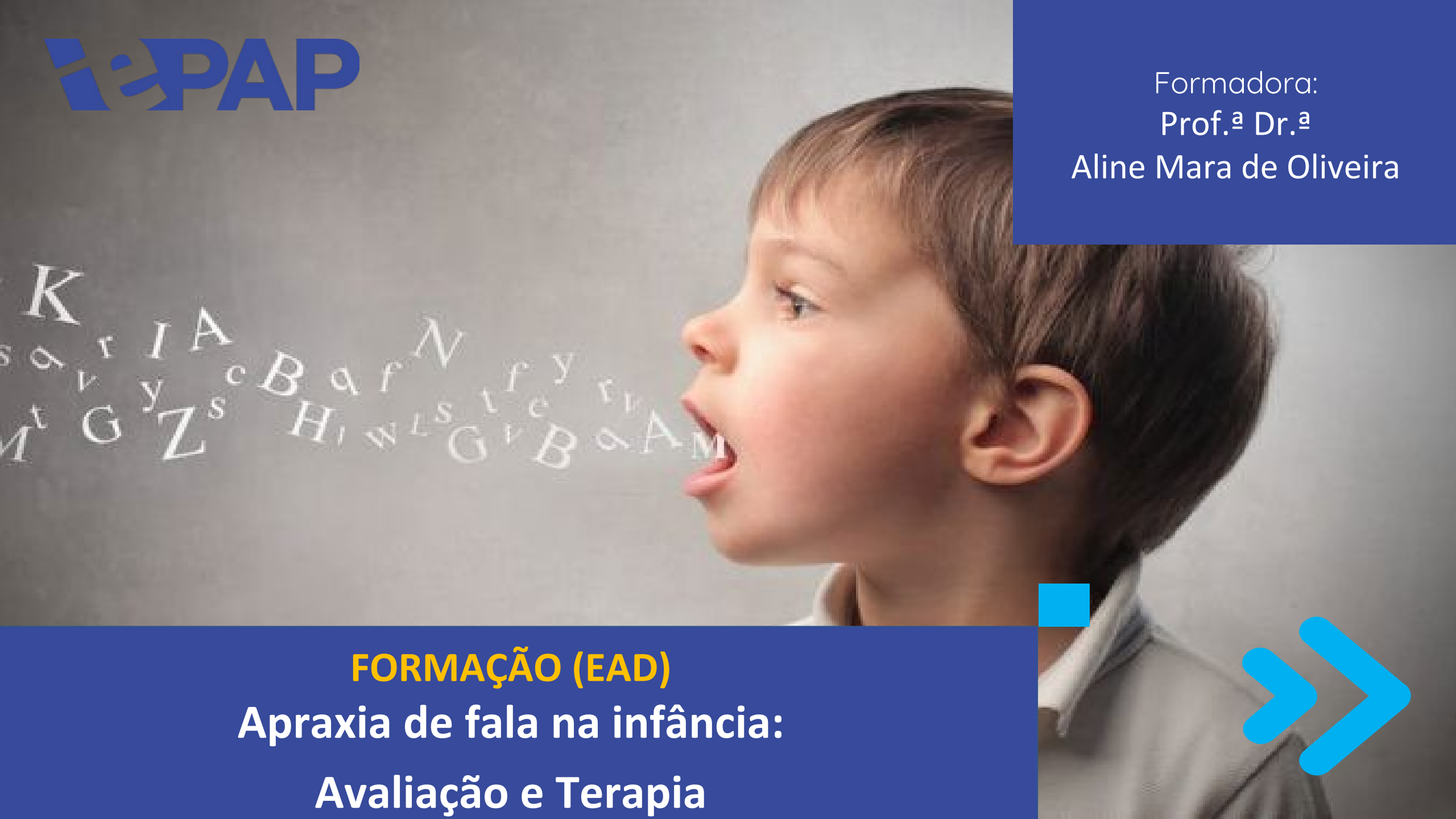


Formadora:
Prof.ª Dr.ª
Aline Mara de Oliveira

FORMAÇÃO (EAD)

Apraxia de fala na infância:
Avaliação e Terapia

CONTEÚDOS TEÓRICOS-PRÁTICOS

- Aquisição motora para o desenvolvimento da fala
- Caracterização dos Transtornos Motores de Fala
- Apraxia de Fala na Infância: conceito, caracterização, diagnóstico diferencial dos transtornos dos sons da fala
- Avaliação clínica fonoaudiológica (informais, formal e dinâmica nos TMF)
- Tratamento para intervenção fonoaudiológica
- Princípios de aprendizagem motora
- Métodos de tratamento baseados em evidências

INTRODUÇÃO

- Princípios de aprendizagem motora
- Tratamento para intervenção fonoaudiológica
- Métodos de tratamento baseados em evidências

Modelos de intervenção para AFI

EVIDÊNCIA CLÍNICA

- **DYNAMIC TEMPORAL AND TACTILE CUEING (DTTC)**
- **RAPID SYLLABLE TRANSITION TREATMENT (REST)**

[http://sydney.edu.au/health-sciences/rest/]
[https://rest.paginas.ufsc.br/]

- ***BIOFEEDBACK* COM ULTRASSONOGRAFIA DE LÍNGUA**
- **NUFFIELD DYSPRAXIA PROGRAM (NDP3)INTEGRATED PHONOLOGICAL AWARENESS(IPA)**

[https://promptinstitute.com/]

- **PROMPT**

BIOFEEDBACK COM ULTRASSONOGRAFIA DE LÍNGUA

BIOFEEDBACK

O *biofeedback* é um meio de fornecer a um indivíduo informações **que geralmente não são conscientes** (maior controle sob a ação a ser realizada).

MULTIDISCIPLINAR

BIOFEEDBACK

Biofeedback são pistas fornecidas **pelo terapeuta,** que auxiliam no monitoramento de um comportamento fisiológico (os movimentos dos articuladores durante a produção de fala), por meio de instrumentos.

(Volin, 1998)

Por que utilizar o *biofeedback*?

Movimentos articulatórios **escondidos** ou **abstração** dos sons ou contrastes encobertos

↓

Desafios na descrição dos movimentos articulatórios ou sons desejados.

↓

Visualização direta dos movimentos articulatórios ou informações acústicas correlatas.

(Cleland, Preston, 2021)

Por que utilizar o *biofeedback*?

Processos de fala se tornem mais **concretos** e **acessíveis;**

Pistas mais explícitas (fgo)

mais consciência da produção de fala (criança);

(Cleland, Preston, 2021)

BIOFEEDBACK VISUAL

- Transtornos Motores de fala
- Princípios de aprendizagem motora
- Feedback de desempenho

(Cleland, Preston, 2021; Preston, Holliman-Lopez, Leece, 2018)

TIPOS DE *BIOFEEDBACK*

1. auditivo

2. tátil/cinestésico

3. visual

4. multissensorial

BIOFEEDBACK AUDITIVO

Instruções verbais

Amplificação sonora

Gravar e ouvir: acurácia

Prosódia exagerada

BIOFEEDBACK TÁTIL

Ponto e modo articulatório

Gestos

Movimento articulatório

Fonte: https://promptinstitute.com/general/custom.asp?page=Portuguese

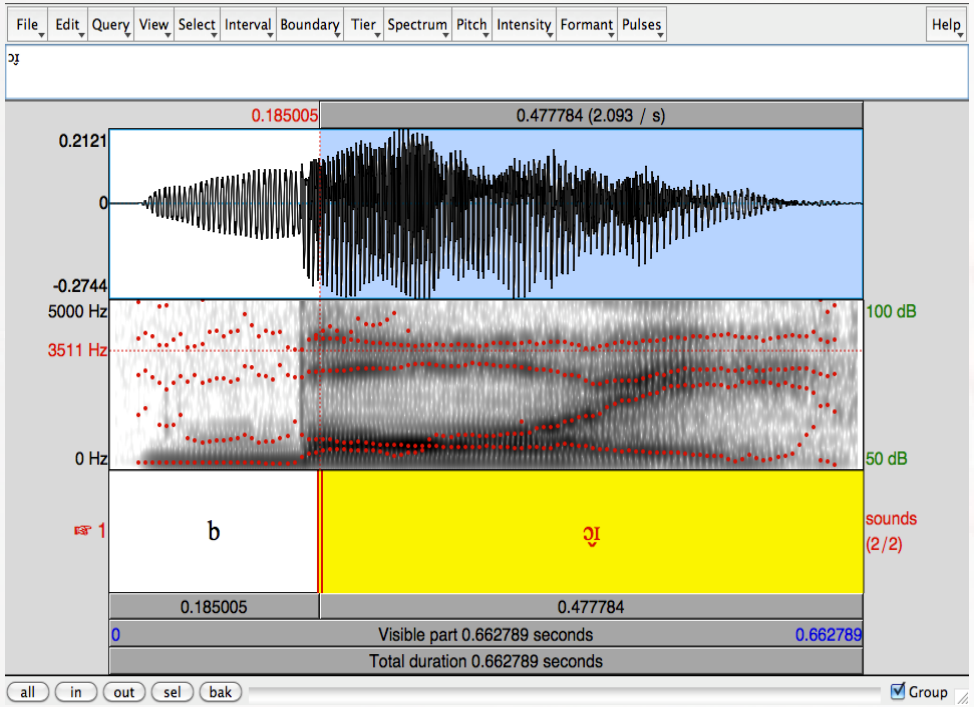
BIOFEEDBACK VISUAL

Espelho

BIOFEEDBACK VISUAL – staRt app

(McAllister Byun, et al., 2017)

BIOFEEDBACK VISUAL – acústico

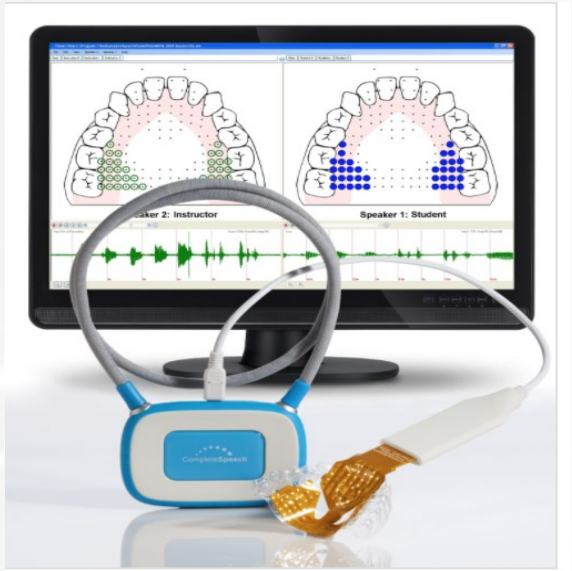


Fonte: https://wp.nyu.edu/byunlab/projects/biofeedback/

Softwares:
Praat, WaveSurfer, CSL

Equipamentos: computador e microfone.

BIOFEEDBACK VISUAL – Eletropalatografia



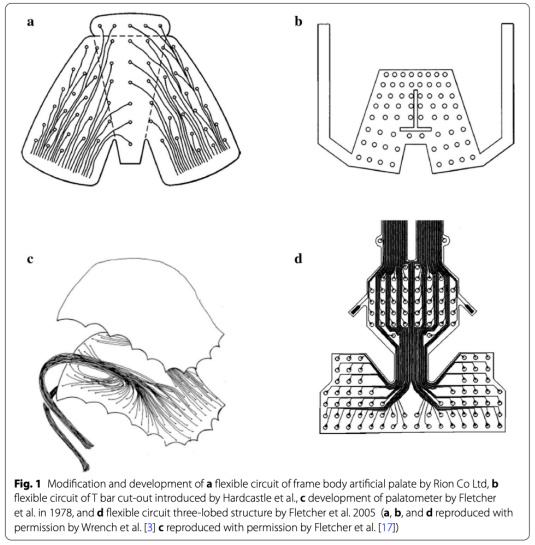
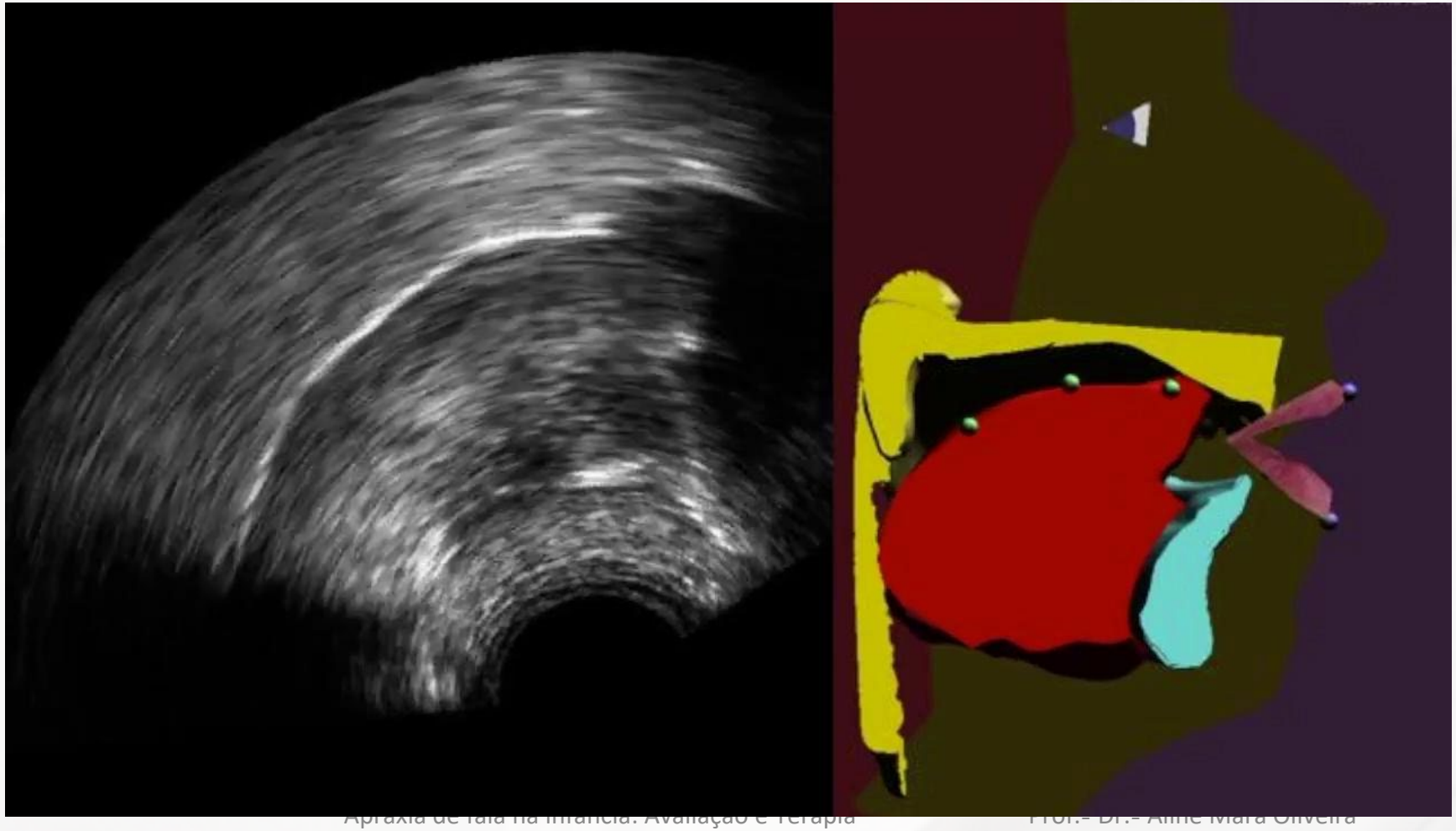


Fig. 1 Modification and development of **a** flexible circuit of frame body artificial palate by Rion Co Ltd, **b** flexible circuit of T bar cut-out introduced by Hardcastle et al., **c** development of palatometer by Fletcher et al. in 1978, and **d** flexible circuit three-lobed structure by Fletcher et al. 2005 (**a**, **b**, and **d** reproduced with permission by Wrench et al. [3] **c** reproduced with permission by Fletcher et al. [17])

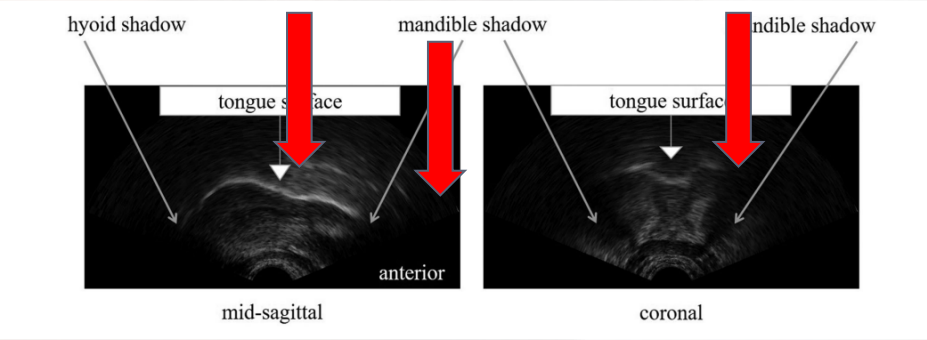
SmartPalate https://www.chsc.org/visual-biofeedback-therapy/

Equipamentos: ***Pseudopalato, conector (para transferir o sinal do palato para o computador) computador ou unidade de prática domiciliar***

BIOFEEDBACK VISUAL –
ultrassonografia de língua



BIOFEEDBACK VISUAL – ultrassonografia de língua



(Gick, 2002; Stone et al, 2005)

Softwares: AAA, Sonospeech, Ultraspeech-tools

Equipamentos: ultrassom portátil , transdutor computador; estabilizador de cabeça; sincronizador do sinal de áudio e vídeo.

Quando utilizar o biofeedback?

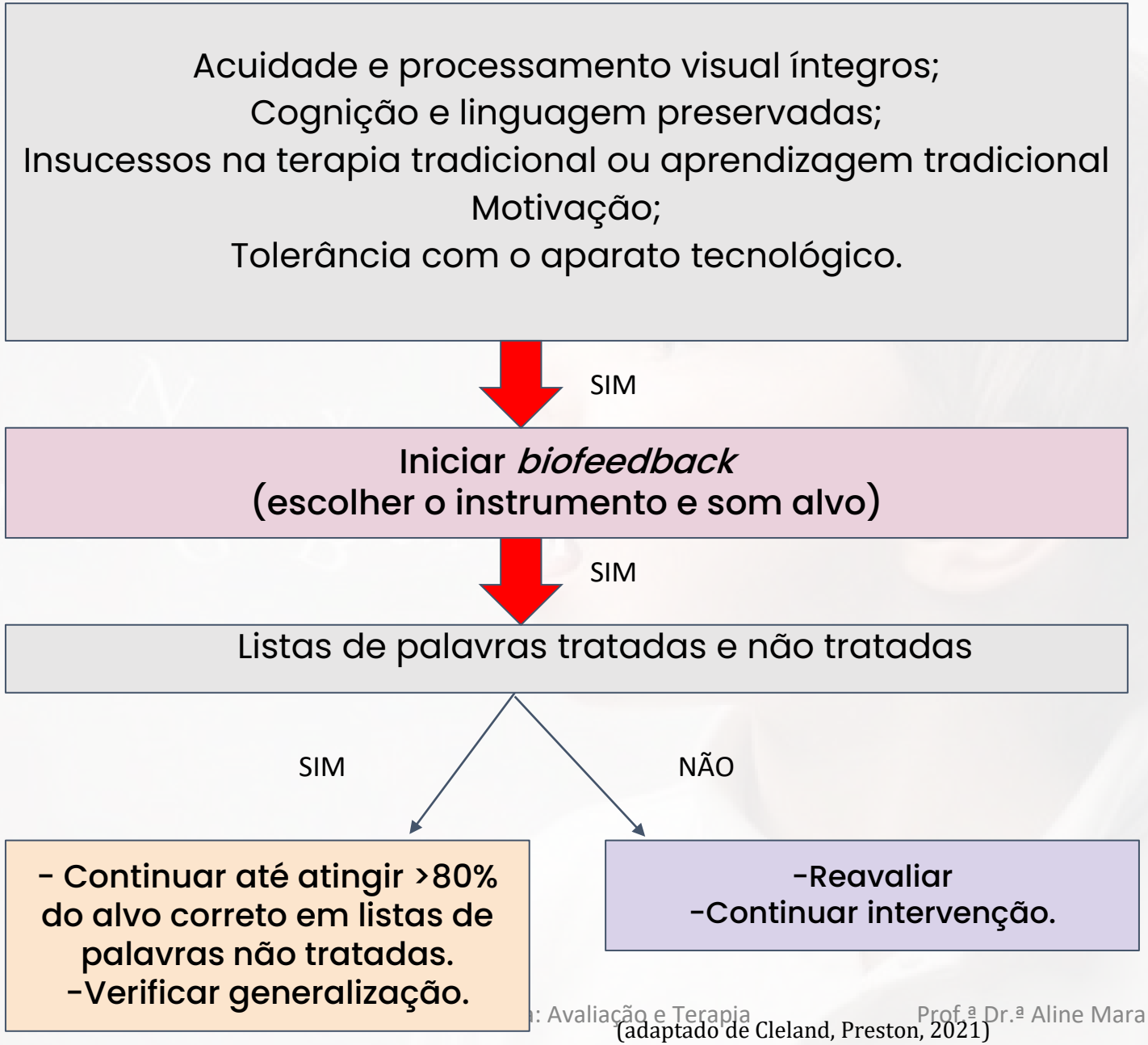
Avaliação

Avaliação instrumental

Intervenção tradicional

***Biofeedback* visual**

BIOFEEDBACK VISUAL – DESIGN DA INTERVENÇÃO



(adaptado de Cleland, Preston, 2021)

BIOFEEDBACK VISUAL –ULTRAX 2020

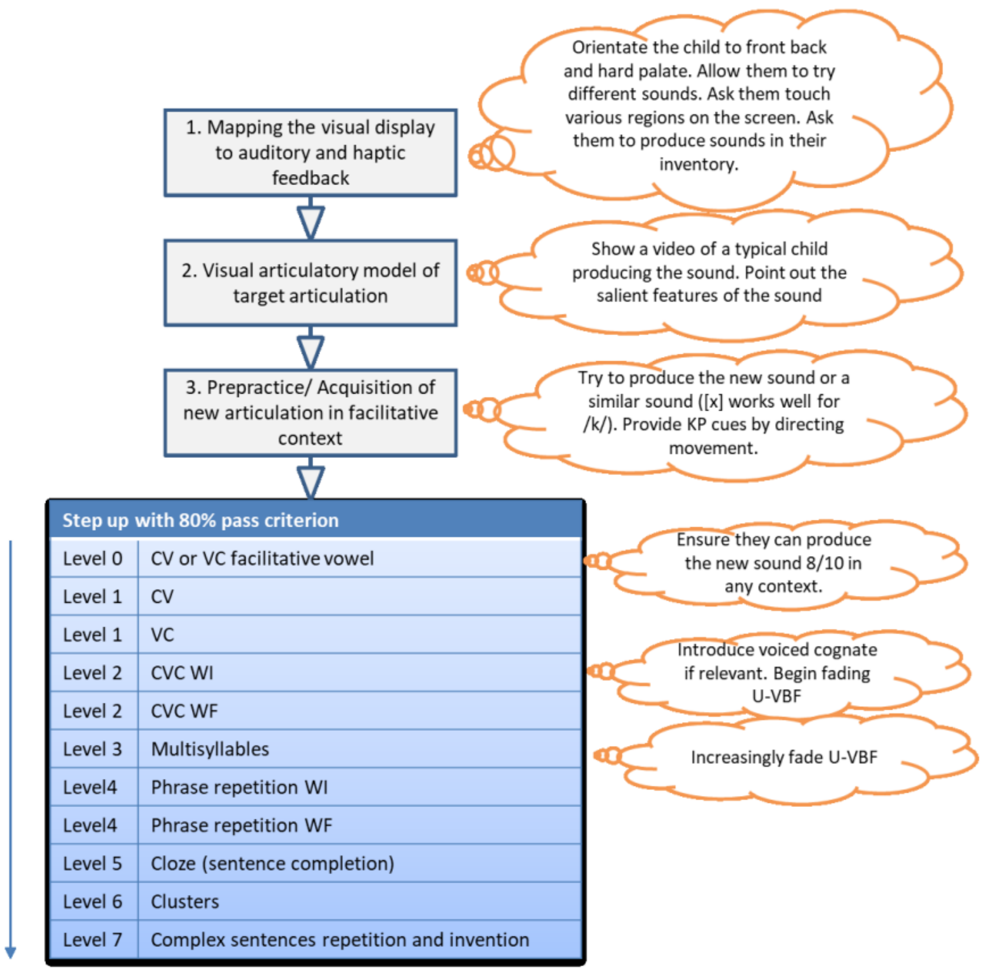
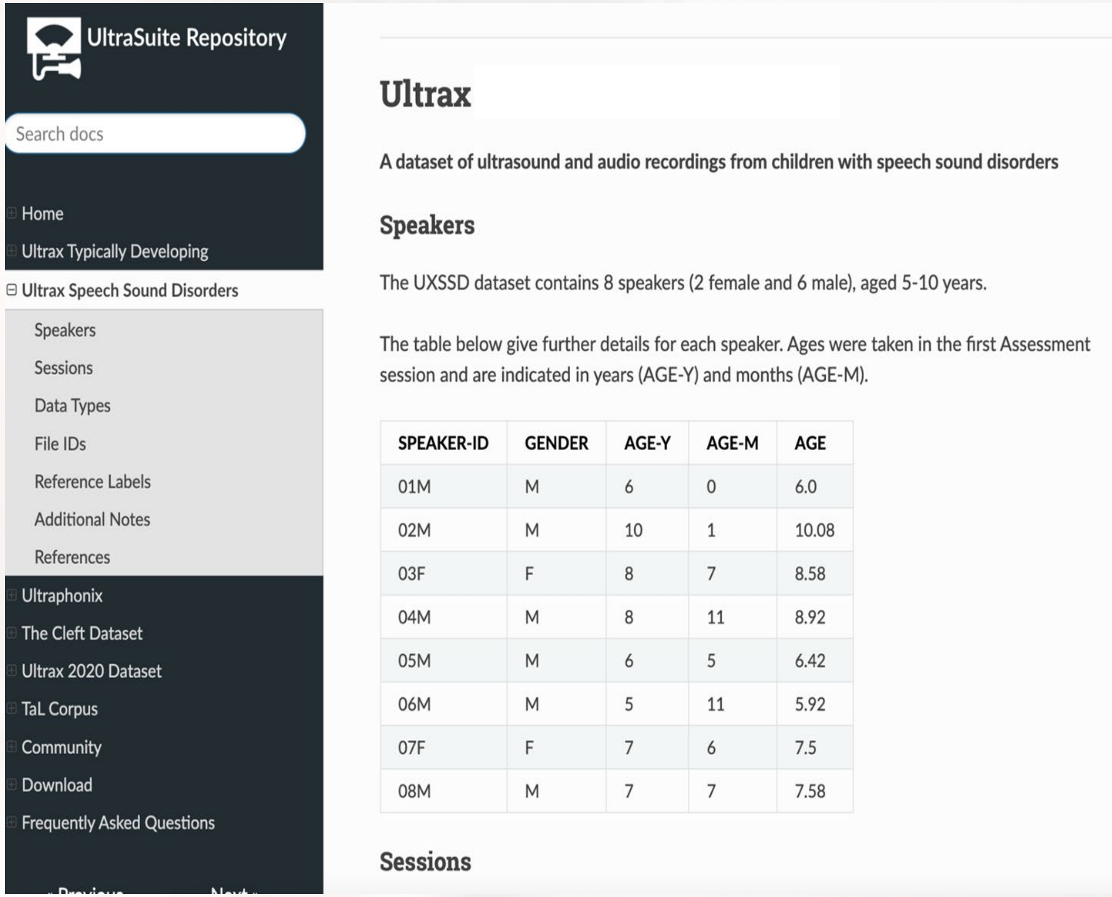


Figure 5: Sequence of U-VBF

https://ultrasuite.github.io/data/uxssd/



Fonte: ULTRAX2020 Ultrasound Technology for Optimising the Treatment of Speech Disorders Clinicians' Resource Manual

BIOFEEDBACK VISUAL – SOM ALVO

Electropalatography
t, d, n, s, z, j, ʃ, ʧ, ʤ, k, g, ŋ, ɹ, l
i

Ultrasound
t, d, n, s, z, j, ʃ, ʧ, ʤ, k, g, ŋ, ɹ, l
All vowels

Visual acoustic
ɹ, l, w, j
All vowels

(Cleland, Preston, 2021)

BIOFEEDBACK VISUAL – PÚBLICO ALVO

- Transtornos fonológicos;
- Erros residuais de fala;
- Róticos;
- Perda auditiva (implante coclear);
- Disartria;
- Síndrome de Down;
- TSF – TEA

- Aquisição e aprendizagem da Segunda língua;

EVIDENCE OF EFFICACY: ULTRASOUND SPEECH THERAPY STUDIES (Oct 2016)

Study	N	Age	Dx	Speech Targets	+ve Result	Mixed Result
Shawker & Sonies (1985)	1	9	DSSD	r	✓	
Bernhardt et al. (2003)	4	16 to 18	HI	s, ʃ, r, l, i, ɪ, u, ʊ	✓	
Bernhardt et al. (2005a)	4	16 to 18	HI	s, ʃ, r, l, i, ɪ, u, ʊ		✓
Adler-Bock et al. (2007)	2	12, 14	DSSD	r	✓	
Bacsfalvi et al. (2007)	3	18	HI	i, u, ʊ , ɪ, ɛ	✓	
Bernhardt et al. (2008)	13	8 to 15	RSSE	r		✓
Fawcett et al. (2008)	3	21 to 27	DS	r	✓	
Modha et al. (2008)	1	13	DSSD	r	✓	
Bacsfalvi (2010)	3	15 to 18	HI	r	✓	
Bacsfalvi & Bernhardt (2011)	7	14 to 19	HI	N/A		✓
Klein et al. (2013)	2	5, 6	DSSD	r	✓	
Lipetz & Bernhardt (2013)	1	15	DSSD	s, z, ʃ, t ʃ	✓	
Preston et al. (2013)	6	9 to 15	CAS	sequences e.g. re, kr		✓
McAllister Byun & Hitchcock (2014)	4	6 to 10	DSSD	r		✓
McAllister Byun & Hitchcock (2014)	4	7 to 15	DSSD	r	✓	
Preston et al. (2014)	8	10 to 20	RSSE	s, z, θ, ʃ, tʃ, r ; Clusters: r, s, l	✓	
Preston et al. (2014)	1	59	AoS	r		✓
Cleland et al. (2015)	7	6 to 10	DSSD	k, g, r, ʃ, t	✓	
Hitchcock & McAllister Byun (2015)	1	11	DSSD	r	✓	
Lee et al. (2015)	1	13	DSSD	r	✓	
Blyth et al. (2016)	2	53, 59	Glossectomy	s, t Participant 1; s, l, tʃ Participant 2	✓	
Bressmann et al. (2016)	4	7 to 10	DSSD	r	✓	
Heng et al. (2016)	2	4	DSSD	k,g Velar Fronting		✓
Melo et al. (2016)	1	5	DSSD	k,g Velar Fronting	✓	
Preston et al. (2016)	3	10 to 13	CAS	r		✓
Preston et al. (2016)	12	10 to 16	RSSE	r	✓	
Preston et al. (2016)	3	10 to 14	CAS	r (two participants), sibilants (1 participant)		✓
Roxburgh et al. (2016)	2	6, 9	CLP	n for one participant; k,g for another	✓	
Sjolie et al (2016)	4	7 to 9	DSSD	r		✓

DSSD	Developmental Speech Sound Disorder
RSSE	Residual Speech Sound Error
CAS	Childhood Apraxia of Speech
HI	Hearing Impairment
DS	Down syndrome
CLP	Cleft Lip and Palate

(Sugden, et al. 2019;

BIOFEEDBACK VISUAL – PÚBLICO ALVO

- Tolerância com o aparato tecnológico:

- **EPG:** desconfortável e que requer tempo para adaptar ao pseudo palato;
- dentição em formação;

- **USG:** incômomodo no início com transdutor e gel, mas depois se adaptam.
- TEA: hipersensibilidade tátil;

(Cleland, Preston, 2021; Preston, Holliman-Lopez, Leece, 2018)

BIOFEEDBACK VISUAL – PÚBLICO ALVO
TRANSTORNO FONOLÓGICO

Using ultrasound visual biofeedback to treat persistent primary speech sound disorders

Joanne Cleland [1], James M Scobbie, Alan A Wrench

Affiliations + expand

PMID: 25751614 DOI: 10.3109/02699206.2015.1016188

Free article

Abstract

Show Video

Growing evidence suggests that speech intervention using visual biofeedback may benefit people for whom visual skills are stronger than auditory skills (for example, the hearing-impaired population), especially when the target articulation is hard to describe or see. Diagnostic ultrasound can be used to image the tongue and has recently become more compact and affordable leading to renewed interest in it as a practical, non-invasive visual biofeedback tool. In this study, we evaluate its effectiveness in treating children with persistent speech sound disorders that have been unresponsive to traditional therapy approaches. A case series of seven different children (aged 6-11) with persistent speech sound disorders were evaluated. For each child, high-speed ultrasound (121 fps), audio and lip video recordings were made while probing each child's specific errors at five different time points (before, during and after intervention). After intervention, all the children made significant progress on targeted segments, evidenced by both perceptual measures and changes in tongue-shape.

Keywords: Ultrasound; speech sound disorders; visual biofeedback.

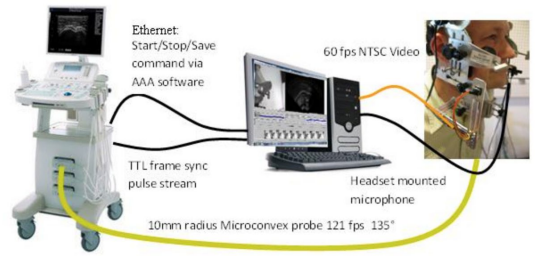


Figure 3: Ultrasound recording set-up showing probe-stabilisation headset.

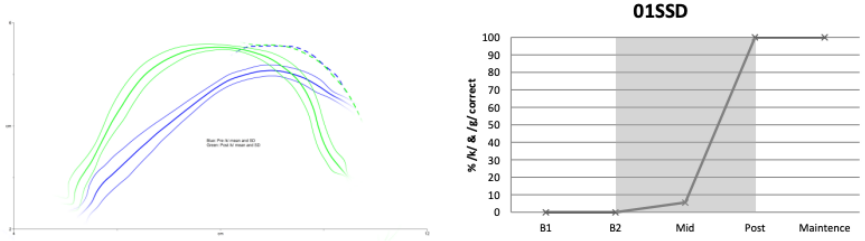


Figure 4a: **01M:** Percentage segments correct (transcription data) at each time point

Figure 4b: **01M:** Pre- (blue) and post-therapy (green) average ultrasound tongue-shapes

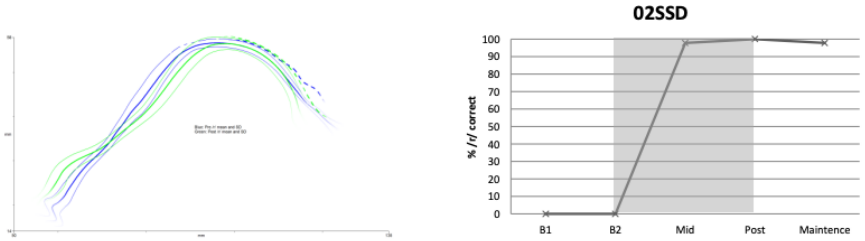


Figure 5a: **02M:** Percentage segments correct (transcription data) at each time point

Figure 5b: **02M:** Pre- (blue) and post-therapy (green) average ultrasound tongue-shapes

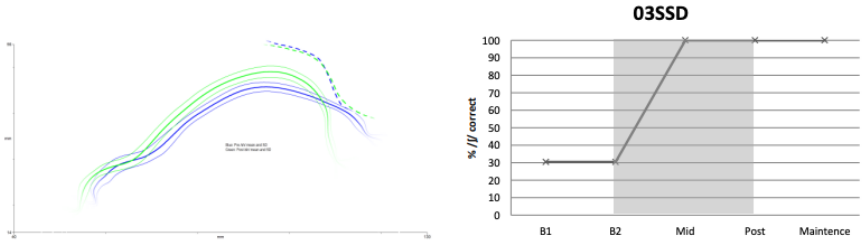


Figure 6a: **03F:** Percentage segments correct (transcription data) at each time point

BIOFEEDBACK VISUAL
ERRO RESIDUAL DE FALA

AJSLP

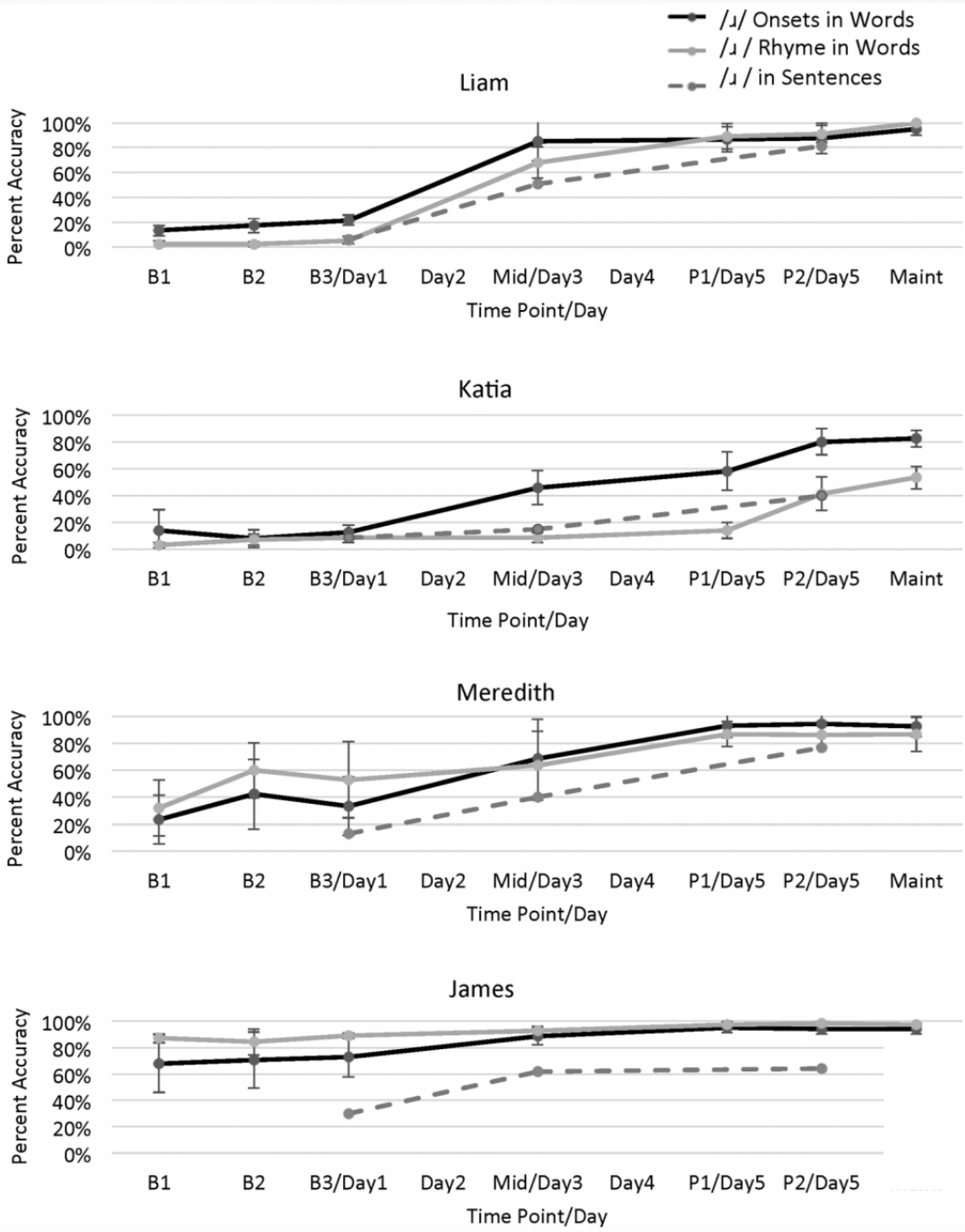
Clinical Focus

Intensive Treatment for Persisting Rhotic Distortions: A Case Series

Jonathan L. Preston[a,b] and Megan C. Leece[a]

Purpose: The study explored changes in accuracy of American English rhotics as a result of an intensive 1-week therapy program for adolescents and young adults with residual speech sound errors that had not resolved with previous therapy.
Method: Four case reports are presented of individuals aged 13, 17, 21, and 22 years with residual /ɹ/ distortions. Each participant attended a 1-week intensive program consisting of pretreatment assessments, 14 hr of therapy, and posttreatment assessment. Treatment sessions included structured motor-based practice, ultrasound visual feedback of the tongue, and auditory speech perception training. To assess generalization, untreated words and sentences with rhotics were recorded before and after therapy; these were rated by listeners who were blind to when the recordings were taken.

Results: All participants showed measurable and statistically significant improvement in speech sou accuracy. Averaged across the 4 participants, rhot accuracy at the word level improved from 35% to 83%. At the sentence level, rhotic accuracy increa from 11% pretreatment to 66% posttreatment in 1 week.
Conclusion: The promise of an intensive treatment that includes motor-based practice, biofeedback, and perception training is illustrated by the case presentati which substantial improvements in speech sound ac were observed.
Supplemental Materials: https://doi.org/10.23641/ 5561254



BIOFEEDBACK VISUAL – PÚBLICO ALVO

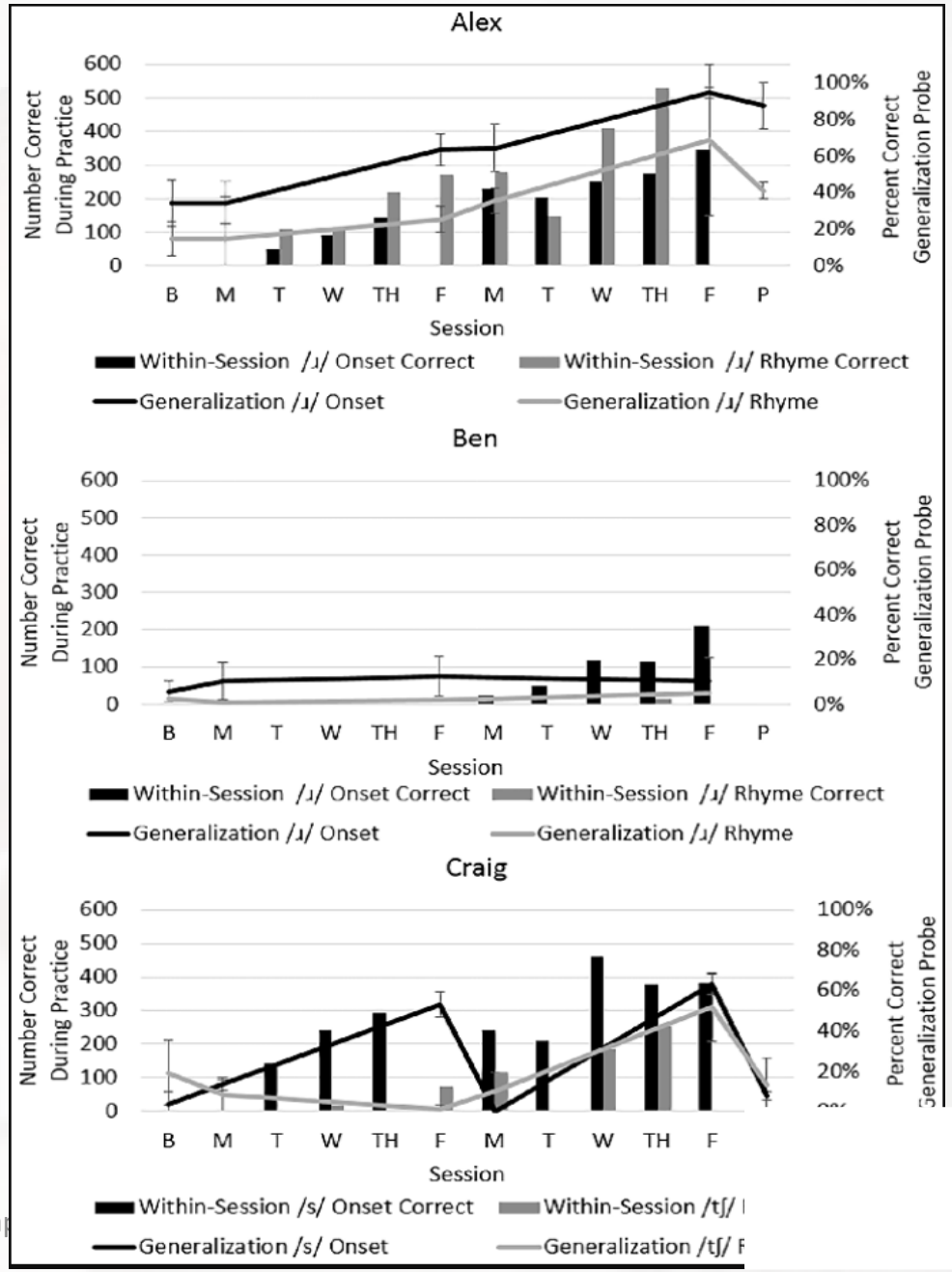
AFI – SÍLABAS

Intensive Treatment with Ultrasound Visual Feedback for Speech Sound Errors in Childhood Apraxia

Jonathan L. Preston[1,2*], Megan C. Leece[1] and Edwin Maas[3]

[1]Department of Communication Sciences and Disorders, Syracuse University, Syracuse, NY, USA
[2]Haskins Laboratories, New Haven, CT, USA
[3]Department of Communication Sciences and Disorders, Temple University, Philadelphia, PA, USA

Ultrasound imaging is an adjunct to traditional speech therapy that has shown to be beneficial in the remediation of speech sound errors. Ultrasound biofeedback can be utilized during therapy to provide clients with additional knowledge about their tongue shapes when attempting to produce sounds that are erroneous. The additional feedback may assist children with childhood apraxia of speech (CAS) in stabilizing motor patterns, thereby facilitating more consistent and accurate productions of sounds and syllables. However, due to its specialized nature, ultrasound visual feedback is a technology that is not widely available to clients. Short-term intensive treatment programs are one option that can be utilized to expand access to ultrasound biofeedback. Schema-based motor learning theory suggests that short-term intensive treatment programs (massed practice) may assist children in acquiring more accurate motor patterns. In this case series, three participants ages 10–14 years diagnosed with CAS attended 16 h of speech therapy over a 2-week period to address residual speech sound errors. Two participants had distortions on rhotic sounds, while the third participant demonstrated lateralization of sibilant sounds. During therapy, cues were provided to assist participants in obtaining a tongue shape that facilitated a correct production of the erred sound. Additional practice without ultrasound was also included. Results suggested that all participants showed signs of acquisition of sounds in error. Generalization and retention results were mixed. One participant showed generalization and retention of sounds that were treated; one showed generalization but limited retention; and the third showed no evidence of generalization or retention. Individual characteristics that may facilitate generalization are discussed. Short-term intensive treatment programs using ultrasound biofeedback may result in the acquisition of more accurate motor patterns and improved articulation of sounds previously in error, with varying levels of generalization and retention.



BIOFEEDBACK VISUAL – PÚBLICO ALVO
AFI – AQUISIÇÃO E GENERALIZAÇÃO

Limited acquisition and generalization of rhotics with ultrasound visual feedback in childhood apraxia

Jonathan L. Preston
Syracuse University and Haskins Laboratories

Edwin Maas
University of Arizona

Jessica Whittle
Haskins Laboratories

Megan C. Leece
Syracuse University

Patricia McCabe
University of Sydney

Abstract

Ultrasound visual feedback of the tongue is one treatment option for individuals with persisting speech sound errors. This study evaluated children's performance during acquisition and generalisation of American English rhotics using ultrasound feedback. Three children aged 10–13 with persisting speech sound errors associated with childhood apraxia of speech (CAS) were treated for 14 one-hour sessions. Two of the participants increased the accuracy of their rhotic production during practice trials within treatment sessions, but none demonstrated generalisation to untreated words. Lack of generalisation may be due to a failure to acquire the target with sufficient accuracy during treatment, or to co-existing linguistic weaknesses that are not addressed in a motor-based treatment. Results suggest a need to refine the intervention procedures for CAS and/or a need to identify appropriate candidates for intervention to optimise learning.

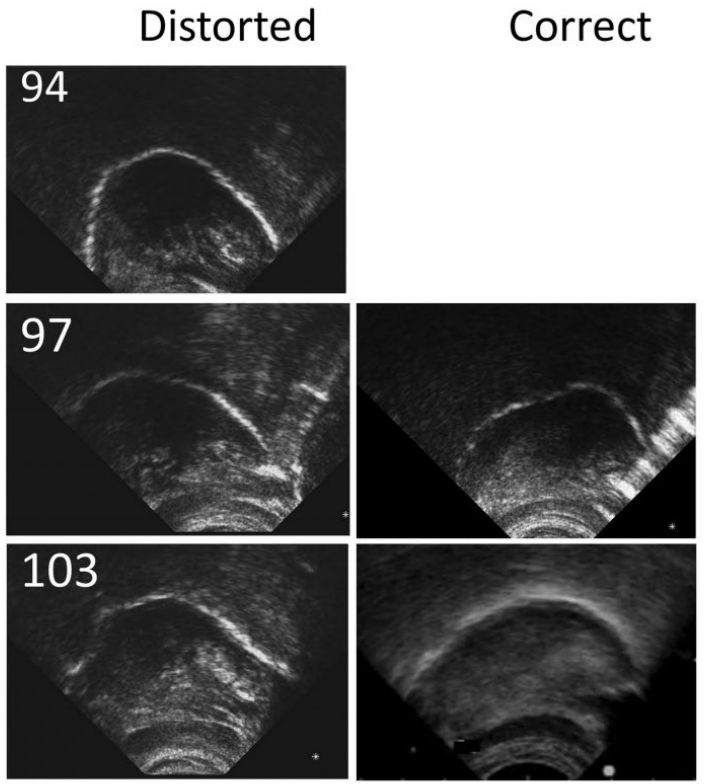


Figure 1.
Example tongue shapes for distorted and correct productions of rhotics
Note: All three distorted productions came from vocalic /ɹ/ productions whereas th
productions occurred in onsets (“broom” for participant 97 and “rain” for 103).

BIOFEEDBACK VISUAL – considerações das sessões

- Princípios da aprendizagem motora;
- Terapia intensiva e individual;
- Duração: de 30 minutos a 1 hora;
- Tentativas: 100 tentativas induzidas em muitas sessões.

BIOFEEDBACK VISUAL

Experiência na UFSC – ULTRAFONO

Biofeedback em crianças com atraso motor da fala

Avaliações	
Características	
Idade	8 anos
Gênero	Masculino
PCC em tarefa de produção de palavras – AFC (PCC) (%)	60,8%
Diadococinesia oral	Dificuldade importante
PCC em tarefa de produção de palavras multissilábicas (%)	42,85%
Palavras Multissilábicas (Acento lexical)	60,80%
Inconsistência de fala (média das produções)	03/08
Acento Frasal	20/24

AVALIAÇÃO CLÍNICA

- Avaliação Fonológica Infantil + PCC-R
- Aspectos segmentais
- Aspectos suprassegmentais
- Aspectos produção motora de fala

14 Speech Production Measures in Brazilian Portuguese Children With and Without Speech Sound Disorder

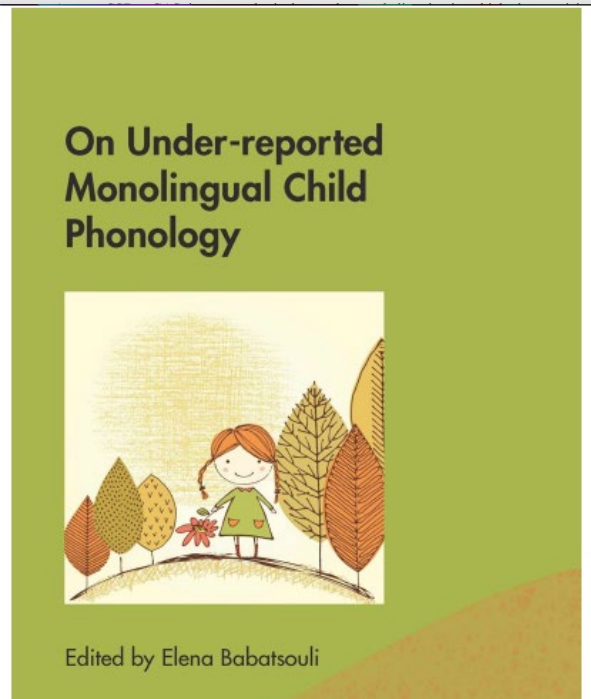
Aline Mara de Oliveira , Gabriely Vitória Veschi, Luiza Polli
Cássio Eduardo Esperandino and Larissa Cristina Berti

Introduction

This chapter addresses the differential diagnosis of children with speech sound disorders (SSDs), comparing the speech production of children with phonological impairment and with suspected childhood apraxia of speech. The chapter will discuss some speech production measures used during the diagnosis of both groups and will compare the results with previous research.

SSDs are deficits in the production of individual speech sounds or sequences of speech sounds caused by inadequate planning, control or coordination of structures of the oral mechanism. SSD is an umbrella term related to any combination of difficulties with perception, motor production and/or the phonological representation of speech segments (including phonotactic rules that govern syllable shape, structure, stress as well as prosody) that impact speech intelligibility (DSM-5; ASHA, 2007; ASHA, 2017; Shriberg, 2003). Speech sound disorders also include articulation disorder, disfluency and voice disorders.

SSDs are a general term that comprises articulation and/or phonological impairment (PI). These disorders may be motor-based (e.g. childhood apraxia of speech, CAS), syndrome-based (e.g. Down syndrome) and sensory-based (e.g. hearing impairment). Traditionally, PI is defined as an alteration found in the phonological system of an individual at preschool age which is of unknown origin, and it can be characterized by substitutions, omissions and/or distortions of the phonological system of speech (Ingram, 1976). PI is characterized by impairments in the phonological representation of speech sounds in the absence of other cognitive, sensory, motor, structural or affective issues (Ingram, 1976).



Biofeedback em crianças com atraso motor da fala

- DOSAGEM: 4 horas por semana x 3 semanas = 12 horas
- 40 min com USG + terapia tradicional - (Princípios de aprendizagem motora)
- Escolha do alvo: hierarquia motora da fala (controle de língua - palavras com k)
- PRÉ PRÁTICA + PRÁTICA

Biofeedback em crianças com atraso motor da fala

- O ultrassom é um instrumento **útil** para a auto percepção do indivíduo quanto aos movimentos da língua.

- Auxílio deste aparato os sujeitos deste estudo mantiveram-se **engajados e motivados** com a visualização do próprio formato da língua e dos **gestos articulatórios** que compõem a fala.

Biofeedback em crianças com atraso motor da fala

CONSIDERAÇÕES IMPORTANTES:

- Intervenção tradicional somada ao *biofeedback* visual, por meio da ultrassonografia de língua, mostrou ser eficaz para melhorar a precisão e a acurácia da fala.

- Limitações: ampliar estudos para generalizações.

Importante

- Acesso ao equipamento;
- Treinamento específico,
- EPG e UGS: são técnicas mais caras que estão disponíveis principalmente em clínicas especializadas e universidades.

Terapias anteriores ineficazes → Terapia biofeedback vantajosa

VANTAGEM FINANCEIRA E DURAÇÃO DO TRATAMENTO

(Preston, Leece, 2017; Preston, Leece, Maas, 2016)

Perspectivas futuras

- Diminuição do custo dos equipamentos;
- Traçar o perfil do candidato ao *biofeedback*;
- Estudos controlados randomizados;
- Estudos translacionais;
- Dosagem;
- *Design* da sessão com *biofeedback*;
- Estudos com outras alterações de fala.

(Preston, Leece, 2017; Preston, Leece, Maas, 2016)

Evidência científica robusta

Protocol for Correcting Residual Errors with Spectral, ULtrasound, Traditional Speech therapy Randomized Controlled Trial (C-RESULTS RCT)

Tara McAllister[1], Jonathan L. Preston[2*], Elaine R. Hitchcock[3] and Jennifer Hill[4]

Abstract

Background: Speech sound disorder in childhood poses a barrier to academic and social participation, with potentially lifelong consequences for educational and occupational outcomes. While most speech errors resolve by the late school-age years, between 2 and 5% of speakers exhibit residual speech errors (RSE) that persist through adolescence or even adulthood. Previous findings from small-scale studies suggest that interventions incorporating visual biofeedback can outperform traditional motor-based treatment approaches for children with RSE, but this question has not been investigated in a well-powered randomized controlled trial.

Methods/design: This project, *Correcting Residual Errors with Spectral, ULtrasound, Traditional Speech therapy Randomized Controlled Trial* (*C-RESULTS RCT*), aims to treat 110 children in a parallel randomized controlled clinical trial comparing biofeedback and non-biofeedback interventions for RSE affecting the North American English rhotic sound /ɹ/. Eligible children will be American English speakers, aged 9–15 years, who exhibit RSE affecting /ɹ/ but otherwise show typical cognitive-linguistic and hearing abilities. Participants will be randomized, with stratification by site (Syracuse University or Montclair State University) and pre-treatment speech production ability, to receive either a motor-based treatment consistent with current best practices in speech therapy (40% of participants) or treatment incorporating visual biofeedback (60% of participants). Within the biofeedback condition, participants will be assigned in equal numbers to receive biofeedback in the form of a real-time visual display of the acoustic signal of speech or ultrasound imaging of the tongue during speech. The primary outcome measure will assess changes in the acoustics of children's production of /ɹ/ during treatment, while a secondary outcome measure will use blinded listeners to evaluate changes in the perceived accuracy of /ɹ/ production after the completion of all treatment. These measures will allow the treatment conditions to be compared with respect to both efficacy and efficiency.

Discussion: By conducting the first well-powered randomized controlled trial comparing treatment with and without biofeedback, this study aims to provide high-quality evidence to guide treatment decisions for children with RSE.

Trial registration: ClinicalTrials.gov identifier NCT03737318, November 9, 2018.

Keywords: Speech sound disorder, Randomized controlled trial, Biofeedback

Research Article

A Pilot Randomized Control Trial of Motor-Based Treatments for Childhood Apraxia of Speech: Rapid Syllable Transition Treatment and Ultrasound Biofeedback

Patricia McCabe,[a] **Jonathan L. Preston,**[b,c] **Pippa Evans,**[a,d] **and Rob Heard**[a]

[a]The University of Sydney, New South Wales, Australia [b]Syracuse University, NY [c]Haskins Laboratories, New Haven, CT [d]The University of Queensland, Brisbane, Australia

ARTICLE INFO

Article History:
Received May 6, 2022
Revision received October 8, 2022
Accepted November 29, 2022

Editor-in-Chief: Katherine C. Hustad

https://doi.org/10.1044/2022_AJSLP-22-00144

ABSTRACT

Purpose: Both Rapid Syllable Transition Treatment (ReST) and ultrasound biofeedback are effective approaches to treating childhood apraxia of speech (CAS). The purpose of the study was to compare outcomes from these two motor-based treatment approaches for school-age children with CAS.
Method: In a single site, single blind randomized control trial, 14 children with CAS ages 6–13 years were randomly assigned to 12 sessions over 6 weeks of either of ultrasound biofeedback treatment (with a speech motor chaining practice structure) or ReST. Treatment was delivered at The University of Sydney by students trained and supervised by certified speech-language pathologists. Transcriptions from blinded assessors were used to compare the two groups on speech sound accuracy (percent phonemes correct) and prosodic severity (lexical stress errors and syllable segregation) in untreated words and sentences at three time points: pretreatment, immediately posttreatment, and 1-month posttreatment (i.e., retention).
Results: Both groups showed significant improvement on treated items indicating a treatment effect. At no time was there a difference between groups. Both groups showed a significant improvement in speech sound accuracy on untreated words and sentences from pre to post and neither group showed an improvement in prosody pre–post. Changes to speech sound accuracy were retained by both groups at 1-month follow-up. Significant improvement in prosodic accuracy was reported at the 1-month follow-up.
Conclusions: ReST and ultrasound biofeedback were equally effective. Either ReST or ultrasound biofeedback may be viable treatment options for school-age children with CAS.
Supplemental Material: https://doi.org/10.23641/asha.22114661

Figure 2. Ultrasound biofeedback treatment flow chart.

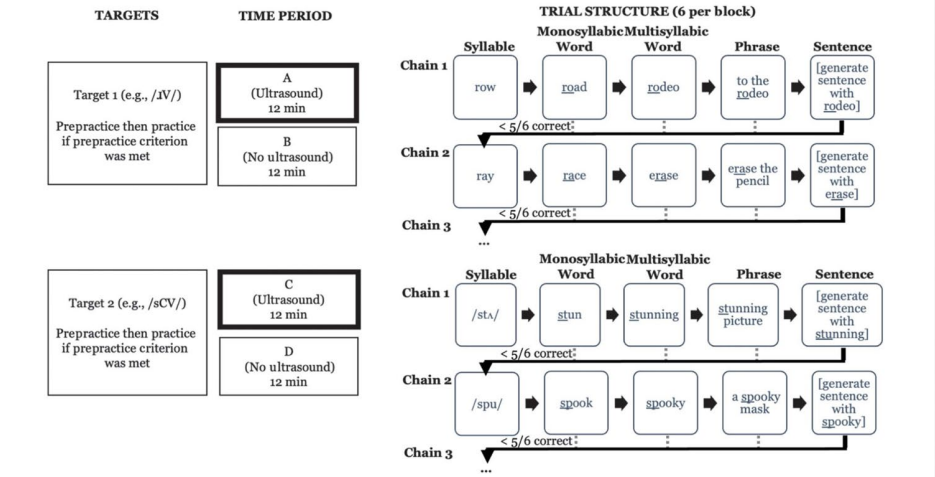
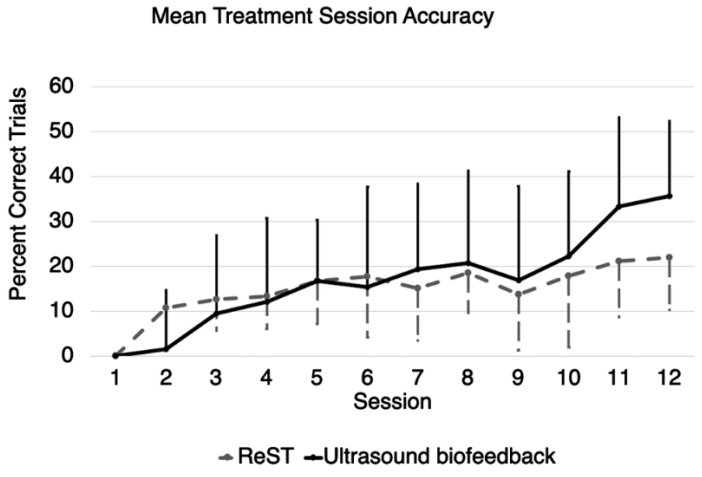


Figure 3. Changes in accuracy of treated items across the 12 treatment sessions for the Rapid Syllable Transition Treatment (ReST) and ultrasound biofeedback treatment groups. Error bars represent 1 *SD*.



RESULTADOS PROMISSORES

USG e ReST: os tratamentos foram associados a uma **maior precisão nos itens tratados**: **generalização e retenção.**

USG e ReST: (PCC) significativamente maior após o tratamento;

USG e ReST: Menos erros prosódicos em palavras não tratadas

Referências

ASHA. AMERICAN SPEECH-LANGUAGE – HEARING ASSOCIATION. Childhood apraxia of speech. **Childhood Apraxia of Speech**. 2007. Disponível em: https://www.asha.org/policy/tr2007-00278/. Acesso em: 17 ago. 2021.

BALLARD, K. J.; ROBIN, D. A.; MCCABE, P. A treatment for dysprosody in childhood apraxia of speech. **Journal of Speech, Language, and Hearing Research,** [*s.l.*], v. 53, v. 5, p. 1.227-1.245, 2010.

EDEAL, Denice Michelle; GILDERSLEEVE-NEUMANN, Christina Elke. The Importance of Production Frequency in Therapy for Childhood Apraxia of Speech. **American Journal Of Speech-Language Pathology**, [*s.l.*], v. 20, n. 2, p. 95-110, maio, 2011. American Speech Language Hearing Association. DOI: http://dx.doi.org/10.1044/1058-0360(2011/09-0005).

FISH, Margareth. **Como tratar apraxia de fala da infância**. [*S.L.*]: Plural Publishing, Inc e Pró-Fono, 2019. 448p.

GUBIANI, Marileda Barichello; PAGLIARIN, Karina Carlesso; KESKE-SOARES, Marcia. Instrumentos para avaliação de apraxia de fala infantil. **Codas**, [*s.l.*], v. 27, n. 6, p. 610-615, dez. 2015. FapUNIFESP (SciELO). DOI: http://dx.doi.org/10.1590/2317-1782/20152014152.

MAAS,Edwin; Robin, Donald A.; Hula, Shannon N. Austermann; Freedman, Skott E.; Wulf, Gabriele. Principles of Motor Learning in Treatment of Motor Speech Disorders. **American Journal of Speech-Language Pathology.** v. 17, n. 3, p. 277-298, 2008.

MAAS, E. *et al.* Motor-Based Intervention Protocols in Treatment of Childhood Apraxia of Speech (CAS). **Current Developmental Disorders Reports**, [*s.l.*], v. 1, n. 3, p. 197-206, 17 abr. 2014. Springer Science and Business Media LLC. DOI: http://dx.doi.org/10.1007/s40474-014-0016-4.

MCCABE, Patricia; THOMAS, Donna Claire; MURRAY, Elizabeth. Rapid Syllable Transition Treatment – A Treatment for Childhood Apraxia of Speech and Other Pediatric Motor Speech Disorders. **Perspectives Of The Asha Special Interest Groups**, [*s.l.*], v. 5, n. 4, p. 821-830, 17 ago. 2020. American Speech Language Hearing Association. DOI: http://dx.doi.org/10.1044/2020_persp-19-00165.

MCCABE, Patricia *et al*. **Rapid Syllable Transition Treatment – ReST**. The University of Sydney. 2017. Disponível em: rest.sydney.edu.au. Acesso em: 17 ago. 2021.

MORGAN, Angela T.; MURRAY, Elizabeth; LIÉGEOIS, Frederique J. Interventions for childhood apraxia of speech. **Cochrane Database Of Systematic Reviews**, Wiley, v. 2019, n. 8, p. 1-59, 30 maio 2018. DOI: http://dx.doi.org/10.1002/14651858.cd006278.pub3.

MURRAY, E.; MCCABE, P.; BALLARD, K. J. A comparison of two treatments for childhood apraxia of speech: Methods and treatment protocol for a parallel group randomised control trial. **BMC Pediatrics,** [*s.l.*], v. 12, n. 1, 2012.

Referências

Namasivayam AK, Coleman D, O'Dwyer A, van Lieshout P. Speech Sound Disorders in Children: An Articulatory Phonology Perspective. Front Psychol. 2020 Jan 28;10:2998. doi: 10.3389/fpsyg.2019.02998. PMID: 32047453; PMCID: PMC6997346.

Adler-Bock M., Bernhardt B. M., Gick B., Bacsfalvi P. (2007). The use of ultrasound in remediation of North American English /r/ in 2 adolescents. Am. J. Speech Lang. Pathol. 16 128–139. 10.1044/1058-0360(2007/017) - DOI - PubMed

Aflalo T. N., Graziano M. S. (2006). Possible origins of the complex topographic organization of motor cortex: reduction of a multidimensional space onto a two-dimensional array. J. Neurosci. 26 6288–6297. 10.1523/jneurosci.0768-06.2006 - DOI - PMC - PubMed

Alfonso P. J., van Lieshout P. (1997). “Spatial and temporal variability in obstruent gestural specification by stutterers and controls: comparisons across sessions,” in Speech Production: Motor Control, Brain Research and Fluency Disorders, eds Hujstijn W., Peters H. F. M., van Lieshout P. (Amsterdam: Elsevier Publishers;), 1151–1602.

Alwan A., Narayan S., Haker K. (1997). Towards articulatory-acoustic models for liquid approximation. J. Acoust. Soc. Am. 101 1078–1089. - PubMed

ASHA (2007). Childhood Apraxia of Speech [Technical Report]. Available at: https://www.asha.org/policy (accessed December 24, 2019).

Bandini A., Namasivayam A. K., Yunusova Y. (2017). “Video-based tracking of jaw movements during speech: preliminary results and future directions,” in Proceedings of the Conference on INTERSPEECH 2017, Stockholm.

Bauman-Waengler J. (2016). Articulation and Phonology in Speech Sound Disorders, 5th Edn Boston, MA: Pearson.

Bernhardt M., Stemberger J., Charest M. (2010). Intervention for speech production for children and adolescents: models of speech production and therapy approaches. Introduction to the issue. Can. J. Speech Lang. Pathol. Audiol. 34 157–167.

Bernstein N. A. (1996). “On dexterity and its development,” in Dexterity and Its Development, eds Latash M. L., Turvey M. T. (Mahwah, NJ: Lawrence Erlbaum Associates;), 1–244.

Bouchard K. E., Mesgarani N., Johnson K., Chang E. F. (2013). Functional organization of human sensorimotor cortex for speech articulation. Nature 495 327–332. 10.1038/nature11911 - DOI - PMC - PubMed

Browman C. P., Goldstein L. (1990b). “Tiers in articulatory phonology, with some implications for casual speech,” in Papers in Laboratory Phonology. Volume I: Between the Grammar and Physics of Speech, eds Kingston J., Beckman M. E. (Cambridge: Cambridge University Press;), 341–376. 10.1017/cbo9780511627736.019

Referências

Dodd B. (2014). Differential diagnosis of pediatric speech sound disorder. Curr. Dev. Disord. Rep. 1 189–196. 10.1007/s40474-014-0017-3 - DOI

Dodd B., Hua Z., Crosbie S., Holm A., Ozanne A. (2006). DEAP: Diagnostic Evaluation of Articulation and Phonology. San Antonio, TX: PsychCorp of Harcourt Assessment.

Fowler C. A. (2014). Talking as doing: language forms and public language. New Ideas Psychol. 32 174–182. 10.1016/j.newideapsych.2013.03.007 - DOI - PMC - PubMed

Fowler C. A., Galantucci B. (2005). “The relation of speech perception and speech production,” in The Handbook of Speech Perception, eds Pisoni D. B., Remez R. E. (Oxford: Blackwell;), 633–652.

Gafos A. (2002). A grammar of gestural coordination. Nat. Lang. Ling. Theory 20 269–337.

Gafos A., Goldstein L. (2012). “Articulatory representation and organization,” in The Handbook of Laboratory Phonology, eds Cohn A., Fougeron C., Huffman M. K. (New York, NY: Oxford University Press;), 220–231.

Gibbon F. (1999). Undifferentiated lingual gestures in children with articulation/phonological disorders. J. Speech Lang. Hear. Res. 42 382–397. 10.1044/jslhr.4202.382 - DOI - PubMed

Gibbon F., Wood S. (2002). Articulatory drift in the speech of children with articulation and phonological disorders. Percept. Motor Skills 95 295–307. 10.2466/pms.2002.95.1.295 - DOI - PubMed

Gibbon F. E., Hardcastle B., Dent H. (1995). A study of obstruent sounds in school-age children with speech disorders using electropalatography. Eur. J. Disord. Commun. 30 213–225. 10.3109/13682829509082532 - DOI - PubMed

Giulivi S., Whalen D. H., Goldstein L. M., Nam H., Levitt A. G. (2011). An articulatory phonology account of preferred consonant-vowel combinations. Lang. Learn. Dev. 7 202–225. 10.1080/15475441.2011.564569 - DOI - PMC - PubMed

Goldman M., Fristoe R. (2000). The Goldman-Fristoe Test of Articulation, 2nd Edn Circle Pines, MN: American Guidance Service.

Goldstein L., Pouplier M., Chen L., Saltzman E., Byrd D. (2007). Dynamic action units slip in speech production errors. Cognition 103 386–412. 10.1016/j.cognition.2006.05.010 - DOI - PMC - PubMed

Goozée J., Murdoch B., Ozanne A., Cheng Y., Hill A., Gibbon F. (2007). Lingual kinematics and coordination in speech-disordered children exhibiting differentiated versus undifferentiated lingual gestures. Int. J. Commun. Lang. Disord. 42 703–724. 10.1080/13682820601104960 - DOI - PubMed

Referências

Shriberg L. D., Aram D., Kwaitkowski J. (1997). Developmental apraxia of speech: III. A subtype marked by inappropriate stress. J. Speech Lang. Hear. Res. 40 313–337. 10.1044/jslhr.4002.313 - DOI - PubMed

Shriberg L. D., Campbell T. F., Mabie H. L., McGlothlin J. H. (2019a). Initial studies of the phenotype and persistence of speech motor delay (SMD). Clin. Linguist. Phonet. 33 737–756. 10.1080/02699206.2019.1595733 - DOI - PMC - PubMed

Shriberg L. D., Campbell T. F., Mabie H. L., McGlothlin J. H. (2019b). Reference Data for Children With Idiopathic Speech Delay With and Without Speech Motor Delay (SMD). Technical Report No. 26, Phonology Project. Madison, WI: University of Wisconsin-Madison.

Shriberg L. D., Fourakis M., Karlsson H. K., Lohmeier H. L., McSweeney J., Potter N. L., et al. (2010). Extensions to the speech disorders classification system (SDCS). Clin. Linguist. Phonet. 24 795–824. 10.3109/02699206.2010.503006 - DOI - PMC - PubMedted

van Lieshout P., Merrick G., Goldstein L. (2008). An articulatory phonology perspective on rhotic articulation problems: a descriptive case study. Asia Pac. J. Speech Lang. Hear. 11 283–303. 10.1179/136132808805335572 - DOI

van Lieshout P., Namasivayam A. K. (2010). “Speech motor variability in people who stutter,” in Speech Motor Control: New Developments in Basic and Applied Research, eds Maassen B., van Lieshout P. (Oxford: Oxford University Press;), 191–214.