Reproducibility of Brain Morphometry from MRI Scans Performed at Different Times of Day

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BACKGROUND

Volumetric measurements of different tissue types, such as grey and white matter, as well as surface-based analysis of the cortex, can provide valuable information about structural development, psychiatric disorders and cognitive function.

However, several factors affect the reliability of morphometric measures such as intra or inter-scan sessions, shim settings, hydration status, scanner heating and hardware components (Jovicich et al., 2009; Hedman et al., 2012).

The aim of this work was to investigate whether brain morphometry measures differed between scans performed early in the morning immediately after the scanner was switched on and late afternoon before the scanner was switched off over a period of six days.

METHODS

- Three healthy adult volunteers were scanned immediately after the MRI scanner was switched on in the morning at 5:30 am and early evening before the scanner was switched off around 6pm.
- scans were repeated over six days. A total of 36 scans were acquired, 18 morning and 18 evening.
- For each subject, a T1-weighted (T1W) structural image was acquired (van der Kouwe et al., 2008) with TR 2530 ms, TEs 1.53, 3.19, 4.86, 6.53 ms, TI 1100 ms, flip angle 7 deg, voxel size 1 × 1 × 1mm³ and matrix size 224 × 224 × 144.
- FreeSurfer version 5.3.0 was used for automated reconstruction and segmentation of T1W structural images.
- Vertex-wise comparison of cortical thickness and local gyrification indices (LGI) were performed to identify mean surface-based differences (morning vs evening scans) for all three subjects over six days and within each subject separately over six days (p<0.05).
- Clusters that survived cluster size correction at α<0.05 were reported.
- Based on literature (Meyers et al., 2016), regional volumes of caudate nucleus, thalamus, putamen, corpus callosum, lateral ventricles, global white and grey matter volumes and total brain volume were compared between morning and evening scans.

RESULTS

- No regions showed significant differences in cortical thickness between morning and evening scans, for all subjects or individual subjects.
- In contrast, morning and evening scans showed differences in the gyrification in different brain regions (**Table 1 and Figure 1)**. These regions are similar for all subjects and individual subjects.

Table 1: Regions showing significant differences in gyrification between Morning and Evening scans of all participants.

Direction	Location	MNI co-ordinates at peak (x y z)	Cluster size (mm^2)
Left hemisphere			
Morning > Evening	Isthmuscingulate	-15.6 -49.4 1.6	1855.83
	Pericalcarine	-11.9 -73.5 12.4	288.26
Evening > Morning	Superior temporal	-56.0 -31.1 -0.4	265.11
	caudalmiddlefrontal	-39.0 5.3 45.6	173.20
Right hemisphere			
Morning > Evening	Middle temporal	60.5 -53.8 1.5	666.51
	Precentral	25.5 -21.4 64.2	851.73
	Supramarginal	41.9 -30.0 37.7	170.99
	Rostral middlefrontal	17.6 61.1 -3.1	162.23
	Precuneus	22.3 -57.6 18.0	155.85
	Supramarginal	52.6 -45.9 36.9	208.61

- When comparing brain volumes, there were no significant differences for putamen, caudate nucleus, thalamus, lateral ventricles, and total white and grey matter.
- Yet evening scans showed significantly greater volume than morning scans (mean morning volume ± SD = 27116.65 ± 1781.20 mm3; evening = 50822.96 ± 3168.25 mm3; p<0.001) in corpus callosum, while morning scans had significantly greater total brain volume than evening scans (morning = 1591156 ± 104599 mm3; evening = 1576438 ± 94062 mm3; p=0.003).

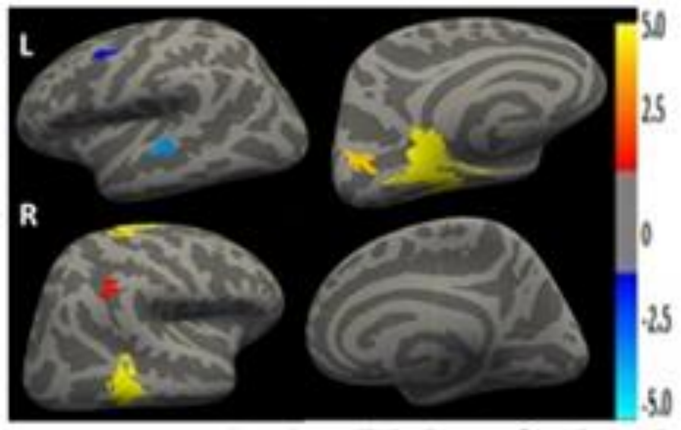

Figure 1: Lateral and medial views of regions showing differences in gyrification between morning and evening scans in left (TOP) and right (BOTTOM) hemispheres. (thresholded at p<0.05, cluster size thresholded p<0.05.

DISCUSSION

- Our results show that the time of day when an MRI scan is performed may affect cortical folding (gyrification) measures, as well as corpus callosum and total brain volumes.
- These data suggest that cortical thickness and most regional brain volumes may offer more reproducible data for morphometric analysis than gyrification.
- The cause of such morphometric variation requires further investigation.

CONCLUSION

Overall, within the limits of the small data set, our results suggest that difference in scan time will affect reproducibility of brain morphometry. Similar investigations with larger samples are warranted.

REFERENCES

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