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Automated microbleed detection screening tool for clinical application using Dyn-UNet

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Introduction

Background:

- Cerebral microbleeds (CMBs) associated with vascular dementia.
- Time consuming manual detection due to their small size
- (5-10mm).
- Lack of generalisability of fully automated detection methods[1].

Aims and Objectives:

- Develop an automated CMB detection tool using Valdo dataset [2]
- Compare with an open-source tool on the multi-centre European prevention Alzheimer's Dementia (EPAD) dataset [3].

Methods

- 3D multi-task segmentation network for cerebral microbleed (CMB) detection

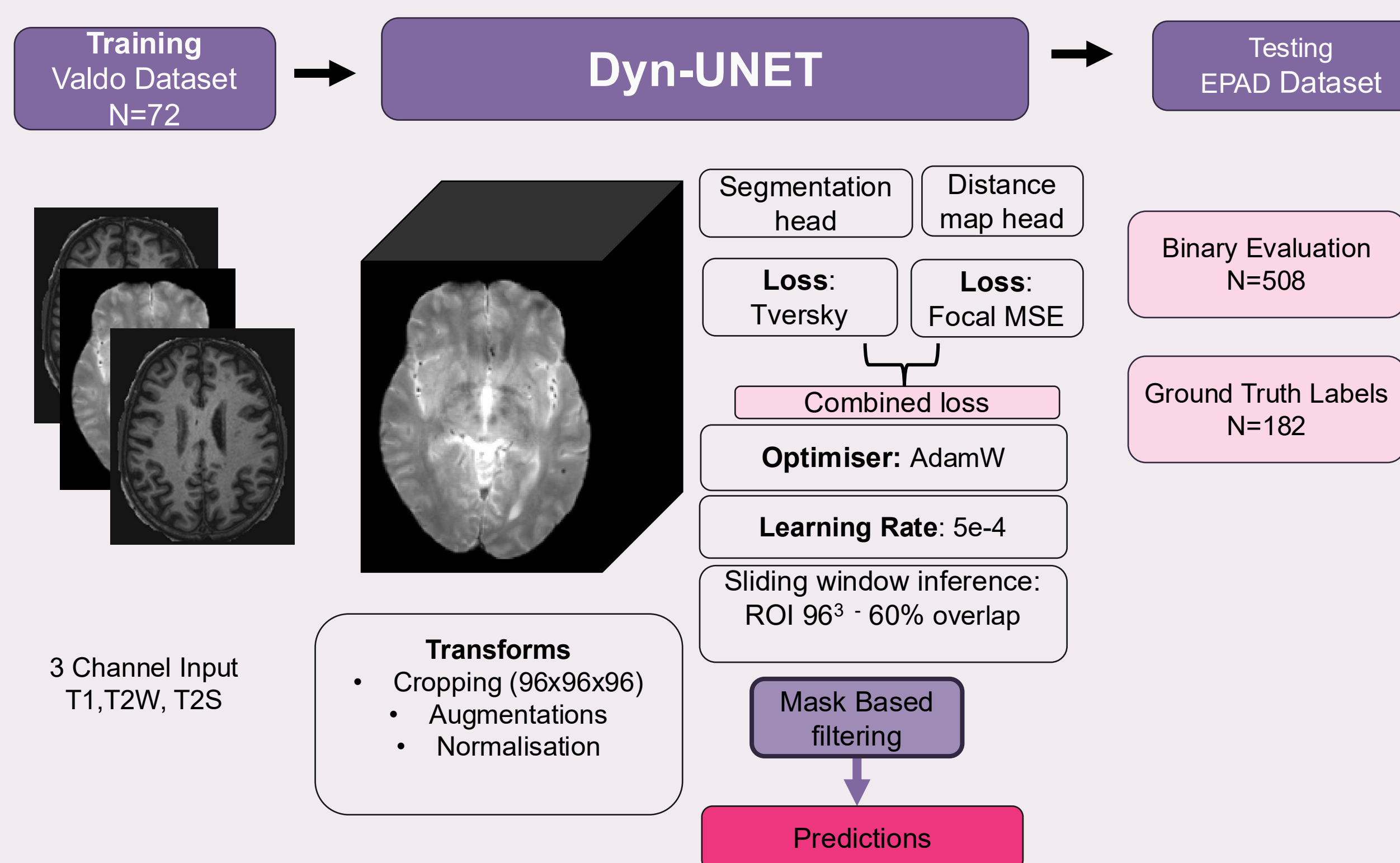


Fig 1:Architecture of the multi-task 3D Dyn-UNet for cerebral microbleed detection

A Dyn-UNET with deep supervision, 3-channel input (T1, T2, T2*) and branches into a segmentation head and a distance-map head, trained with a combined (uncertainty-weighted) loss. Final predictions are filtered using a brain mask. Binary evaluation based on presence or absence of microbleed

	N	Sensitivity /Recall	Precision	F1	Balanced accuracy
Internal	72	96.0 ±5.55	77.4±4.01	85.7±6.10	66.2±6.60

Table1: Subject level Internal tool average cross-fold validation metrics

Subject level training classification results (VALDO dataset) using 3-fold cross validation reported as mean ± standard deviation

Results + Future Work

Main Findings

- Good sensitivity for the internal tool
- Reduced performance in the deep and infratentorial brain regions
- A Second stage false positive discriminator to be introduced to improve specificity

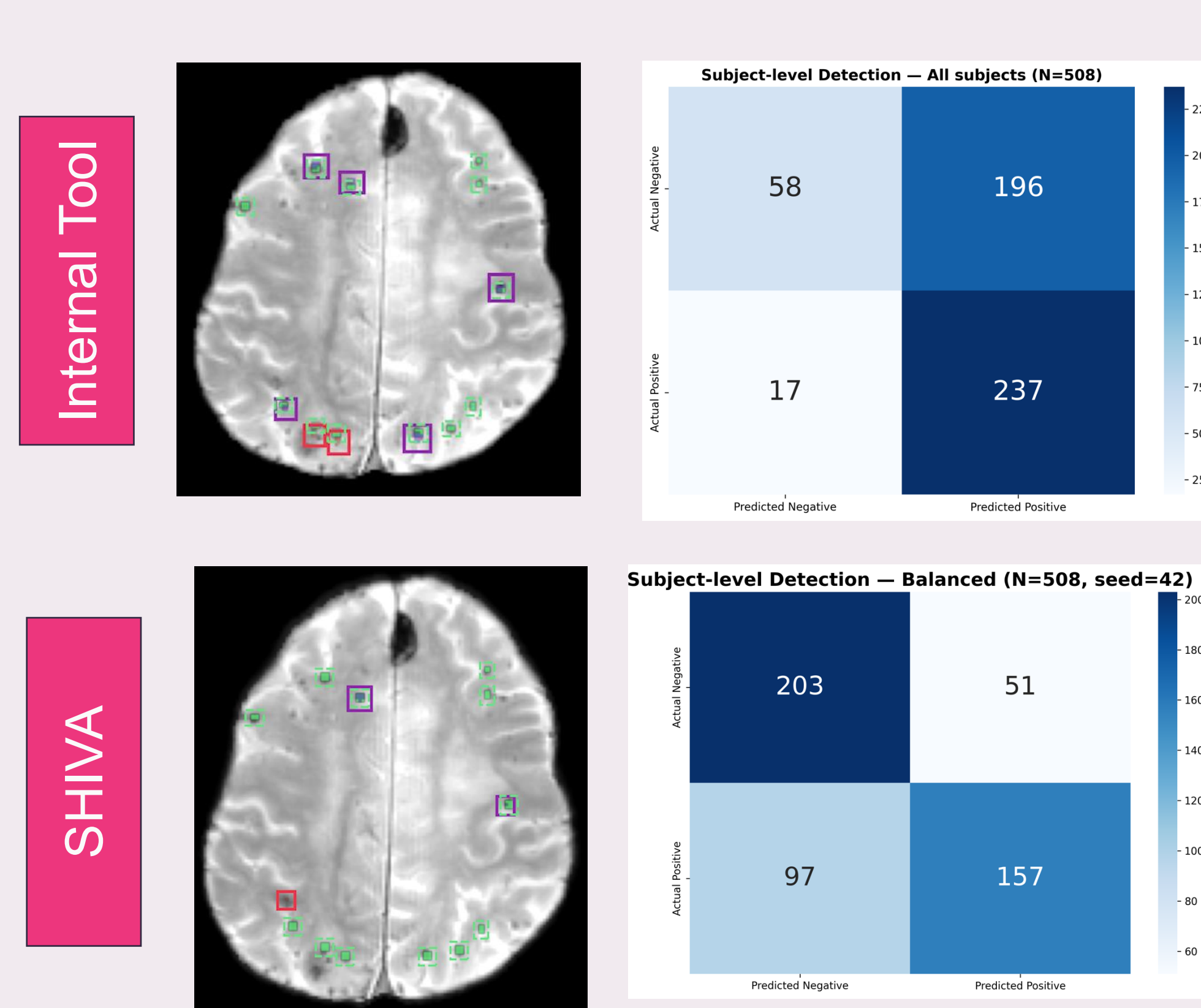


Figure 2:Qualitative predictions and confusion matrix on EPAD comparing internal vs SHIVA
Ground truth in green, correct predictions in purple, incorrect predictions in red

	Recall/ Sensitivity	Precision	F1	Balanced accuracy
Internal	93.3 [90.1, 96.2]	54.7 [50.0, 59.4]	69.0 [64.9, 72.8]	58.1 [55.2, 60.9]
SHIVA	61.8 [56.0, 67.4]	75.5 [69.5, 81.6]	68.0 [63.0, 72.6]	70.9 [67.1, 74.8]

Table 2: Subject level performance on EPAD (N=508).
Metrics are reported as median [Q1 and Q3] for Internal tool vs SHIVA

	N	Recall/ Sensitivity	Precision	F1	FP/Subject
Internal	182	74.1 [68.9, 79.3]	31.6 [27.7, 35.5]	46.8 [43.3, 50.7]	4.4 ± 3.9
Shiva	182	51.2 [44.1, 58.0]	71.1 [64.8, 77.4]	48.6 [42.0, 54.7]	0.6 ± 1.2

Table 3: Lesion level comparison metrics on EPAD dataset (N=182) with voxel-level ground truth.
Metrics are reported as median[Q1 and Q3] for Internal vs SHIVA tool

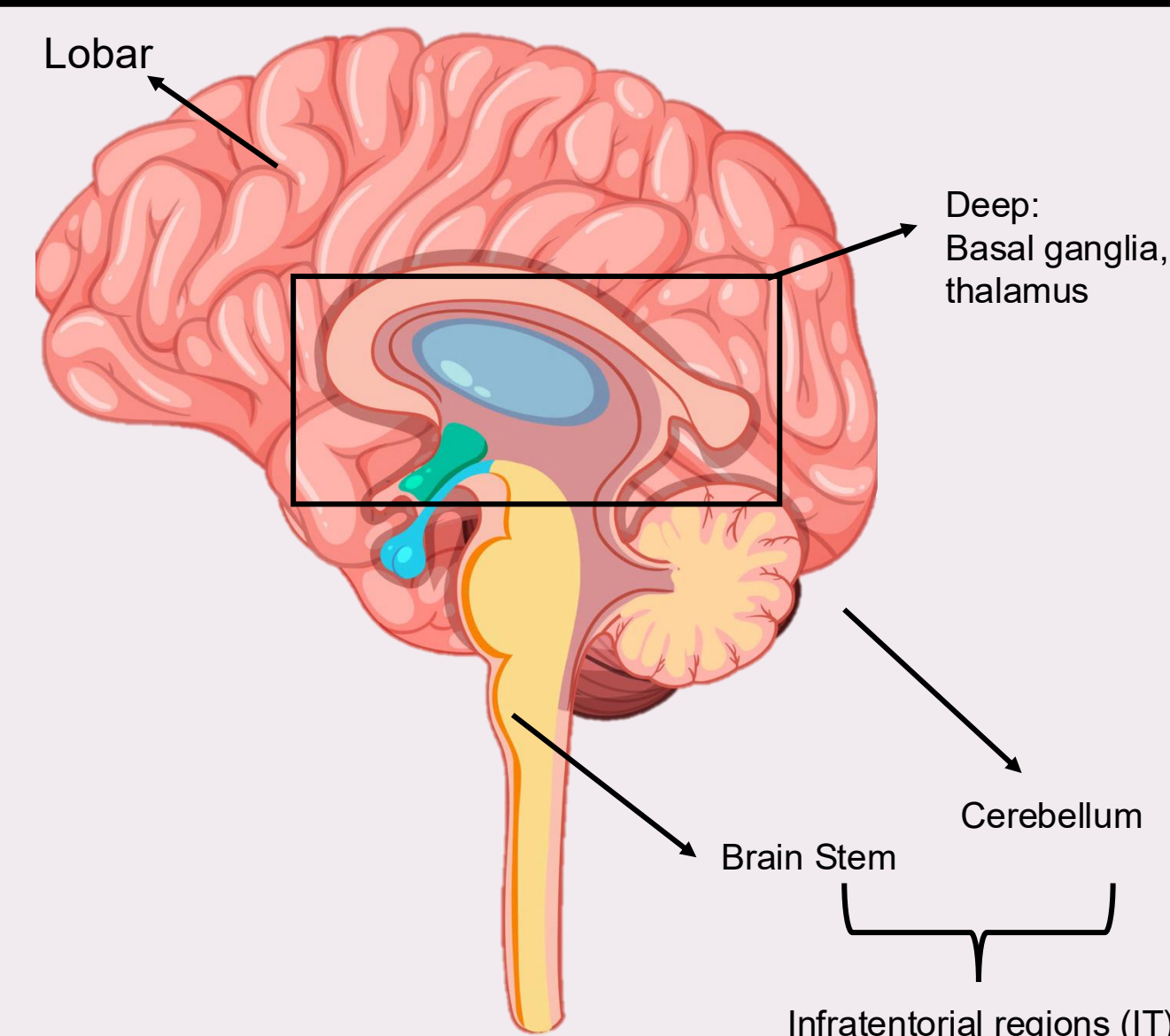


Fig 3: Anatomical regions of the brain

A description of the brain showing the anatomical layers grouped as lobar, deep and the infratentorial regions

	N Tp/total	Tool	Recall/ Sensitivity	Precision	F1
Lobar	634	Internal	50.9	53.0	51.9
		SHIVA	31.6	81.2	45.5
Deep	143	Internal	72.0	30.7	43.0
		SHIVA	45.8	60.0	52.0
IT	45	Internal	40.0	36.0	37.9
		SHIVA	51.1	82.8	63.2

Table 4: Regional (lobar, deep, infratentorial) performance on EPAD dataset
Metrics pooled across subjects (single value)

References

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