

Right Caudate Volume and Parent Ratings of Executive Functions in Pediatric Attention Deficit Hyperactivity Disorder (ADHD)

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Background/Aim/Hypothesis

- Attention-deficit/hyperactivity disorder (ADHD) is a highly prevalent childhood disorder.
- Symptoms include inattention or hyperactivity and impulsivity, which increases the risk for lower academic performance, accidents and injury, and additional mental health disorders.
- Children with ADHD also struggle with executive function (EF) deficits related to working memory, inhibition and verbal fluency (Willcutt et al., 2005).
- Previous research has shown ADHD-related volume differences in the **thalamus, hippocampus, caudate**, and **putamen**, but the potential correlation between subcortical volume and performance on EF tasks remains unknown (Batty et al., 2015; Hoogman et al., 2017)
- Identifying structural characteristics of subcortical brain areas that correlate with EF performance may help identify a novel treatment target for future therapeutic interventions.

Hypotheses were:

- ADHD group will have **smaller caudate and putamen** volume compared to typically developing controls (TDC)
- Children with ADHD will have weaker performance on the EF tasks compared to the TDC group.
- Parents of children with ADHD will report higher levels of EF challenges compared to the TDC group.

Methods

Participants

- 24 children diagnosed with ADHD (mean age = 11.64, SD = 2.54 years; 12 M)
- 25 TDC (mean age = 11.09, SD = 2.49 years; 14 M)

EF Test Measures

- Parents completed EF rating scales; BRIEF-2
- Inhibition: Continuous Performance Task (CPT-3)
- Working Memory: WISC-V Digit Span and Spatial Span Backwards

Magnetic Resonance Imaging Acquisition (MRI)

- T1-weighted anatomical MRI scans (32 channel head coil, 3T GE 750w scanner) were obtained from the Alberta Children's Hospital
- All children were ADHD medication-free at the time of scan (minimum 48-hour washout period)
- Scans were analyzed in Free Surfer 6.0 for subcortical volumes of the caudate and putamen (Figure 3)

Statistical Analyses

- Multivariate Analysis of Covariance were conducted to investigate the differences in subcortical volume between children diagnosed with ADHD versus controls (typically developing children).
- Pearson Correlations were conducted to evaluate the relationship between subcortical volume, EF performance and EF ratings by parents.

Results

Executive Function Group Differences

- Parents of children with ADHD reported significantly more EF challenges compared to the TDC group, $F(5,43) = 20.89, p < .001$, partial eta square = .71).
- No significant group difference was observed on the Working Memory ($F(2,46) = 1.38, p = .26$, partial eta squared = .06) or on the Response Inhibition task ($F(4,39) = 2.48, p = .06$, partial eta squared = .20)

Subcortical Group Differences:

- No significant group difference in volume was observed between children with ADHD and TDC group, $F(4,41) = .79, p > .05$, partial eta square = .07).

Correlations

- Pearson correlations demonstrate negative correlations between right caudate volume and parent ratings of emotion regulation ($r = -.52, p = .009$) in the ADHD group.
- No correlations were observed between ADHD symptoms and volumes of subcortical regions.
- Linear Regression model showed that 26.3% of the variance in emotion regulation in the ADHD group was accounted for by the right caudate volume.

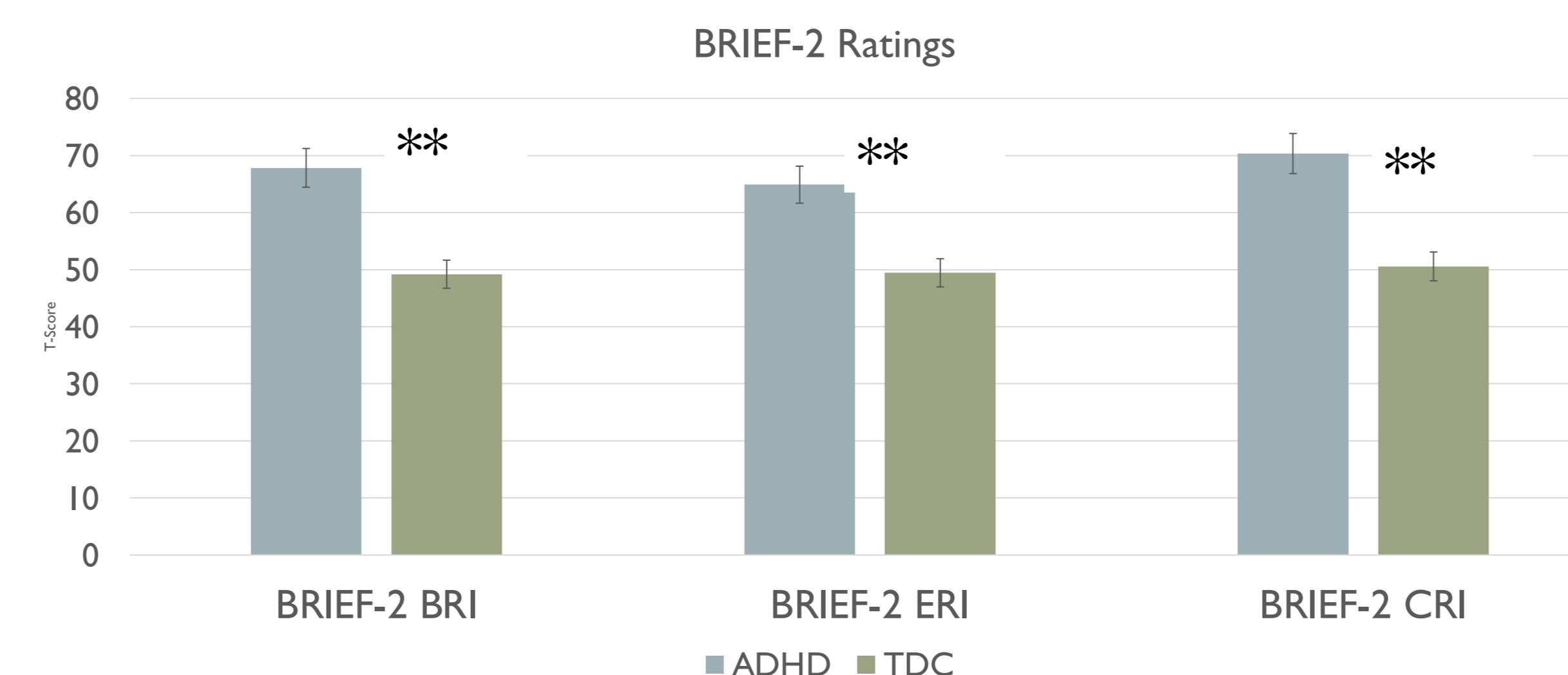


Figure 1. Parent EF ratings on BRIEF-2 between Children with ADHD and the TDC groups

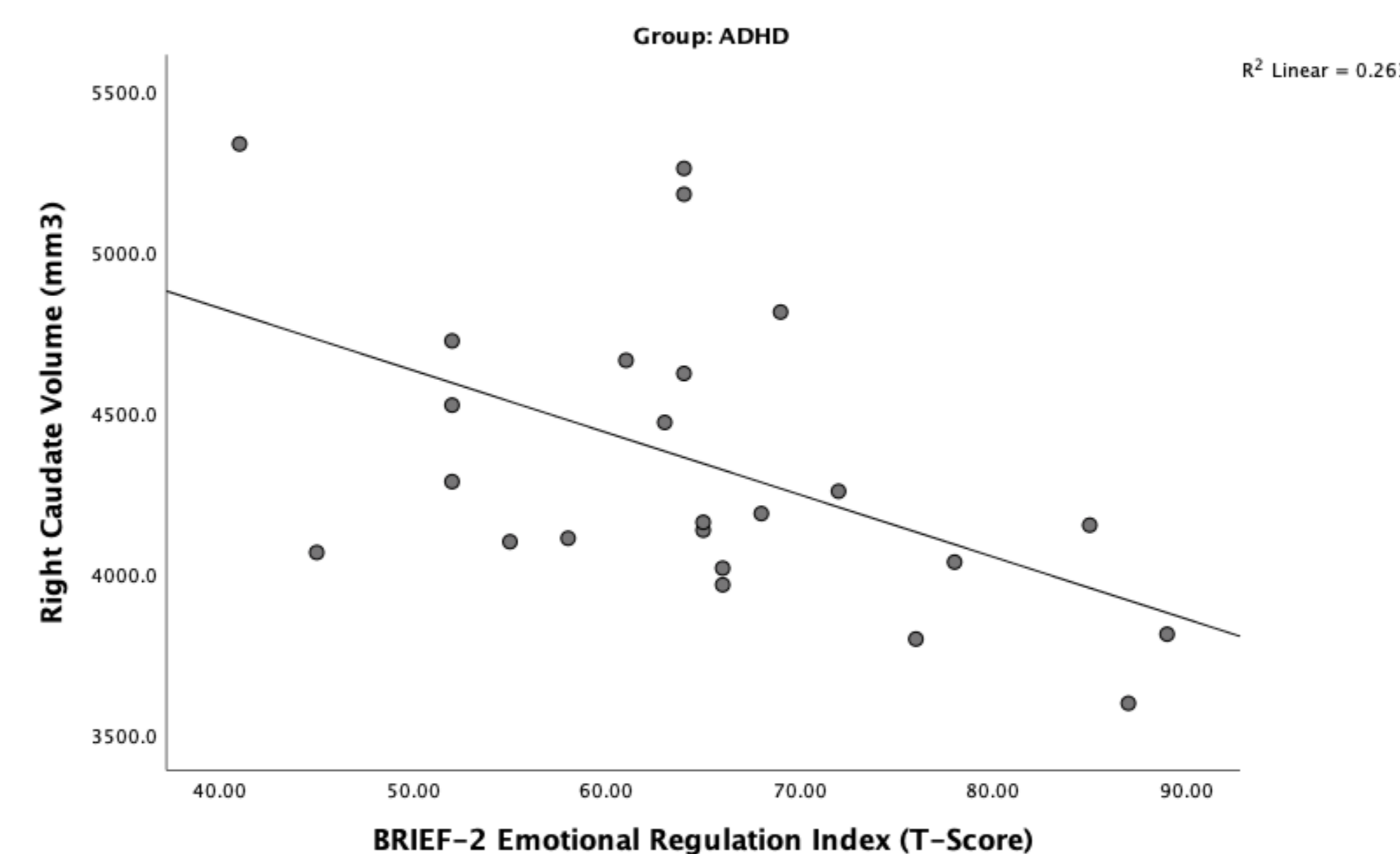


Figure 2. Correlations of BRIEF-2 Emotional Regulation Index score with Subcortical volume of the Right Caudate (Rcaud) across the ADHD group

Discussion

- Our study showed significant EF difficulties based on parent ratings, with parents of children with ADHD reporting increased EF difficulties compared to peers.
- No significant volumetric difference was observed in the caudate or the putamen.
- Likely due to the heterogeneous presentation of children with ADHD both in neuroanatomical and behavioural findings.
- Right caudate was related to parent ratings of EF in pediatric ADHD participants.
- Specifically, the Emotional Regulation Index was significantly correlated with the right caudate volume and predicted 26.3 % of the variability.

Potential Impact: Given the current findings, there is an increased need to target interventions specifically to manage emotional regulation challenges in the identified subgroup of children.

- Right Caudate could be a potential biomarker for ADHD.

Limitation and Future Research:

- Small sample size: future studies with large sample size need to replicate findings.
- ADHD participants were referred by clinicians and were not on medication naïve.
- Future studies need to investigate changes in subcortical volume following medication trial.

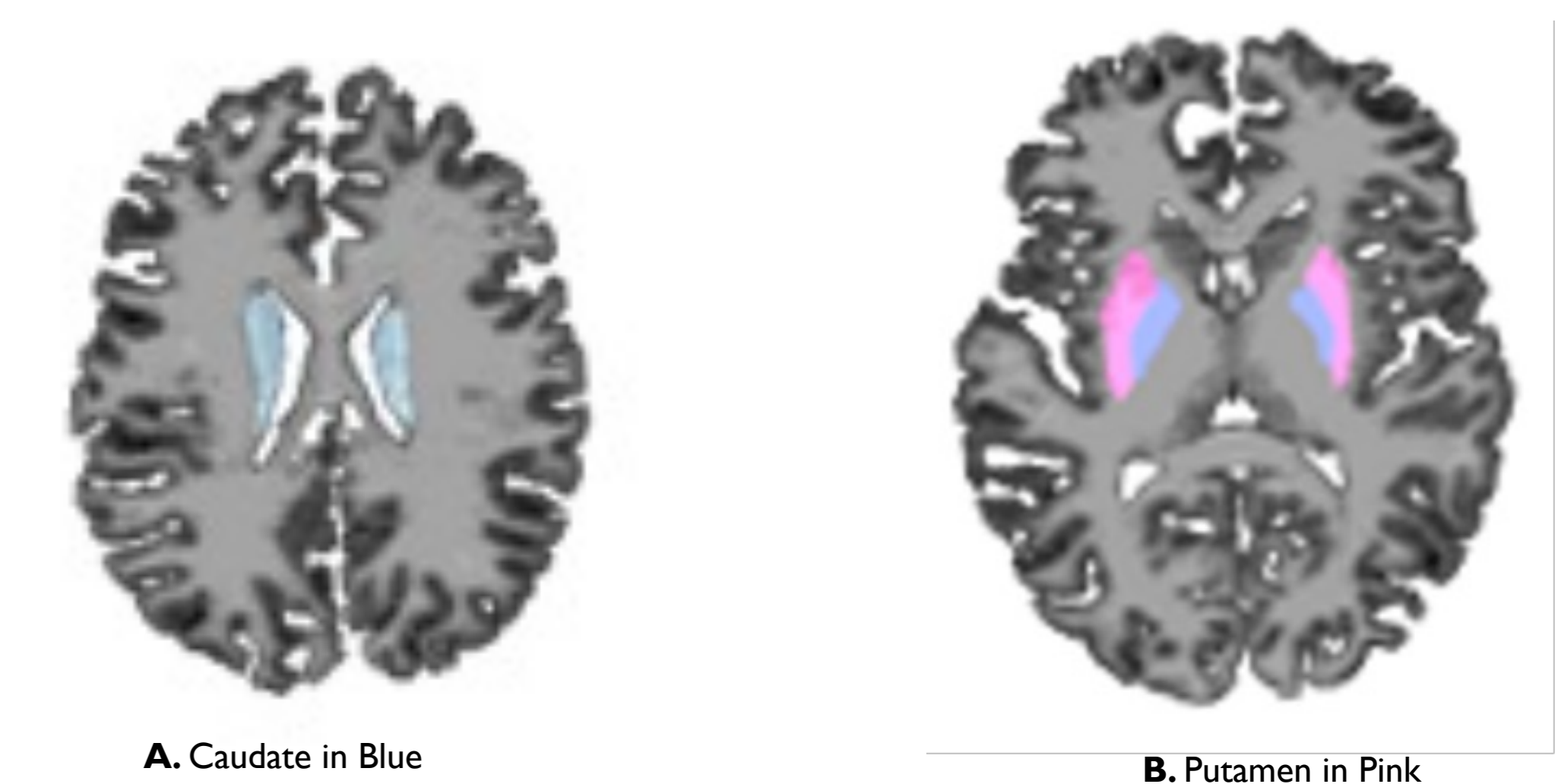


Figure 3. Free Surfer Segmentation of Subcortical Regions A) Caudate and B) Putamen.