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Automatic Internal Segmentation of Caudate Nucleus for Diagnosis of Attention-Deficit/Hyperactivity Disorder

Context: Attention-Deficit/Hyperactivity Disorder

Attention-Deficit/Hyperactivity Disorder (ADHD) is a developmental disorder characterized by **inattentiveness, motor hyperactivity and impulsiveness,** which represents the most prevalent psychiatric disorder in childhood. It is estimated that half of children with ADHD will display the disorder in adulthood.

Studies on **volumetric brain Magnetic Resonance Imaging (MRI)** showed neuroanatomical abnormalities in pediatric ADHD [1]. In particular, **the diminished right caudate volume** is one of the most replicated findings among ADHD samples in morphometric MRI studies [2].

ADHD Diagnostic Test Method

We propose an **automatic method for internal caudate nucleus segmentation based on machine learning, and define an automatic ADHD diagnostic test.** The proposed method is split in **three main steps**:

* right caudate body volume (rCBV) and bilateral caudate body volume (bCBV).
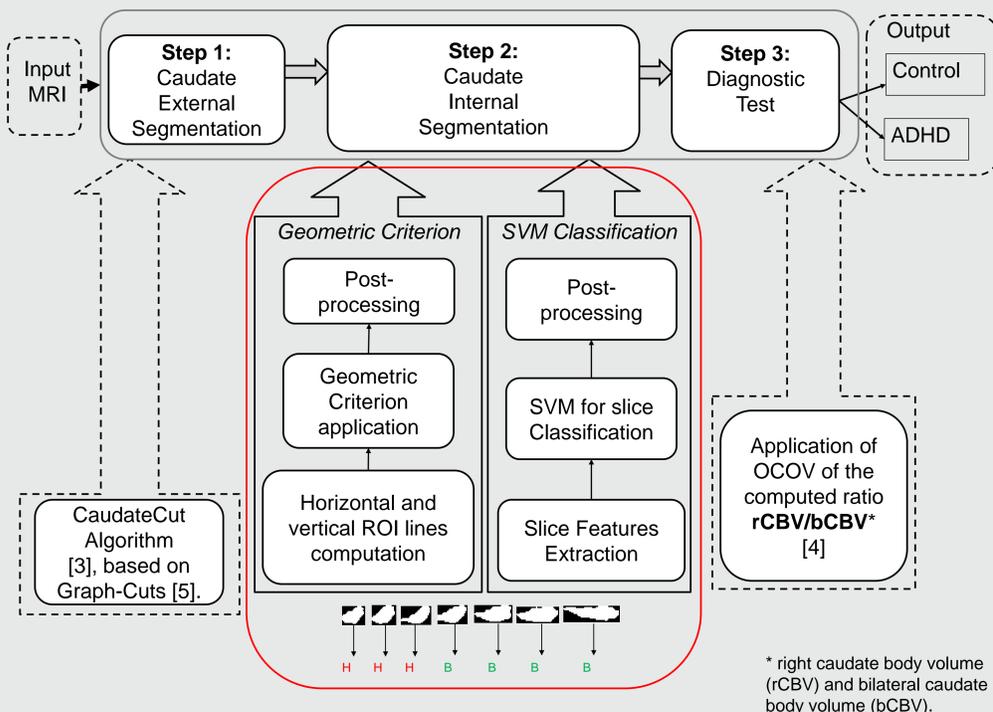
Caudate Internal Segmentation

* *Automatic Geometric Criterion Classication.*
  $h \leq 2w(Head); h > 2w(Body);$

The two larger horizontal and vertical lines are depicted in red over the ROIs
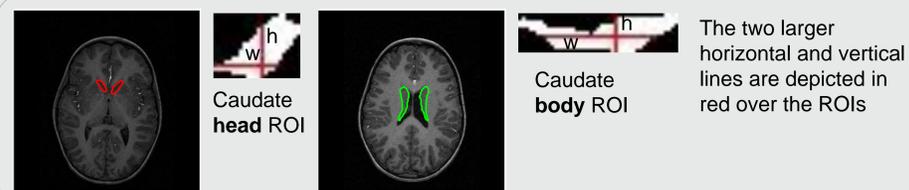
* **Shape-based SVM Classication**. Extraction of an extended set of caudate region shape features and classification using SVM.

Example of a ROI with its bounding box (red), ellipse (blue), and centroid (orange)
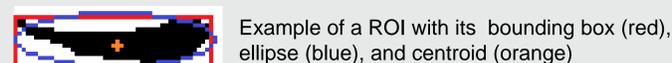
* *Post-processing: Decision Stumps (DS).*
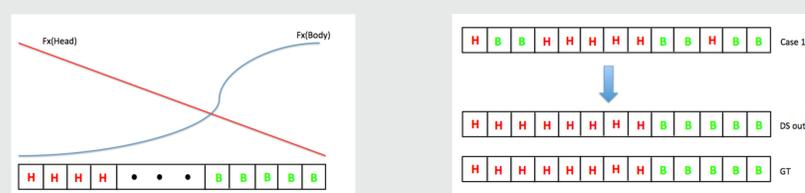
Results

* The study population: 39 children with ADHD and 39 control subjects.
* MRI 1.5-T system volumes of resolution 256 x256 x 60, axial projection.

Internal caudate segmentation:

	Accuracy	Geom. Crit.	L-SVM
		87.1%	92.8%

Statistical analysis:

rCBV/bCBV	Mean	σ	diff	t	p
Control	0.53	0.06	0.05	2.41	0.0092
ADHD	0.48	0.05			

Roc Analysis on rCBV/bCBV :

External seg./Internal seg.	Sens.	Spec.	AUC	OCOV
Manual/Manual [8]	60%	95%	0.84	0.482
CaudateCut / SVM Linear+DS	68.42%	89.47%	0.75	0.491

Diagnostic Test:

Sensitivity	Specificity	OCOV
48.72%	84.62.8%	0.4828

Conclusions

We presented a fully automatic strategy to assist in the **diagnosis of ADHD** in the pediatric population, inspired in a previously presented manual study stating that the ratio **rCBV/bCBV** was statistically different in ADHD and control groups. We separately validated the internal caudate segmentation and the ADHD diagnostic test, obtaining highly similar results to manual annotations in both cases.

References

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