FREQUENT ARTICULATION DISORDERS IN CHILDREN

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ABSTRACT

Millions of children worldwide suffer from articulation disorders. An essential part of their treatment requires performing home exercises prescribed by their Speech Language Pathologist.Hence, academic institutions and companies are developing algorithms to address the correct classification of good versus poor phoneme articulation. As of today, the efforts to cover all the phonemes in the English language provide less than 90% accuracy.

TIK TALK to Me Ltd., an Israeli company that develops methods and devices for treating speech disorders, conducted a large-scale study on children's most frequent articulation disorders.

Over more than 24 months, the company accumulated records from some 250 children, ages 3 to 12, treated by 45 Speech Language Pathologists (SLPs) in the US. The metadata analysis obtained from the above records shows that 80% of the children required treatment on one or more of just 6 out of the 44 phonemes in the English language. The significance of the above findings is not just of academic interest to the community of speech-language pathologists. Companies and researchers should prioritize reaching top performance in the six most frequent articulation problems.

1. BACKGROUND

Over 10% of the worldwide population suffers from some sort of speech-sound disorder with the need for treatment, especially acute at an early age. Numerous studies show that children with speech disorders are made fun by other children during the critical first years of schooling. Many develop an inferiority complex; they underperform in school, and their future becomes compromised from the outset. In the western world alone, there are millions of children between ages 3 to 12 that need treatment. Children treated by competent Speech Language Pathologists (SLP's), that exercise as prescribed by the SLP, usually recover and integrate successfully into society. However, by the present procedures, the execution of the workouts is not supervised by the SLPs. In between sessions, the child is given homework that require tedious and boring repetition of sounds, words and sentences. Most children dislike the exercises and avoid doing them unless forced by their caregiver. Most often the caregiver lacks the competence of an SLP in judging good versus poor phoneme articulation by the child. Since the SLP has no visibility over the homework done between sessions, time and again little or no progress is achieved between two sessions. This makes the current treatment procedures inefficient, frustrating, and lengthy.

2. THE CHALLENGE

In an attempt to provide competent and reliable feedback to children exercising at home, several efforts are trying to address the correct classification of good versus poor phoneme articulation

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with various degrees of accuracy. As one can see in the attached references, none of the present attempts are close to achieving above 90% accuracy in classifying a large number of phoneme disorders.

It appears that different models give different accuracy for different phones (see, for example, [1], [2], and [5]). Clearly, by focusing on just the six most frequently treated phones, one can expect to achieve above 90% and provide reliable feedback to children exercising at home.

3. THE DATA

The following excerpt from the extensive study spreadsheet gives an abbreviated version of the database that served for the analysis of the frequency of children's articulation disorders treated by SLPs in the US. The data was collected over more than two years with the participation of 245 children and 45 SLPs in several states in the US. For the purpose of discretion, the patients and the SLPs are identified only by their respective ID numbers. The full names of the patients and the SLPs, as well as SLPs association with different clinics and institutions, are guarded in TIK LK's securitized server. They can be made available for inspection by authorized personnel.

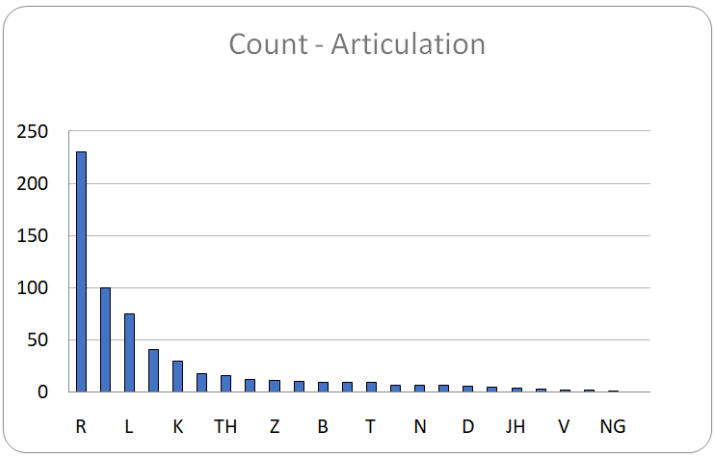
Table 1. Patients' treatment plans as defined by the SLPs for childeren working with the Tiktalk app.

Child ID	phoneme set	sound position	Limitation	clusters	sound occurrences	SLP ID	State
2762	L	Initial	With Imitation	Without	Single	26	No State
2757	R	Initial	With Imitation	Without	Single	26	No State
2756	S	Initial	With Imitation	Without	Single	26	No State
2750	R	Initial	With Imitation	Without	Single	26	No State
2915	R	Initial	With Imitation	Without	Single	26	No State
2915	R,Vocalic R	Medial	With Imitation	Without	Single	26	No State
2915	R,Vocalic R	Final	With Imitation	Without	Single	26	No State
2915	R Blends	Initial	With Imitation	Without	Single	26	No State
2915	R Blends	Medial	With Imitation	Without	Single	26	No State
2917	S	Final	With Imitation	Without	Single	26	No State
2917	G,K	Initial	With Imitation	Without	Single,Multiple	26	No State
2919	S	Final	With Imitation	Without	Single	26	No State
2919	G,K	Initial	With Imitation	Without	Single,Multiple	26	No State
2920	R	Initial	With Imitation	Without	Single	71	Ohio
2927	R	Initial	With Imitation	Without	Single	65	Ohio
2927	R	Medial	With Imitation	Without	Single	65	Ohio
2927	R,Vocalic R	Final	With Imitation	Without	Single	65	Ohio
2926	R	Initial	No Imitation	Without	Single	59	Maryland
2960	S	Initial	No Imitation	With	Single,Multiple	60	Maryland
2960	S	Medial	No Imitation	Only	Single,Multiple	60	Maryland
2960	S	Final	No Imitation	With	Single,Multiple	60	Maryland
2960	CH	Initial	No Imitation	Without	Single,Multiple	60	Maryland
2960	CH	Medial	No Imitation	With	Single,Multiple	60	Maryland

4. ANALYSIS AND RESULTS

After analysis of the data, it appears that only 24 sounds out of the 44 phonemes in the English language pose articulation problems in children. Counting the number of treatments dedicated to each of these 24 sounds that children have difficulties articulating, it became clear that just six phonemes account for 80% of the treatments.

# Patients	Sound	Count	%	
245	**R**	230	37.5	**80%**
	S	100	16.3	
	L	75	12.2	
	SH	41	6.7	
	K	30	4.9	
	CH	18	2.9	
	TH	16	2.6	
	G	12	2.0	
	Z	11	1.8	
	F	10	1.6	
	B	9	1.5	
	DH	9	1.5	
	T	9	1.5	
	M	7	1.1	
	N	7	1.1	
	P	7	1.1	
	D	6	1.0	
	HH	5	0.8	
	JH	4	0.7	
	W	3	0.5	
	V	2	0.3	
	Y	2	0.3	
	NG	1	0.2	
	ZH	0	0.0	



The above findings can significantly shorten the efforts in achieving above 90% accuracy of the feedback provided to most children exercising at home!

As for the remaining sounds, until sufficiently accurate algorithms are developed, they will require more frequent personal interventions by the SLP to evaluate the goodness of articulation of the patient and guide them accordingly.

REFERENCES

[1] Long Zhang, at all, "End-to-End Automatic Pronunciation Error Detection Based on Improved Hybrid CTC/Attention Architecture, " *Sensors* 2020, https://doi.org/10.3390/s20071809

[2] Mostafa Shahin and Beena Ahmed, "Anomaly detection based pronunciation verification approach using speech attribute features,"Speech Communication, 111 (2019) 29–43

[3] Franco H., Neumeyer L., Digalakis V., and Ronen O., "Combination of Machine Scores for Automatic Grading of Pronunciation Quality,"Speech Communication, vol. 30, no. 2, pp. 121-130, 2000.

[4] Ito A., Lim Y., Suzuki M., and Makino S., "Pronunciation Error Detection Method Based on Error Rule Clustering Using A Decision Tree, " in Proceedings of 9th European Conference on Speech Communication and Technology, Lisbon, pp. 173-176, 2005.

[5] Strik H., Truong K., De-Wet F., and Cucchiarinia C., "Comparing Different Approaches for Automatic Pronunciation Error Detection, " Speech Communication, vol. 51, no. 10, pp. 845-852, 2009.

[6] Wei S., Hu G., Hu Y., and Wang R., "A New Method for Mispronunciation Detection Using Support Vector Machine Based on Pronunciation Space Models," Speech Communication, vol. 51, no. 10, pp. 896-905, 2009.

[7] Zahid S., Hussain F., Rashid M., Yousaf M., and Habib H., "Optimized Audio Classification And Segmentation Algorithm by Using Ensemble Methods," Mathematical Problems in Engineering, vol. 2015, pp. 1-11, 2015.

[8] Vladimir Tregubov, "Using Voice Recognition in E-learning System to reduce Educational inequality During COVID -19, International Journal of Computer Science Engineering and Applications (IJCSEA)Vol. 11, No 2/3/4, August 2021.