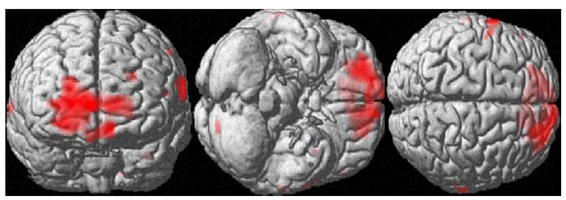


Figure 6. BOLD fMRI: Music Task
Unlike in controls, Dr. Grandin's brain activity was increased (q<0.05, FDR) in her medial prefrontal cortex, (especially pregenual right anterior cingulate) while listening to her favorite song (Led Zeppelin's *Stairway to Heaven*), compared to brain activity during other songs.

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CONCLUSIONS

- There is evidence of some unique differences found in Dr. Grandin's brain structure and function compared to the neurotypical population as represented by our sample.
- Due to sample size limitations and the problem of making inferences based on a single case, the results of this study should be interpreted with caution.