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## PROBLEM STATEMENT

- Rhythmic speech in children has received little attention.
- Recent studies have shown rhythm to be related with language abilities.
- Musical rhythm discrimination skills strongly correlated with an expressive grammar task in typically developing (TD) six-year olds (Gordon et al., 2014).
- The Music Cognition Lab at Vanderbilt is interested in further exploring effect of musical training in improving rhythmic abilities in six-year olds with language disorders such as SLI.
- Currently, the data analysis process used to determine an individual's rhythmic abilities is inefficient and impractical in a clinical setting.
- There is a clinical need for a diagnostic device with an intuitive interface that is capable of immediate analysis and display of feedback.

## CLINICAL BACKGROUND

### Specific Language Impairment (SLI)

- Delayed mastery of language skills in children who have no hearing loss or other developmental delays.
- A common childhood disorder that affects 7-8% of kindergarteners.
- Characterized by decreases in ability to form proper grammar and decreased vocabulary.
- Impaired perception and production of rhythmic language.
- Children with SLI often have a general lack of confidence when speaking.

### Nuclear Synchrony

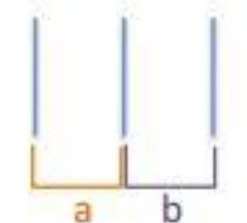
- Consistency of child's speech within a phrase.

### Global Synchrony

- Synchronization of child's speech to isochronous metronome.

**Nuclear Synchronization Index**  
Mean vector length of phase

$$\text{Phase} = \frac{a}{a + b}$$



**Global Synchronization Index**  
Mean Asynchrony

$$\text{Asynchrony} = |s - m|$$

s = time of (1<sup>st</sup> or 3<sup>rd</sup>) speech beat  
m = time of closest occurring metronome beat

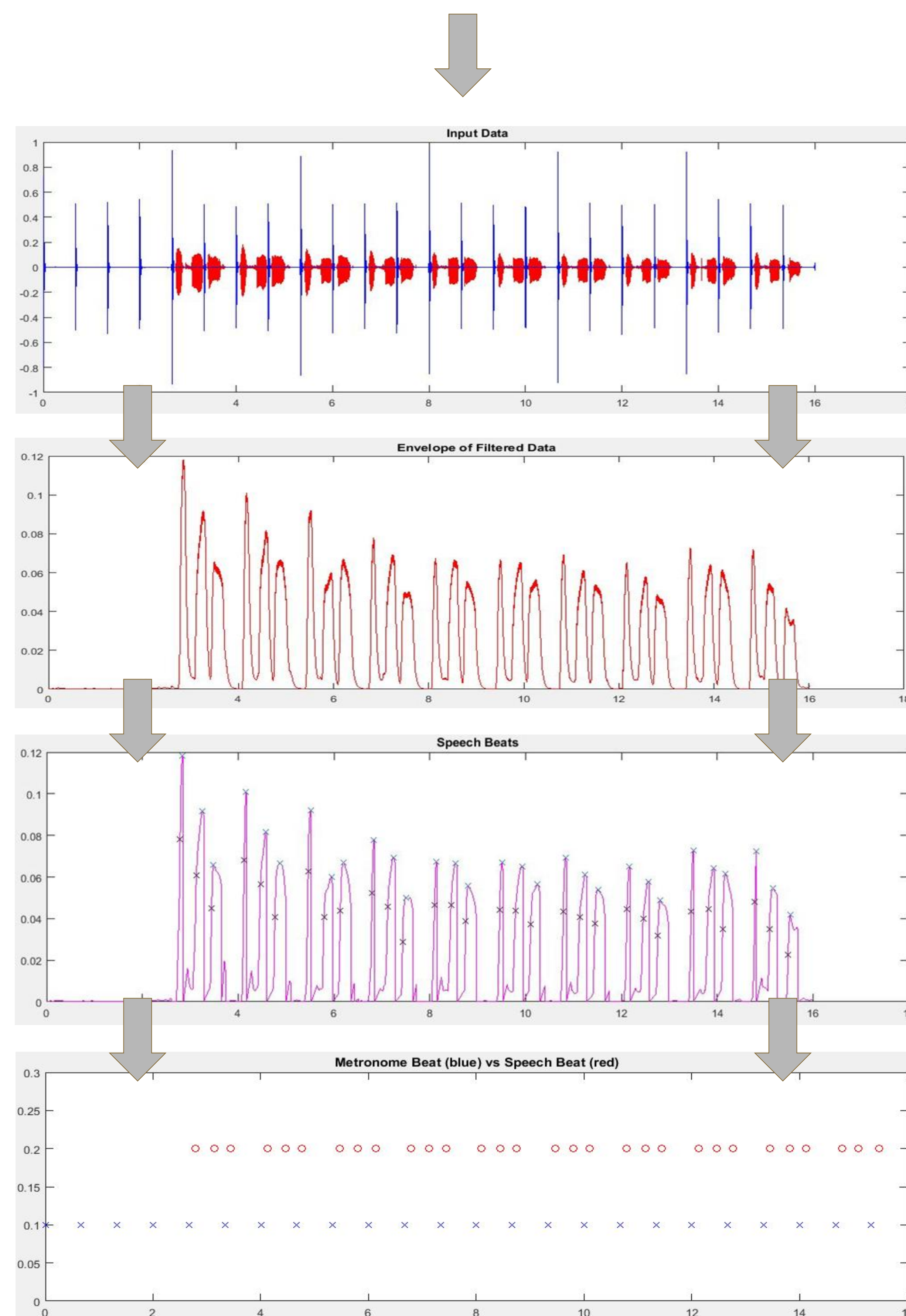


## NEEDS ASSESSMENT

1. Simultaneously detects the rhythm of the English language and the rhythm of musical metronomes.
2. Streamlines data in one software program.
3. Reduces time needed to analyze data.
4. Uses consistent analytics.
5. Provides feedback to user and lab staff.
6. Has an intuitive interface.
7. Stores data for future analysis and retrieval.
8. Is safe, physically compatible with children, and comfortable.
9. Should a nuclear and nuclear score representative of the participant's rhythmic abilities.

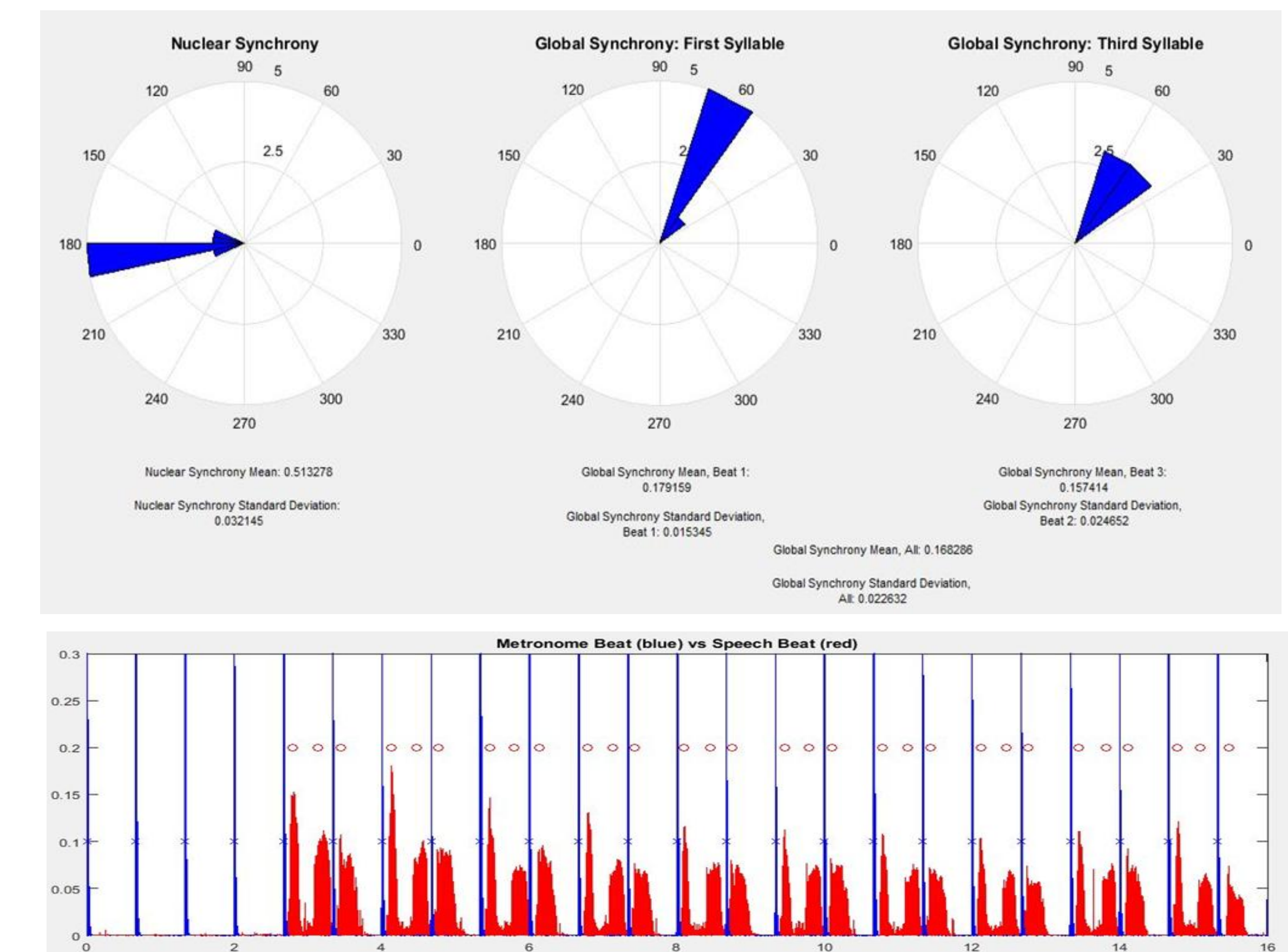
## DESIGN COMPONENTS

- **Hardware:** FocusRite 2i2 Sound Card, SM58 Microphone, Sony Headphones, Connecting Cables & Converters
- **Software:** MATLAB with PsychoPhysics Toolbox and Gstreamer to record speech and analyze synchrony



## RESULTS

Rose plots with mean and standard deviation scores:



## FUTURE DIRECTIONS

- Baseline normal speech rhythm in children.
- Baseline the speech rhythm in children with Specific Language Impairment (SLI).
- Musically train children with SLI and track their progress with speech rhythm metrics.
- Package and sell program for use in clinical diagnostics.
- Explore further uses as a therapeutic method for SLI.

## CONCLUSIONS

We have successfully designed and created a program to reduce data collection and analysis time in speech cycling tasks performed by children both with and without specific language impairment. Nuclear and global synchrony scores are able to quantify a person's rhythmic abilities. This enables for better diagnostics of SLI.

## ACKNOWLEDGEMENTS

This work was supported by the Vanderbilt University Biomedical Engineering Department.

## REFERENCES

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3. Williams, Allison. "Nuclear and Self Synchrony Analysis" MATLAB Code. Vanderbilt University Music and Cognition Lab 2016.