



Background

- Quantification of child vocalization is an important metric for understanding child language acquisition (Canault et al 2016).
- Children with cochlear implants (CIs) are at a disadvantage because they cannot pick up all acoustical aspects of language.
- LENA is a recording device that can be used to capture sounds in a child's auditory environment. Using an automated algorithm, LENA classifies segments of audio by acoustic parameters such as rhythm, pitch, and high/low-frequency intensity.
- Little independent research has quantified accuracy of LENA's machine decisions for identifying child vocalizations, making the device of unknown utility for rigorous research.
- Question: How much is LENA reliable in identifying child vocalization in a natural home environment?



Methods

- 23 children with a range of hearing statuses had their natural home environment audio recorded by LENA (attached to them in a vest) for approximately 16 hours, once every three months.
- LENA goes through a tree of "decision making" of whether or not there is speech, who the speaker is (whether it was a child or the Key child), and who he or she may be speaking to.
- Human coders analyzed random 30-second intervals, determining the speaker(s) and determining to whom the speaker was talking. There was excellent agreement on identifying these factors.
- Analysis and comparison was made between the humans' input and LENA's automated algorithmic decisions at each place of audio (100ms as one frame). Average agreement between LENA and human classification was determined, specifically in identifying target or other child speech.

Results

		LENA Classifications							
Human classifications		Adult Female	Adult Male	Target Child	Other Child	Noise	Silence	Media	Total
	Target Child	3,315	322	18,660	15,179	280	1,890	426	40,072
	Other Child	1,246	77	1,049	7,020	75	295	139	9,901
Totals		4561	399	19709	22199	355	2185	565	66158

Table 1: LENA's classifications of child speech. LENA's classifications of the Target Child matched human codes approximately 46.6% of the time and Other Child matched about 70.9% of the time. LENA's automatic processing is not efficient for identifying child speech.

Human Classification	Table 2. Mean percentage and standard deviation (in parentheses) of correctly classified speech.	
	LENA Classification	
	Child Speech	Everything Else
Child Speech	62.5 (10.5)	37.5 (10.5)
Non-Child Speech	10.5 (6.73)	92.6 (5.86)

Human Classification	Table 3. Mean percentage and standard deviation (in parentheses) of correctly classified speech.	
	LENA Classification	
	Child Speech	Everything Else
Target Child	65.3 (12.4)	34.7 (12.4)
Other Child	53.3 (29.3)	44.4 (29.3)

Human Classification	Table 4. Mean percentage and standard deviation (in parentheses) of correctly classified speech.	
	LENA Classification	
	Target Child	Other Child
Target Child	39.3 (16.4)	26.0 (19.4)
Other Child	16.3 (22.3)	37.0 (27.4)

Table 2: LENA correctly classified Child speech 62.5% of the time and correctly classifies Non-Child speech 92.6% of the time.

Table 3: LENA identifies the Child speech as the Target Child correctly only 65.3% of the time. It also identifies the Other Child as Child speech 53.3% of the time with great variability.

Table 4: After LENA identified a child speaker, it correctly identified the Target Child 39.3% of the time and the Other Child correctly 37.0% of the time.

Discussions

- LENA is used clinically to automatically assess the progress and potential of linguistic development in children with cochlear implants. The automated determination of target child vocalizations helps to identify crucial metrics for development, such as conversational turns and adult word count. These measures are used by clinicians to appropriately administer treatment plans and monitor progress.
- Although it is convenient, this research shows that LENA can often produce errors, leading to misinterpretation and relaying of false information from clinicians to clients.
- If target child vocalizations are over-quantified, clinicians and caregivers alike can be misled to think children are more developmentally advanced than they are. Incorrect guidance to at-risk populations can impair language development.

Conclusions

- LENA was accurate in classifying Child Speech little more than 50% of the time, making it clinically unreliable.
- Though the LENA program is convenient, it should not be used as a stand-alone assessment tool for children with language impairments.
- Further research is needed in determining our coders' inter-rater reliability and how to predict LENA's reliability in different metrics of language acquisition (ie conversational turns).

References

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