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FNeuroNet: a sex-specific deep learning framework for Autism Spectrum Disorder (ASD) and Attention Deficit and Hyperactivity Disorder (ADHD) classification in female cohorts based on resting-state fMRI images

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INTRODUCTION

- Emerging evidence suggests that ASD manifestations in females may present with subtler clinical features compared to male counterparts, while ADHD in this demographic predominantly manifests through inattentive symptomatology rather than hyperactive-impulsive behaviors.
- Such phenotypic convergence contributes to substantial diagnostic challenges, rendering conventional assessment protocols particularly susceptible to misclassification in this population.

OBJECTIVE

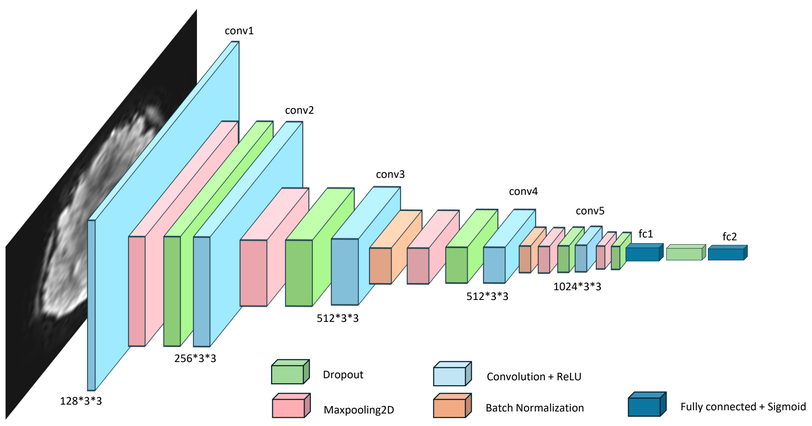
We aim to propose a lightweight deep neural network, FNeuroNet, to accurately differentiate female ASD and ADHD individuals. It improves patients' quality of life through timely intervention.

METHOD

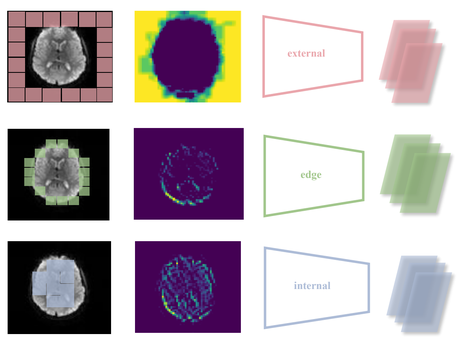
Our methodology was benchmarked against prevalent ImageNet pre-trained models, including MobileNet, Xception, and ResNet18, for training on resting-state fMRI images. The FNeuroNet architecture was systematically engineered with optimized convolutional layers, strategically positioned maxpooling operations, and adaptive dropout mechanisms, specifically tailored to address the unique characteristics of resting-state fMRI data through careful consideration of its patterns.

RESULTS

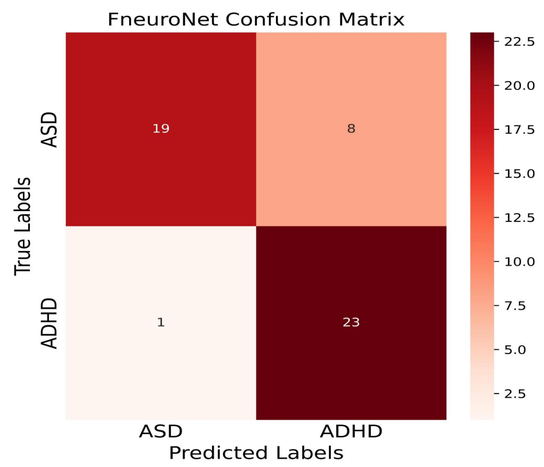
- The experimental results demonstrated that FNeuroNet achieved the best performance metrics on the testing set, attaining **a classification accuracy of 0.8235, a precision of 0.7419, a recall of 0.9583, and an F1-score of 0.8364.**
- Comparative analysis revealed that the proposed model significantly outperformed conventional pre-trained deep neural network architectures, establishing its superior discriminative capability in the target classification task.



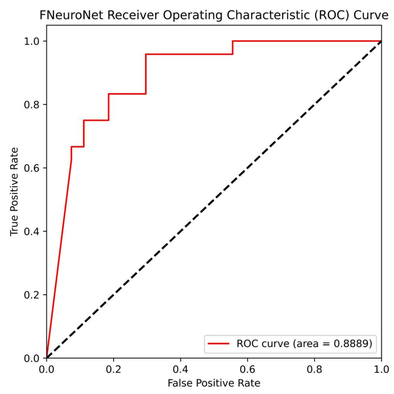
The framework of FNeuroNet, including multi-convolutional layers, batch normalization layers, maxpooling layers and dropout layers.



Feature extract and output by different convolution layers of the random samples during the training process.



Confusion matrix of FNeuroNet neural network between the predicted labels and true labels on the testing set.



Area Under Curve of FNeuroNet.

CONCLUSIONS

- This system demonstrates significant potential in classifying ASD and ADHD between female.
- It augments the accuracy of clinical decision-making processes while improves patients' quality of life through timely intervention.
- Moreover, its multi-platform compatibility enables real-time processing of patient health records, thereby expediting diagnostic evaluations and therapeutic interventions to enhance healthcare delivery efficiency.

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