Estimating Hippocampal Subfield Volume in Typical and Atypical Youth

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Introduction

- Down Syndrome (DS) is the most common genetic cause of intellectual disability. It can lead to developmental issues and health risks.
- The hippocampus is a brain region that specializes in learning and memory. Autopsies indicate a smaller hippocampus in those with DS than those who are typically developing (TD).
- Studies that have been done to examine hippocampal development in youth are inconclusive, possibly due to subfield volume differences over the course of development.
- Hippocampal subfields have not been manually segmented in Magnetic Resonance Images (MRIs) from children with DS, the necessary protocol given the variability in this group.
- To estimate the subfield volumes and compare relative development between groups, we performed MRIs on 20 youth, both TD and DS, and gathered data from their sleep and cognitive assessments.
- The Cornu Ammonis (CA) regions and Dentate Gyrus (DG) make up the hippocampal formation and play an important role in memory. They require additional neurogenesis, formation of new neurons, and could be impaired in DS.

We predict a decrease in volume of CA and DG regions of DS participants and a stronger Inter-Rater Reliability (IRR) for TD populations

Methods

- Scanned participants aged 11-20
- Segmented hippocampal subfields using ITK-snap and Dr. Arne Ekstrom's protocol
- Evaluated group differences and IRR

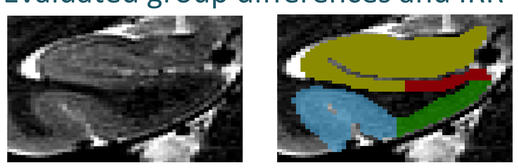

Figure 1. Anterior hippocampus before and after manual segmentation

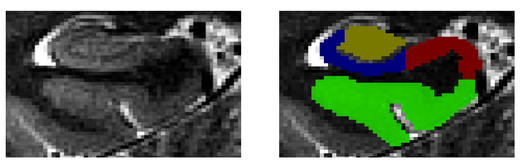

Figure 2. Posterior hippocampus before and after manual segmentation

Results

Hippocampal Subfields Volume by Group

CA + DG, anterior

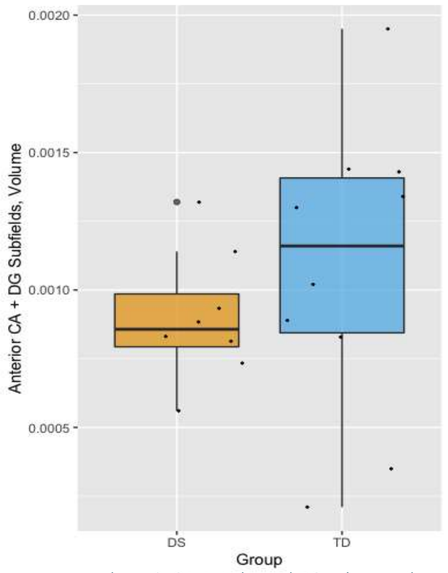

Figure 3. CA Anterior and DG volume estimates

CA1, posterior

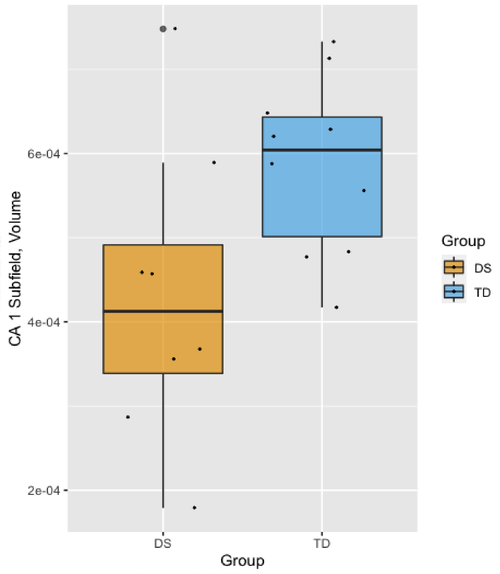

Figure 4. CA1 volume estimates

CA3 + DG, posterior

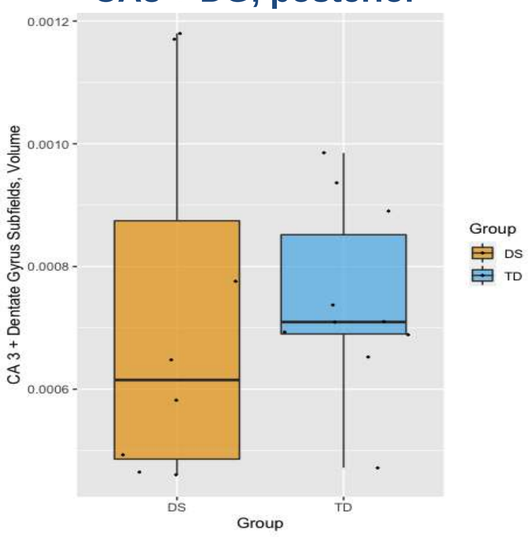

Figure 5. CA Anterior and DG volume estimates

IRR, anterior and posterior

	IRR, %	95 % Confidence Interval
CA + DG, anterior	96.4	0.705, 0.996
CA3 + DG, posterior	95.2	0.65, 0.978

Figure 6. Inter-rater reliability, the percentage of agreement between multiple raters

Note for figures 3-5: all subfield volumes are shown as a percentage of total brain volume, to correct for global differences between groups.

- The CA Anterior volumes were not significantly different between the two groups, t(1,16)=-0.86, *p*=.40, but there was a much higher variance in TD group.
- **The CA 1 subfield was significantly larger for TD youth; t(1,16)=-2.34, bootstrapped *p*=.03.**
- The CA3/DG held much greater variance for the group with DS, but the means were not significantly different; t(1,16)=-0.24, bootstrapped *p*=.83.
- **We achieved high values for inter-rater reliability, both over our target of 95%.**
- IRR was higher for typically developing teens and lower for the brains of participants with DS. IRR for TD segmentations was 96.1%, while IRR for DS segmentations was 69.5%.

Discussion

- **There are initial differences in means of subfield volumes between the DS and TD groups**
- **Based on our initial results, we expect to see significant group differences when all hippocampi are segmented, and all raters' results are considered**
- We were not able to examine sex differences in subfield volume as our n was too small, but this will be included in our future work.
- Our future work also involves using these estimates as seeds for functional connectivity analyses in order to see interactions between different brain regions
- We will also compare this with our sleep and cognitive test data to look for sleep disruption patterns and correlations with performance on cognitive tasks
- This knowledge can be used for future neuroscience and psychology research, education, and intervention studies

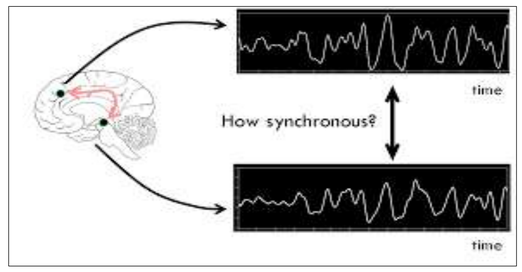

Figure 7. Diagram of functional connectivity, activity correlations over time between brain regions

References

Acknowledgments

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