The effect of face-masking structural MR images on the reliability of brain measures

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Introduction:

Nowadays, MRI brain scans are of high resolution and therefore surface rendering may lead to identification of the scanned participant (Prior et al., 2009). Most MRI-viewers have a built-in feature to display imaging data as surface rendering making identification relatively easy. To address this privacy concern different methods have been developed to remove or blur voxels that contain facial features. In this study we evaluated one of these methods: Face Masking (Milchenko and Marcus, 2013, http://nrg.wustl.edu/software/face-masking/). The aim of this study was to explore the trade-off between quality of de-identification, the impact on brain voxels and the reliability of segmentations.

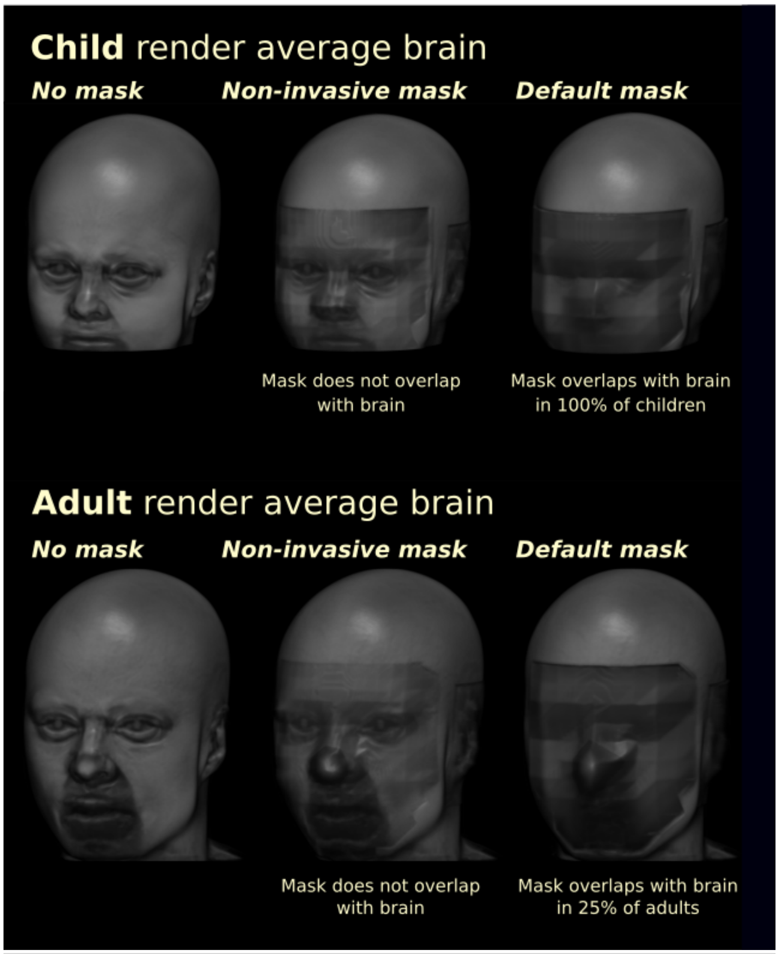
Methods:

We included T1-weighted scans of 25 healthy children with a mean age of 9 (8-10) years and 16 healthy adults with a mean age of 23 (19-31) years. For the adult sample test-retest data was available with a scan interval of one week. MRI scans were acquired at 3T using the same protocol for children and adults on a Philips Achieva scanner. First, the de-identification properties and possible overlap of the different masks with brain tissue were evaluated visually. The number of subjects in which the mask overlapped brain voxels was counted. Next, to measure the reliability of brain measures (Schnack et al., 2004) we used the intraclass correlation coefficient (ICC, Shrout and Fleiss, 1979). ICCs were computed to quantify the effect of face masking with default settings on the reliability of brain measures derived with FreeSurfer's automatic segmentation pipeline (Fischl et al., 2002). FreeSurfer version 6.0 was used in combination with the Desikan-Killiany atlas (Desikan et al., 2006) to extract 218 regional measures of (sub)cortical volume, cortical thickness and cortical surface area. ICCs were calculated between brain measures derived from the same scan with mask versus without mask, in children and adults separately. Additionally, test-retest ICCs were calculated in adults.

Results:

The face mask with default settings overlapped with brain tissue in 25% of the adults and in 100% of the children. Adjusting the coarseness of the mask reduced the incidence of overlap, but also reduced the de-identification properties of the mask (Figure 1). ICCs between regional brain measures derived from scans with mask and without mask were high for children and adults. In children the mean ICC over all regional measures was 0.94 with an ICC below 0.75 for 2% of the brain measures. These lower ICCs were found for cortical thickness in in the left insula, right frontal pole and right lateral orbitofrontal cortex, for surface area in the right precentral gyrus and for gray matter volume in the right entorhinal cortex. In adults the mean ICC was 0.96 with an ICC below 0.75 for 2% of the brain measures. Lowest ICCs were found for cortical thickness in the left insula and left medial orbitofrontal cortex and for surface area in the left insula and left frontal pole. In adults, test-retest ICCs without mask were highest for regional measures of (sub)cortical volume and cortical surface area, followed by cortical thickness. The mean ICC over all regional measures was 0.91 with an ICC below 0.75 for 10% of brain measures. Lowest ICCs were found for cortical thickness in the insula and some frontal regions. ICCs were comparable for test-retest scans with and without face mask.

Figure 1. The trade-off between de-identification properties and invasiveness of the face-mask. Renders of the child brain (average of 25 scans) and the adult brain (average of 16 scans) without mask, with the non-invasive mask and with the default mask. The non-invasive mask is defined as the highest coarseness value at which there were no incidences in which the mask overlapped brain tissue.



Conclusions:

There is a trade-off between de-identification and invasiveness using face-masking procedures and this balance is more delicate in children. Comparing local test-retest ICCs and ICCs computed from masked versus unmasked scans, we conclude that the reliability of brain segmentations is minimally affected by face masking.

Imaging Methods:

Anatomical MRI [1]

Informatics:

Informatics Other [2]

Keywords:

Cortex
Data analysis
Design and Analysis
Informatics
NORMAL HUMAN
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STRUCTURAL MRI
Sub-Cortical
Other - Face-masking ; Privacy

[1|2]Indicates the priority used for review

My abstract is being submitted as a Software Demonstration.

No

Please indicate below if your study was a "resting state" or "task-activation" study.

Other

Healthy subjects only or patients (note that patient studies may also involve healthy subjects):

Healthy subjects

Was any human subjects research approved by the relevant Institutional Review Board or ethics panel? NOTE: Any human subjects studies without IRB approval will be automatically rejected.

Yes

Was any animal research approved by the relevant IACUC or other animal research panel? NOTE: Any animal studies without IACUC approval will be automatically rejected.

Not applicable

Please indicate which methods were used in your research:

Structural MRI

For human MRI, what field strength scanner do you use?

3.0T

Which processing packages did you use for your study?

Free Surfer

Provide references using author date format

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