# Review of: "Dyslexia biomarker detection with Quantitative electroencephalography (QEEG) data in children: Feasibility, Acceptability, Economic impact, Pilot Study and Survey Results"

Loretta Gasparini

Potential competing interests: No potential competing interests to declare.

This paper seeks to classify children as typically developing or dyslexic using machine learning methods (artificial neural networks, ANN) to analyse the children's quantitative electroencephalography (QEEG) recordings. They collected QEEG recordings across 8301 sessions from 207 7-10-year-old children (96 with dyslexia; 111 typically developing, TD) and trained and tested the ANN on those recordings. The models were able to classify 98.8% of the recordings as belonging to a dyslexic or TD child, which the authors interpret as high accuracy. The authors also collected parental surveys about the feasibility and acceptability of the screening method. The authors conclude that this method could be used for detecting dyslexia in children at school. This study is interesting in using novel machine learning methods to strive to classify children with dyslexia, which is still largely underdiagnosed, particularly in Turkey, the location in question.

However, this paper has several flaws that limit its readability and interpretation of results.

**Major issues**

1. In the study the authors collected recordings across 8301 sessions from 207 children, and as far as I can tell they treated the 8301 recordings as separate data points, rather than informing the model when they belonged to the same child. I understand that this would cross-contaminate the training and test data blocks in the cross-validation process: if the model is exposed to a recording from Child 1 in the training block and told that Child 1 is dyslexic, and then encounters another recording from Child 1 in the test block, those two recordings will be very similar because they come from the same child and so the model will easily be able to classify that child as dyslexic. This is not the same as the model being able to be trained on Child 1's recording and then correctly classify Child 2 who it has never encountered before. I suspect this is why the classification had 98.8% accuracy but only 76% of the parents reported that the results of the app's diagnosis corresponded to that of the psychiatrist's diagnosis. If measures were taken to account for repeated measures in the model, this should be made clearer.
2. Various terms and methods were not properly defined. This means the methods are difficult for a reader to understand, and it would be very difficult for someone to reproduce the methods. Please define and provide a citation for further reading, for instance:

    a. Page 1: First mentions of "QEEG" and "ANN" in the abstract (they do not need to be defined here, but abbreviations spelt out)

b. Page 3: “discriminant function”, “centroids”, “fuzzy logic classifiers”, “precision”, “recall”, “F-score”, “Multilayer Perception”, “PCA”
c. Page 6: “Mat plot library”, the “x” in “z = (x-m)/s”
d. Page 7: “epoch 60”, “batch size”, “loss as binary cross-entropy”

3. There are various grammatical and spelling errors throughout the paper, which impede interpretability. This might be helped by a native English editor.

**Minor issues**

1. Page 2: “These algorithms use psychometric test results, functional magnetic resonance imaging (fMRI) scans, Electroencephalography (EEG) scans, positron emission tomography (PET) scans, Magnetoencephalography (MEG) scans, eye tracking information, face images, handwritten texts, and mobile-based games.” – Provide a citation for each example
2. Page 4: “The children chosen to participate in the experiment were chosen at random.” – Chosen at random from where?
3. Page 5: “The survey to assess the app’s feasibility and acceptance by the users consists of 6 questions”- Mention earlier that the “users” are parents
4. Page 5: “(5) Is the price of acquiring the solution (EEG headset and software subscription) high/ moderate/ low at home? (6) Is the price of 1-time measurement (children with dyslexia/ TDC classification) at school high/ moderate /low?” – What prices were parents presented with to make those judgements?
5. Page 5: “2.2.3. Socioeconomic status survey” – these are details about the inclusion criteria in this paragraph, so the subheading doesn’t seem appropriate
6. Page 5: “The distance between the participant and the mobile phone screen was 0.5 meters.” – What were children looking at on the mobile phone screen?
7. Page 7 – Figure 2 picture quality is low
8. Page 7: “True Positive (TP): entities that are acknowledged by classification and match with ground truth; True Negative (TN): Entities that are not acknowledged by classification and match with ground truth; False Positive (FP): entities that are acknowledged by classification but do not match with ground truth; False Negative (FN): entities that are not acknowledged by classification” – I don’t find these descriptions clear
9. Page 8: “Mean ± standard deviation is used in the specification of numerical data… Mann-Whitney U test, a comparison of changes is made using the Wilcoxon test.” – this explains what each of these methods does in general, but does not explain what each of these methods are actually used for in this study, i.e. what RQs they are answering.
10. Page 9: “Although misclassifying TDC sessions as children with dyslexia -false positives- sessions would not create problems when it comes to the training” – I disagree, overclassifying children with dyslexia would also be a problem
11. Page 12: “82% of the respondents find the app easily usable at home (Research Question 3)” – I don’t think it being easily usable at home actually targets acceptability. It is more related to feasibility?
12. Page 12: Figure 7 bar plot should have max 100%, not 120%

13. Page 14: “It does not take much amount of time and money for the family to get this assessment.” – but 80% said it would be a high price to pay for at home?
14. Page 15: “There are people who do not trust technological solutions and want to continue with traditional training methods for their children with dyslexia” – provide a citation for this statement