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Interpreting Speech Perception in Children with Phonological Deficits: Evidence from Event related Potentials (ERP)

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Introduction

Children with dyslexia and children with speech sound disorder exhibit differing issues in regard to their speech and language. Dyslexia is a difficulty decoding written language, such as with word recognition or spelling. Speech sound disorder is characterized by speech production errors. Although dyslexia and speech sound disorders are often co-morbid, each can occur singularly (Lewis et al, 2011). Although both disorders respond to expert intervention, the underlying deficits last a lifetime and may negatively affect quality of life. Early identification is paramount to preventing long-term negative outcomes. A better understanding of how these disorders are activating in the brain is required to improve early identification and treatment in clinical work.

ERP data comes from an EEG (electroencephalographic) signal. The EEG signal is produced by placing a net of 128 electrodes on a participant's head and it records the signal generated by the brain during neural processing. The ERP data is based on time-locked segments, specifically after a stimulus is presented and provides outstanding temporal resolution in response to the stimuli (Molfese, Molfese & Kelly, 2001). By using data collected through electrophysiological measures, this project seeks to understand how these distinct disorders may have similar or different phonological mechanisms.

Data Analysis Procedure

The data for this project was previously collected behavioral and EEG data from 32 children aged 7;6-9;6. There were four groups: typically developing, SSD, dyslexia, dyslexia & SSD. The children first participated in behavioral testing to discriminate the three phonetic contrasts, BAWA, DAGA and RAWA. Then during the EEG session, ERP (event-related potential) data was recorded brain activation during identification of each phonetic contrast.

This data was analyzed using the EP Toolkit, a statistical package addition to MatLab. In order to organize the results into a statistical package, the test subjects were organized, making sure all participants were accounted for and in the correct order. For each BAWA, DAGA, RAWA, we looked at all subjects averaged together and saw where the blue line crosses the orange in the scree plot which coincides with an approximated eigenvalue. The estimated amount of factors appropriate for our model is shown. In our case, we standardized them and selected an output with 4 and then 6 factor models. For the DAGA data, we looked at the output for a 5 factor analysis, but untimely determined it did not significantly add to the model. We selected the most parsimonious model which included 4 factors.

We conducted a two-step principal components analysis (PCA). The first step yields temporal factors and the second step yields spatial factors relevant to the temporal factors. For each stimuli BAWA, DAGA, RAWA we gathered the MatLab output.
Once the factor was determined, we identified the peak latency for each temporal factor. We also gathered the difference between the factor variance and the total variance for each factor. In MatLab, we generated a map of relevant electrodes for each spatial factor, yielding a total of 16 unique channel configurations for each stimuli contrast. Using the peak latency and the spatial factors, we generated topoplots for each temporal factor for visual inspection. From this data we created text files of the peak latency and maximum voltage for each temporal and spatial factor for each child. This was input into a database for statistical analysis.

Results & Discussion

In the behavioral results, BAWA all children discriminated similarly. With DAGA, typical children and children with dyslexia discriminated significantly better than dyslexia or SSD. In the RAWA contrast, typical children and children with dyslexia or SSD preformed similarly, but children with dyslexia and SSD performed better.

Through the data analysis procedure, we recorded data in regard to the temporal and spatial factors. The EEG data files of statistically analyzed output produced data that may lead to future distinct conclusions but is not conclusive at this time.

As we prepared and analyzed data, we recognized the variability which would come through the possible inaccurate EEG data due to varying factors such as movement during testing.

Conclusion

This study has helped us reason that, although not conclusive, there appears to be differences in the brain activation of children with dyslexia and SSD.

Future research studies can build on this study through using a larger sample size of children. Also, different types of neuroimaging (such as MRI) can be used to add an additional layer of understanding to how the phonological mechanisms of children with dyslexia and SSD may be different. While the EEG imaging gives the temporal brain activity, the MRI imaging will give a clearer picture of where exactly the brain is activating through a greater spatial structural map of the brain.

References
