

A Head-to-Head Comparison of Fully-Automated Segmentation Pipelines: QyScore® vs Freesurfer vs FSL vs ANTs



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QYNAPSE



BACKGROUND

- The gold-standard for brain segmentation is expert manual segmentation, which is both time-consuming and prone to high inter-rater variability.
- Fully automated segmentation tools have emerged, offering faster and more reproducible brain region measurements, though their accuracy and ease of implementation can differ.
- QyScore® is a fully-automated CE-Marked and FDA-cleared medical imaging platform, certified for structural neuroimaging segmentation.
- We evaluated QyScore®'s performance against other leading segmentation pipelines, being FreeSurfer, FSL, and ANTs.

METHODS

- A total of 34 T1-weighted images were used for manual and automatic segmentations of the following brain regions: whole brain grey matter ($n = 22$), whole brain white matter ($n = 22$), hippocampus ($n = 34$), amygdala ($n = 34$), brainstem, cerebellum, caudate, putamen, thalamus, globus pallidus, and lateral ventricles ($n = 32$) (Table 1).
- Automated segmentations were produced by QyScore® v2.0, FreeSurfer v8.1.0, FSL v6.0.7.19, and ANTs v2.6.5, using default parameters, followed by parameter optimization in the instance of preprocessing or segmentation failures. Consensus manual segmentations, created by three expert neuroradiologists, were used as ground truth.
- The Dice Similarity Coefficient (DSC) between manual gold-standard consensus and automated segmentations were used to compare the accuracy of each automated segmentation pipeline.

RESULTS

- QyScore® was the **best performing segmentation** approach across all brain markers, achieving the highest dice coefficients compared to FreeSurfer, FSL, and ANTs, $p_{bonf} < 0.001$; Table 1; Figure 1.
- QyScore® and ANTs successfully processed and segmented 100% of subjects without errors using default parameters, whereas 33.3% of automated segmentations produced by FreeSurfer, and 5.6% for FSL, required parameter optimization and reanalysis.

Table 1: Mean Dice similarity coefficients for each of the 11 structures available for QyScore®, FSL, FreeSurfer and ANTs, with standard deviations and range in parentheses.

	Grey Matter	White Matter	Hippocampus	Amygdala	Thalamus	Putamen	Globus Pallidus	Caudate	Brainstem	Cerebellum	Lateral Ventricles
QyScore®	87.7 (1.4, 84.3-89.7)	92.6 (1.2, 88.7-94.4)	85.9 (2.6, 80.9-91.8)	79.8 (4.6, 69.4-91.4)	91.9 (1.8, 85.6-95.0)	91.2 (1.7, 86.4-93.3)	88.6 (3.3, 73.5-92.0)	90.9 (2.0, 84.1-93.6)	93.5 (0.7, 92.4-95.2)	95.8 (0.8, 93.7-97.4)	93.2 (2.2, 88.1-97.0)
FreeSurfer	84.7 (2.2, 79.2-89.0)	89.7 (2.4, 81.2-92.2)	83.3 (2.1, 79.0-89.4)	76.1 (4.3, 67.0-83.7)	90.8 (1.5, 86.1-94.5)	87.4 (3.6, 70.2-90.9)	78.3 (6.3, 61.5-86.2)	87.5 (2.2, 82.2-90.9)	86.6 (1.0, 84.8-89.5)	94.4 (0.8, 91.8-95.7)	90.1 (3.1, 84.5-95.3)
ANTs	75.2 (15.6, 15.2-86.9)	82.0 (19.2, 1.2-92.4)	N/A	N/A	N/A	N/A	N/A	N/A	79.2 (3.7, 71.4-85.1)	91.0 (1.5, 88.1-93.3)	N/A
FSL	73.8 (12.1, 45.9-84.7)	85.1 (6.3, 70.4-92.1)	74.7 (24.6, 0.0-86.7)	64.8 (22.8, 0.0-81.7)	75.7 (27.1, 0.0-90.8)	73.1 (33.1, 0.0-90.8)	67.4 (31.2, 0.0-87.5)	71.0 (32.4, 0.0-90.3)	68.7 (29.3, 0.0-85.0)	N/A	N/A

CONCLUSION

- QyScore® was simple to implement, fully automated, requiring no expert knowledge to operate, and **outperformed other pipelines in segmentation accuracy across all brain markers**.
- QyScore® **enables objective, reproducible brain measurements** to improve clinical diagnosis and monitoring of CNS diseases like Alzheimer's disease, Parkinson's disease and multiple sclerosis.
- QyScore® uniquely provides both **accuracy and reliability**, supporting its implementation into healthcare and clinical trials.

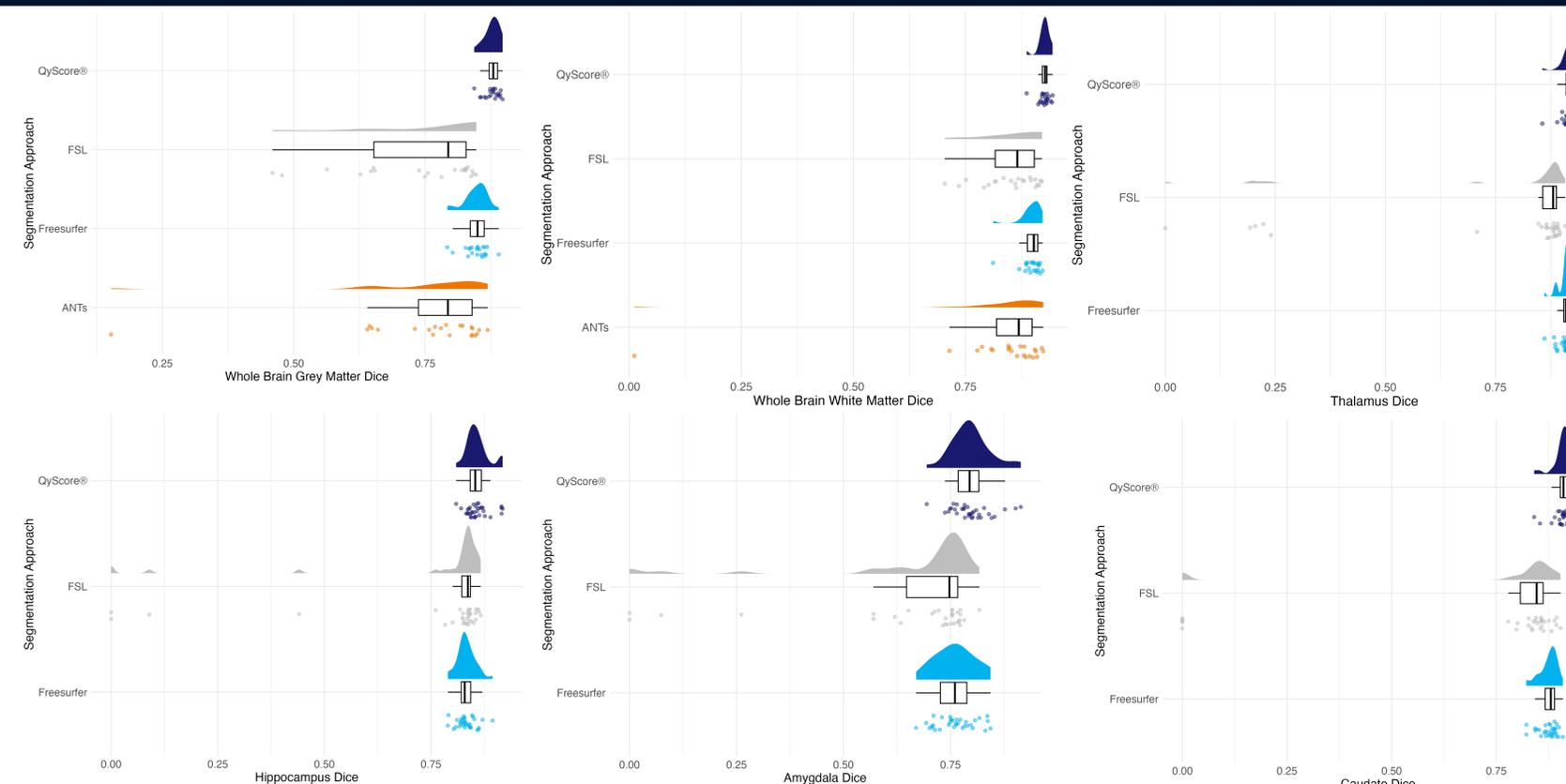


Figure 1. Dice similarity coefficients (DSC) for brain region segmentations across QyScore®, FSL, FreeSurfer, and ANTs. Higher DSC values (closer to 1) indicate greater overlap with the manual ground truth, reflecting higher segmentation accuracy.

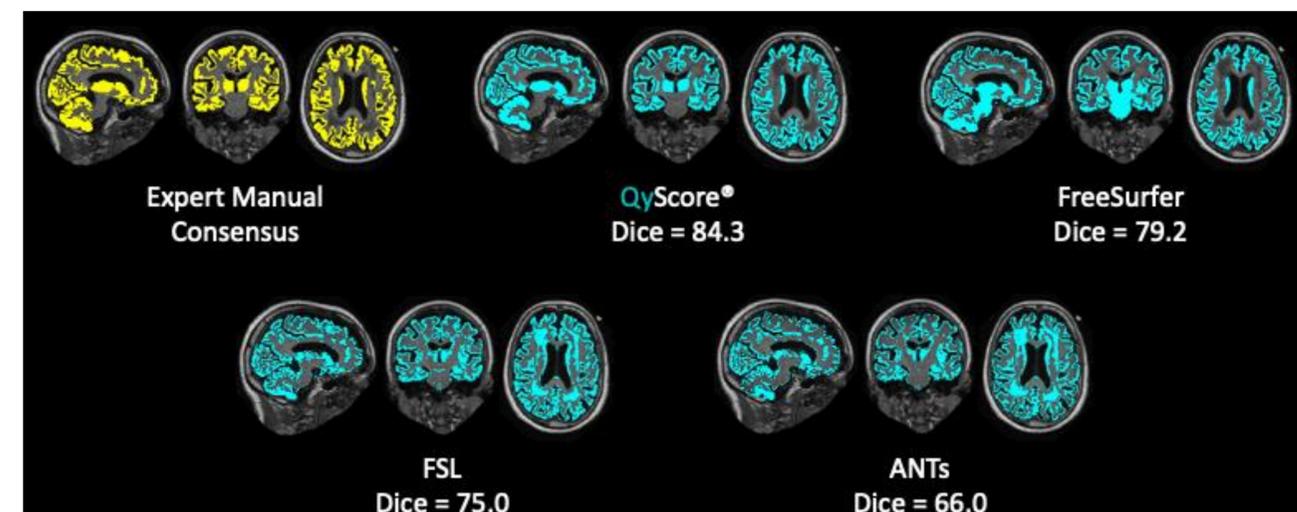


Figure 2. Shows the whole brain grey matter expert manual consensus segmentation for an example subject, alongside the fully-automated segmentations by QyScore®, FreeSurfer, FSL, and ANTs.