Sex-Based Comparison of Subcortical Regions in the Human Brain

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Introduction/ Abstract

This research project aimed to identify statistically significant differences between male and female adolescent human brains through digitally rendered images. The volumes of the individual regions of the male and female brains were derived from a large data set and compared to determine which areas had statistically significant differences. In finding which regions have these differences, researchers demonstrate the need for more modeling of the sex-separated brain, particularly that these differences are statistical in region volume, separate from overall brain volume. These differences can be indicative of different reactions to traumatic brain injuries (TBI's) on the same region of the brain for different sexes. Furthermore, the lasting impacts of traumatic brain injuries can be different between the sexes, which can be linked to the differing sizes in region of the brain.

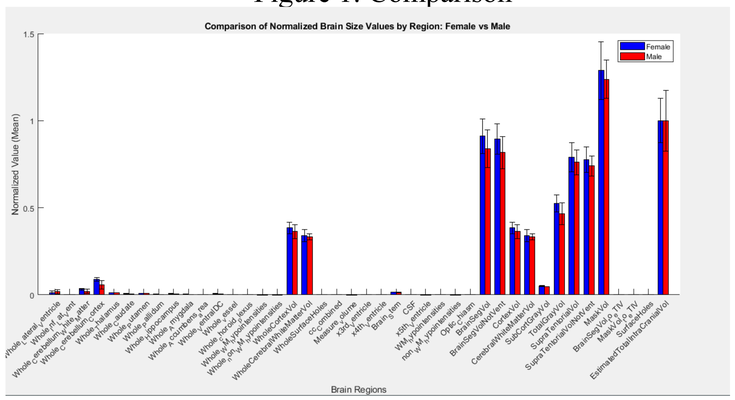
Methodology

The data from this study was collected from one hundred healthy subjects, fifty of which male and fifty female, between the ages of 18 and 21. It was compiled from an anonymous database and the data was then analyzed using FreeSurfer Automatic Segmentation, which identified sixty-five regions of the brain and areas of interest. The regions were split into left and right portions of many parts of the brain, and so by using MATLAB, they were combined into each section as a whole.

Each brain region, organized by sex was then normalized as compared to the average total intracranial volume based on sex. This normalization is to account for the difference in the overall size of the two sexes. The values were then evaluated for the mean and standard deviation, and the sex-separated means were graphed with the standard deviation as the error bars. This process was performed for both the male and the female data sets. T-tests were also used to determine the statistically significant differences.

Results

Figure 1: Comparison



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Discussion and Conclusion

Figure 1 demonstrates the differences between the male and female regions of the brain. Of the eight statistically significant regions, only two have greater values in females than in males: the caudate and cerebral white matter. This is consistent with the previous literature regarding the white matter mass.

The results lead to a significant conclusion that research focused on the sex differences in the subcortical regions is needed. Two areas of the brain were seen higher in females, which may provide insight into the distribution of grey and white matter between the sexes. Because the white matter is significantly higher in females than males, it may indicate that the grey matter would be the inverse.

The results indicate a need to distinguish between the sexes and regions of the brain during brain modeling and templates to have a more holistic understanding for design and research purposes. Further work should be done on different age groups, as shown in figure 2 to determine the risk factors and implications of traumatic brain injury in the elderly in addition to the young population.

Figure 2: Preliminary