

## On the comparability of volumetric brain data in the multicentric IMAGEN study

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### Introduction

Much effort has been made to correct for susceptibility induced distortions in EPI; geometrical distortions, however, are widely assumed to be sufficiently corrected for by the manufacturer's reconstruction software. Due to the increasing interest in volumetric data from structural brain scans this question has gained new attention. Especially for large, multicentre studies this is a highly relevant issue. The quality control for IMAGEN study [1], a European research project on risk taking behavior in teenagers, has thus been extended a posteriori for an improved assessment of site and scanner effects for volumetry. First results of that investigation are presented here.

### Methods

For IMAGEN, more than 2000 healthy, 14 y old adolescents were scanned at 8 European sites with different scanners (table 1; site #4 became #9 after changing the scanner in the midst of the project). Sequence standardization was rigorous but ultimately limited by scanner inequalities. As not all vendors provided 3D algorithms, 2D distortion corrections were applied whenever possible. After an initial quality assessment, a subset of  $n = 1620$  (f: 867, m: 753) was selected for the present analysis. Non-accelerated 3D-MPRAGE images (1.1 mm isotropic, TR/TE/TI=6.9/2.8/900 ms) were analyzed using FreeSurfer 5.0.0 [2]. Each site periodically scanned an ACR phantom [3]. After baseline acquisition was completed, two adults (1f, 1m) and two precision geometry phantoms travelled all sites within a few weeks to be scanned. Both phantoms are inserts to a water-filled cylindrical (L=18.7 cm, i.d.=18 cm), #1 is a cubic grid phantom of 15 mm mesh size, #2 a 13-mm cubic grid of 10.8-mm bores machined in a solid perspex block (Fig. 1).

site	Scanner	B0	SW vers.	receiver coil
1	GE SIGNA HDx	3 T	14.0	8HRbrain
2	Philips Achieva	3 T	3.2.1.1	SENSE-Head-8
3	Philips Achieva	3 T	2.5.3.3	SENSE-Head-8
4	GE Signa excite	3 T	11	8HRbrain
5...8	Siemens TrioTim	3 T	VB17	Head 12
9	Siemens Verio	3 T	VB17	Head 12

Table 1: scanner parameters

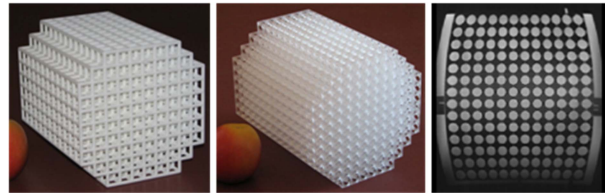


Fig 1: Left: grid phantom (#1). Middle: bore phantom (#2). Right: Coronal image of phantom #2 with sagittal 2D distortion correction applied.

### Results and Discussion

The site averages of most anatomical measures from the FreeSurfer analysis vary significantly and it is not a priori clear whether this is a real effect or an instrumental artifact. Results for intracranial volume (ICV), one of FreeSurfer's most robust output data (single subject reproducibility  $\pm 0.3\%$ ), are shown in Fig 2a. The site variation is similar for the male and female subgroups. The total volume of the ACR phantom, in contrast, varies much less by only  $\pm 1\%$  from site to site (Fig. 2b). Still Fig. 2a) is not reflecting real anatomic variations, however, as the ICVs from both travelling volunteers (Fig 2c), are not at all constant but vary by  $\pm 2\%$ . The MR image of geometry phantom #2 (Fig. 1, rhs) indicates the inadequacy of the manufacturer's distortion corrections for volumetric studies if only a 2D algorithm is provided. But even this cannot explain the sobering result of Fig. 2c) as sites #2 and #3 both used the same scanner model and 3D correction. Tentatively applying Fig. 2c) as a correction curve to Fig. 2a) it can, in the present stage of the analysis, not be ruled out that ICV variations of several percent do indeed exist even if large subject groups are averaged. Ultimately, this can only be answered, once the local distortion measured with the geometry phantoms have been applied and all datasets have been reanalyzed. The travelling-volunteer data will be the test bench for any such procedure.

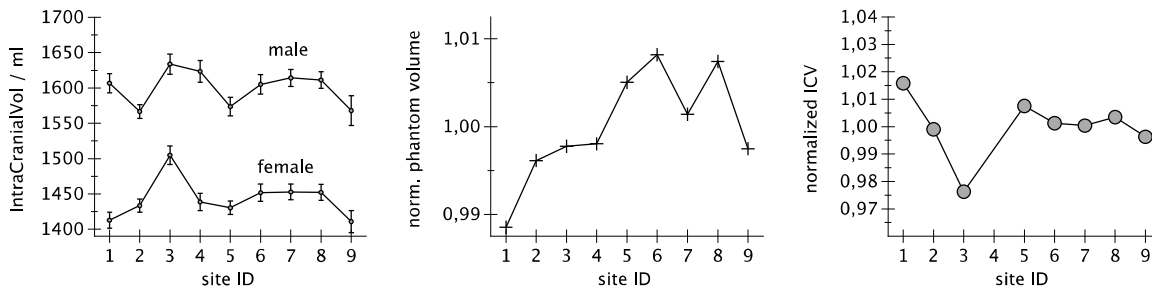


Fig 2: a) ICV averages vs site ID. Error bars indicate the standard deviation of the mean for each site (left). b) ACR phantom volumes normalized to the group average (middle). c) normalized, average ICV of travelling volunteers (right)

### References

[1] Schumann et al., Mol Psychiatry 15 (2010) 1128-39. [2] Dale et al., Neuroimage 9 (1999) 179. [3] www.newmaticmedical.com.