Current Approaches to Treating School-age Children with Apraxia of Speech and other Speech Sound Disorders

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Disclosures

No other relevant financial or nonfinancial conflicts of interest to report

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Agenda

Part II

12:30-2:00   Dynamic Temporal and Tactile Cueing; Rapid Syllable Transition Training

2:00   BREAK

2:15-3:45   Cueing Late Developing Sounds, Speech Motor Chaining The evidence base of some older and newer approaches,

Q&A

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Motor Learning Principles Summary

TO **ACQUIRE** A SKILL (MOTOR PERFORMANCE)	TO **RETAIN** A SKILL (MOTOR LEARNING)
• Knowledge of performance	• Knowledge of results
• High frequency of feedback	• Lower frequency of feedback
• Immediate feedback	• Delayed feedback
• Many trials per session	• Many trials per session
• Blocked practice	• Random practice
• Constant practice	• Variable practice
• Small stimulus set	• Large stimulus set
• Simple targets	• Complex targets

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Planning Treatment

WHAT to treat
◦ Whole word/phrase (e.g., "Mommy", "Bobby")
◦ Nonword (e.g., "keefida")
◦ Syllable sequence (e.g., /ki/)
◦ Syllable or word shapes (e.g., CVC)
◦ Syllable or word shapes with specified places of articulation (e.g., CVC with *labial – V – Alvoelar* movements)

HOW to treat
◦ Dynamic Temporal Tactile Cueing
◦ Rapid Syllable Transition Training
◦ Speech Motor Chaining
◦ …
◦ We will select approaches today that (a) are free and (b) have some evidence

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Challenge Point Framework

Maximum learning requires challenging the client

Optimum learning is a function of:
◦ Client's skills/knowledge
◦ Information available (feedback from SLP)
◦ Task difficulty (stimuli)

Rvachew & Brosseau-Lapré (2012); Guadagnoli & Lee (2004); Hitchcock & McAllister Byun, 2014

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Challenge Point Framework

We should be constantly adapting the task and the information available to facilitate learning
- But my goal for today is, "Child will produce phrases containing bilabials with minimal cueing."
- This is _not_ flexible!
- We are working toward adaptive paradigms for treatment.

CAS Treatment

A MOTOR LEARNING PERSPECTIVE

CAS Treatment

Dynamic Temporal & Tactile Cueing (DTTC)

Rapid Syllable Transition Training (ReST)

Speech Motor Chaining

Biofeedback

Other "hot topics" in CAS

DTTC

DYNAMIC TEMPORAL & TACTILE CUEING

INTEGRAL STIMULATION

Strand (2019)

DTTC/Integral Stimulation

Emphasize the movement, not isolated sounds

"Listen to me, what me, do what I do."

Increase target complexity
- Start with simple syllables (my, bye, do), progress to harder words (mom, bob, dad, hi), them progress to phrases (e.g., "hi mom")

Within one level of complexity, fade cues (max → min)
- Simultaneous production, direct imitation, delayed imitation, visual cue
- Vary prosody

DTTC/Integral Stimulation
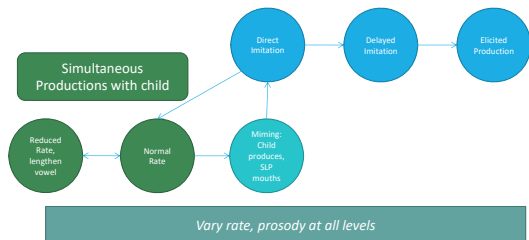
Dynamic framework for intervention

Does not follow prescribed order for each trial

Prosody and rate are modified at all steps

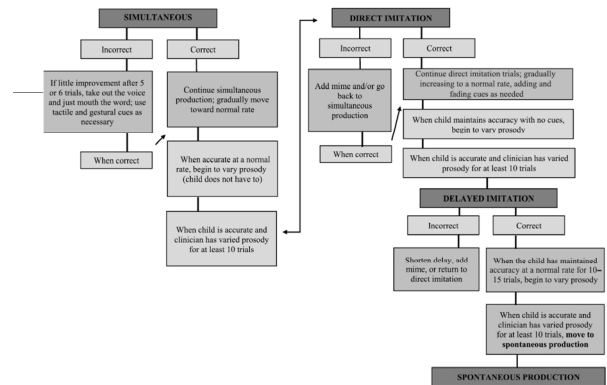Level and type of intervention depends on child's production and what is needed in that moment

DTTC: Levels of Support

Simultaneous Productions with child → Direct Imitation → Delayed Imitation → Elicited Production

Reduced Rate, lengthen vowel → Normal Rate → Miming: Child produces, SLP mouths

Vary rate, prosody at all levels

Examples

SIMULTANEOUS
- Incorrect: If little improvement after 5 or 6 trials, take out the voice and just mouth the word; use tactile and gestural cues as necessary
- Correct: Continue simultaneous production; gradually move toward normal rate
  - When accurate at a normal rate, begin to vary prosody (child does not have to)
  - When child is accurate and clinician has varied prosody for at least 10 trials

DIRECT IMITATION
- Incorrect: Add mime and/or go back to simultaneous production
- Correct: Continue direct imitation trials; gradually increasing to a normal rate, adding and fading cues as needed
  - When child maintains accuracy with no cues, begin to vary prosody
  - When child is accurate and clinician has varied prosody for at least 10 trials

DELAYED IMITATION
- Incorrect: Shorten delay; add mime, or return to direct imitation
- Correct: When the child has maintained accuracy at a normal rate for 10–15 trials, begin to vary prosody
  - When child is accurate and clinician has varied prosody for at least 10 trials, move to spontaneous production

SPONTANEOUS PRODUCTION

DTTC/Integral Stimulation

When the production is incorrect, SLP provides verbal or **quick** tactile cue and moves back a step on the continuum based on the support needed by the child

Uses a small number of stimuli that are presented within modified blocks
◦ 4-7 words produced ~15 – 20 times each
◦ 3 different blocks

Child <u>must</u> be able to imitate

DTTC/Integral Stimulation

Free videos!
https://www.youtube.com/playlist?list=PL922IXvEXgbwuUAonyVdPeVwh441MV5mO

Video examples

Evidence
◦ Strand & Debertine (2000)
◦ Strand, Stoeckel, & Baas (2006)
◦ Strand & Skinder (1999)
◦ Maas & Farinella (2012)
◦ Mass, Butalla, & Farinella (2012)

DTTC/Integral Stimulation
Case Study

You meet Tommy, a 4 year old with severe CAS. Tommy displays the ability to produce CV, CVCV, and a limited range of VC and CVC syllable shapes. While he displays the ability to produce /b, m, p, n, d/ and simple vowels /a, i, u, o/, he does not produce these consistently across contexts. He frequently displays vowel distortions across all syllable shapes, exhibits timing errors (voicing, nasality) and omits final consonants. You decide to try DTTC and target movement gestures for VC and CVC syllable shapes.

What are 2 target words that you could select in treatment that follow VC and CVC shapes and include sounds in his inventory?

Practice DTTC by moving up and down the cueing hierarchy – one person is the client, another the SLP. Be adaptive!
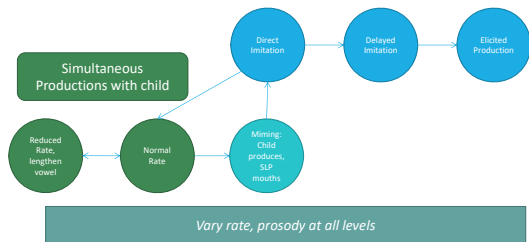

Target Summary

	Bilabials	Labio-dental	Inter-dental	Alveolar	Palatal	Velar	Glottal
Nasals	m			n		ŋ	
Stops	p b			t d		k g	
Fricatives		f v	θ ð	s z	ʃ ʒ		h
Affricates					tʃ dʒ		
Liquids				l	r		
Glides	w				j		

Vowels:
/ɑ/
/i/
/u/
/o/

Syllables:
CV
CVCV

Emerging:
VC
CVC

DTTC: Levels of Support

ReST

RAPID SYLLABLE TRANSITION TRAINING

Rapid Syllable Transition Tx (ReST)

A program designed to adhere to motor learning principles for CAS

Feedback/training focuses on

(a) articulatory accuracy (**SOUNDS)**

(b) appropriate stress **(BEATS)**

(c) smooth syllable transitions (**SMOOTHNESS)**

Rapid Syllable Transition Tx (ReST)

Select 20 nonsense words appropriate for the client
◦ 10 beginning with stressed syllable (e.g., DInarop)
◦ 10 beginning with unstressed syllable (e.g., reGLIsion)
◦ Phonemes already in client's inventory

Rapid Syllable Transition Tx (ReST)

Pre-practice (about 10 minutes)
◦ Focus on performance/acquisition
◦ Blocked practice
◦ Immediate KP feedback on all trials
◦ Teach concept of **sounds**, **beats**, **smoothness**
  ◦ "Correct" trials must be correct in all 3 aspects
◦ Pre-practice ends when the client has 5 correct productions
  ◦ Sessions 1 & 2 allow for 20 minutes of pre-practice to teach these concepts; if pre-practice exceeds 20 minutes without 5 correct, move to 2-syllable words

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Don't forget Prosody!

Contrast stressed and unstressed syllables
  (big blocks vs. little blocks)
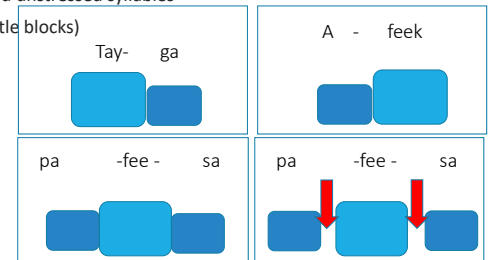
Rapid Syllable Transition Tx (ReST)
Pre-practice Example

Target	Child's Response	SLP Feedback
DInarop	**DINAROP**	"The beats weren't right"
DInarop	**DI**nawop	"The /r/ wasn't right"
DInarop	**DI**narop	"Good. You got the sounds, and beats, and it was smooth!"
a**REE**low	a . **REE** . low	"You didn't connect all the sounds. Keep it smooth, no pauses"
a**REE**low	a**REE**low	"Good. You got the sounds, the beats, and it was smooth."

Rapid Syllable Transition Tx (ReST)

Practice (motor-learning focused)
- 20 nonsense words are randomized
- Only delayed knowledge of results feedback
  - "Good" or
  - "Not that time."
- Feedback frequency is reduced throughout practice
  - 18/20 items, then 14/20 items, then 10/20 items, then 6/20 items, then 2/20 items
  - On average, feedback (delayed KR) is given on 50% of trials per session

Rapid Syllable Transition Tx (ReST)
Practice Example

Target	Child's Response	SLP
gra**DAY**miture	gra**DAY**miture	(delay) "Good."
a**REE**low	a . **REE** . low	
DInarop	**DINAROP**	(delay) "Not quite that time."
re**GLI**sion	we**GLI**son	

Rapid Syllable Transition Tx (ReST)

How are pre-practice and practice different?

What principles of motor learning do you see in practice?

Nonsense words are treatment target (use written stimuli). Thoughts?

Rapid Syllable Transition Tx (ReST)

FREE materials, manuals, training videos, syllable generator:

http://sydney.edu.au/health-sciences/rest/resources.shtml

THE UNIVERSITY OF SYDNEY

Is ReST appropriate for my client?

ReST Candidacy questionnaire from the ReST website

Child and Family suitability questions	Y/N
Does the child have a diagnosis of CAS?	
Aged 4 -13 years old?	
If 4-5 years old	
- is the child resilient? Do they tolerate some level of failure without giving up?	
- has the child had at least one block of therapy previously or started formal schooling?	
Does the child have at least 4 consistent consonants?	
Does the child have at least 4 consistent vowels?	
Is CAS the only significant developmental diagnosis?	
Can the child tolerate about 10 minutes of drill therapy?	
Can the child tolerate a 50-60 minute speech therapy session?	
Can your child tolerate getting things wrong?	
Can you as a parent tolerate your child getting things wrong?	
Can the child have treatment by a clinician at least twice sessions a week, for 12 sessions?	

Clinician suitability questions	Y/N
Can you stick to a set program?	
Are you resilient to children having limited success in the early stages of therapy?	
Could you give feedback on only some of the child's productions?	
Can you take clinical data before treatment, every 4 sessions and after treatment on real words to check the work you are doing in ReST therapy is making a difference to the child's everyday speech?	

Rapid Syllable Transition Tx (ReST)

Has been used with children ages 4-13 years

Evidence
◦ Ballard, Robin, McCabe, & McDonald (2010)
◦ Thomas, McCabe, Ballard (2014)
◦ Murray, McCabe, & Ballard (2015)
◦ Thomas, McCabe, Ballard, & Lincoln, (2016)

Rapid Syllable Transition Tx (ReST)
Case Study

Tommy is now a third grader. He has mastered most of the "early 8" and "middle 8" phonemes. However, he is inconsistent on (but stimulable for) /ʃ, tʃ, dʒ/. He is not stimulable for /r, l, s, z/. He has frequent errors on lexical stress and he often separates syllables.

You decide to try ReST
1. What are three appropriate 3-syllable nonsense words
2. Teach *sounds, beats, smoothness* in these nonsense words in Pre-practice
3. Now try Practice on these 3 nonwords
   ◦ Randomize, only KR feedback. Reduce feedback!

Independent analyses may help you describe inventory

	Bilabials	Labio-dental	Inter-dental	Alveolar	Palatal	Velar	Glottal
Nasals	m			n		ŋ	
Stops	p b			t d		k g	
Fricatives		f v	θ ð	s z	ʃ ʒ		h
Affricates					tʃ dʒ		
Liquids				l	r		
Glides	w				j		

Possible ReST Targets

		goomisher	shagoibee
		bashoimee	mabeener
shoibeger	shegooner	goibishee	geboishee
shaboimer	moobesher	goimeber	boosheger
megoonee	boishimer	begoisher	gemoibee
mooshaber	boigermee	goimesher	begooshee

Case Study

Tommy is now a 7th grader. His prosody is pretty good although there are still some occasional errors in stress and/or instances of syllable segregation.

He is not yet stimulable for /r/, /s/, /l/

How do you teach these sounds?

Cueing Late-Developing Sounds

MAKING SURE YOUR PRE-PRACTICE AND YOUR KNOWLEDGE OF RESULTS FEEDBACK IS SPECIFIC!

Be Specific in Your Cues

Avoiding cueing "move your tongue."

Be specific. The tongue is 3 dimensional and has functionally distinct parts.
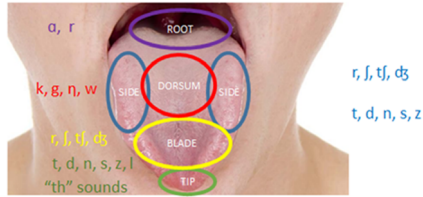
α, r

ROOT

k, g, ŋ, w   SIDE DORSUM SIDE   r, ʃ, tʃ, dʒ

t, d, n, s, z

r, ʃ, tʃ, dʒ
t, d, n, s, z, l   BLADE

"th" sounds   TIP

Be Specific in Your Cues: /r/

	Know the phonetic requirements of the sound	Have a good guess at what your client is doing wrong

	Correct /r/	Distorted /r/
Front of tongue (tip, blade, anterior dorsum)	Up off floor of mouth toward hard palate	Too low
Posterior tongue dorsum	Low	Too high
Tongue root	Back in pharynx	Not retracted
Sides of tongue	Against back teeth	Lacking lateral contact

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Be Specific in Your Cues: /r/

Tongue-palate contact

Correct /r/
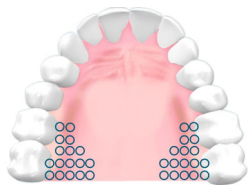
Tongue shape

Correct /r/

Image: Boyce (2015)

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These ultrasound images of the tongue are from
a 7 year old with a derhoticized /r/ and /ɝ/.

Notice the front of the tongue stays low during the rhotic sound.
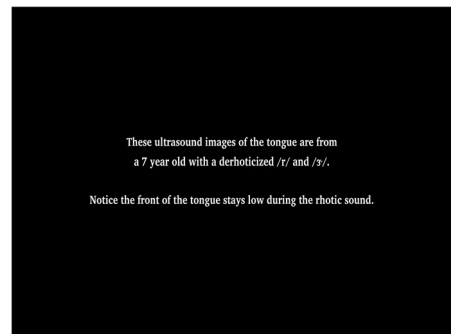
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Be Specific in Your Cues: /r/

	Phonetic Placement Cue	Shaping
Front of tongue (tip, blade, anterior dorsum)	Lift the front of the tongue up off the floor of the mouth	/l/ → /r/ to encourage elevation of front of tongue
Posterior tongue dorsum	Pull the back of the tongue down and back into your throat	/ɑ/ → /r/ to encourage low dorsum & tongue root retraction
Tongue root		
Sides of tongue	Feel the sides of the tongue against the back molars	/ʃ/ → /r/ or /i/ → /r/ to encourage elevation of sides of tongue

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Be Specific in Your Cues: /r/

Analogies

Boat

Bird

Marble

Camel
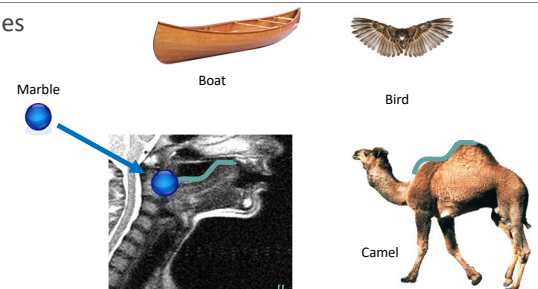
Be Specific in Your Cues

Use visual strategies to help children understand phonetic placement
- https://www.seeingspeech.ac.uk/ipa-charts/
- Sagittal ultrasound and animated images show children where the tongue should be in the mouth and what approximate shape
- Electropalatography images show where tongue contacts the hard palate

Be Specific in Your Cues: /s/
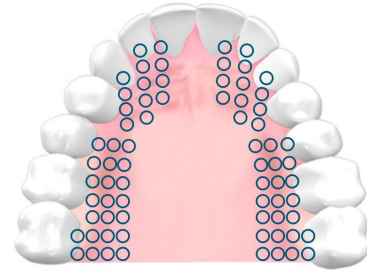
Be Specific in Your Cues: /s/

	KNOW THE PHONETIC REQUIREMENTS OF THE SOUND	HAVE A GOOD GUESS AT WHAT YOUR CLIENT IS DOING WRONG	
	Correct /s/	**Lateralized /s/**	**Dentalized /s/**
Front of tongue (tip/blade)	Tip up to alveolar ridge forming a groove OR Tip down, blade up to alveolar ridge forming a groove	Tip up to alveolar ridge No groove	Tip or blade up against teeth (too far forward) Very minimal groove (too shallow/skinny)
Sides of tongue	Against back teeth	Lacking lateral contact	Against back teeth

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Be Specific in Your Cues: /s/

Cues for lateralized distortions of /s/, /z/, /ʃ/, /tʃ/
- Lift sides of the tongue up
- Press sides of the tongue against back teeth (molars)
- Air should go down the center of the tongue, not out the sides
- Make a groove in the middle of the tongue

Be Specific in Your Cues: /l/

Press the tip behind the top front teeth only

Speech-Motor Chaining

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Speech Motor Chaining

Core syllable patterns: CC, VC, CC

Core syllable is targeted, then build around it
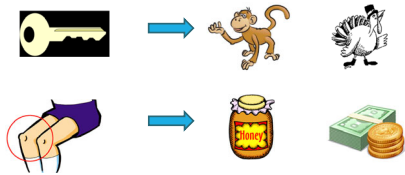
Young (1987)

Speech Motor Chaining

Forward Chaining
- /re/ → raid → radio → radio station
- /lo/ → load → loading → loading the truck

Backward Chaining
- /ro/ → rose → arrows → shoot the arrows
- /ɪtʃ/ → witch → sandwich → make a sandwich

(cf. Preston et al., 2013, 2014)

Speech Motor Chaining
General Session Structure

Pre-practice – Focus on *acquisition* of target syllable
- Cue, cue, cue, cue
- Feedback, feedback, feedback, feedback
- Make it easy. Give lots of help. Aim for success

Practice – *practice* the target
- Less cueing/feedback
- Make it systematically harder (but achievable)
- Aim to challenge the child. Some errors are okay.
- Focus on *motor learning*

Preston, Leece & Storto, 2019

Speech Motor Chaining
Pre-Practice Structure

Focus on *acquisition* of target syllables, achieve stimulability

We aim for 12 correct productions of a sound in multiple examples of a syllable position (3 correct in each of 4 contexts)
- Ex: Target /r/ onset: /re/ /ro/ /tr/ /br/
- Ex: Target /s/ coda: /is/ /es/ /ps/ /ts/

Strategies
- Phonetic Placement Cueing
- Facilitating Contexts
- Shaping

Preston, Leece & Storto, 2019

Speech Motor Chaining
Practice Conditions

Increasing complexity in 5 levels
- Syllables → monosyllabic words → multisyllabic words → phrases → sentences
- All in one session, if possible

Reducing amount of feedback

Changing type of feedback

Encouraging self-monitoring

Adding prosodic variation
- Varied rate (fast, slow)
- Varied loudness (loud, whisper)
- Varied intonation (rising, falling)

Preston, Leece & Storto, 2019

Speech Motor Chaining Practice Conditions

Practice occurs in blocks of 6 consecutive attempt

Decision is made after 6 attempts:
- Do I make the task harder?
- Do I make it easier?

We use 5/6 correct as our criteria for advancing

Preston, Leece & Storto, 2019

Speech Motor Chaining
Sample Data Sheet

Speech Motor Chaining
Video Examples

Speech Motor Chaining
Free Resources

Manuscript, sample speech motor chaining data sheet, video examples freely available https://osf.io/5jmf9/

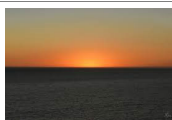Chaining Website https://chaining.syr.edu/SpeechMotorChaining
  Including help videos:
  http://speechproductionlab.syr.edu/Chaining%20Help.html

Case Study

Tommy is now a 8th grader. His is still not yet stimulable for /r/, /s/, /l/

How do you teach these sounds?

Biofeedback Approaches

ON THE HORIZON

Ultrasound biofeedback training

Ultrasound may be a useful biofeedback tool for correcting certain errors on lingual phonemes
  ◦ Liquids /r, l/
  ◦ Lateralized sibilants
  ◦ Velars
  ◦ Alveolars
  ◦ Vowels

*For CAS, ultrasound may give clients additional information about sequencing skills

What is ultrasound biofeedback and why might we want to use it?
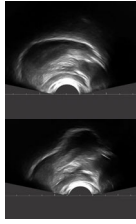
Ultrasound visualization of the tongue in real-time

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What is ultrasound biofeedback and why might we want to use it?

Facilitate Acquisition

Teach stimulability for new sounds

Provide detailed feedback about tongue movements (Knowledge of Performance feedback)
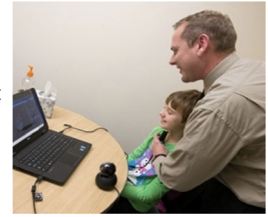
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Interpreting the Images: Sagittal view

Images courtesy of Suzanne Boyce
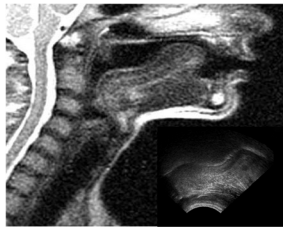
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Alveolar Consonants

What do you expect to see happening?

/t, d, n/
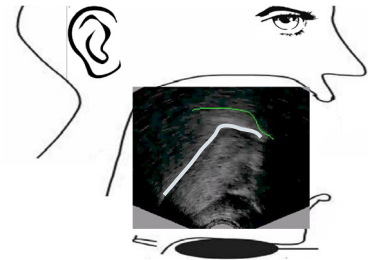
65

Velar Consonants

What do you expect to see happening?

/k, g, ŋ/

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/k/ and /l/ isolation, clusters
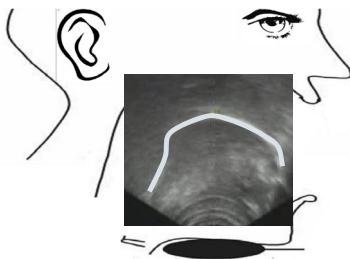
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Rhotic sounds /r/

English /r/ has a complex articulatory configuration consisting of **two major tongue constrictions**:

1. Anterior (oral)
2. Posterior (pharyngeal)
3. A "drop" or "dip" between 1 and 2
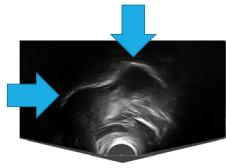
Sagittal view
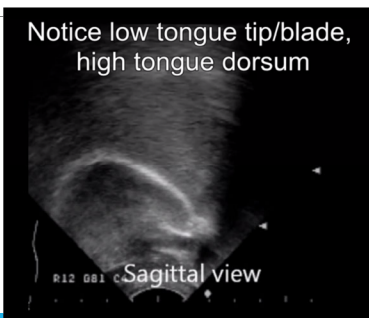Bunched /r/

Dorsum   Blade/Tip
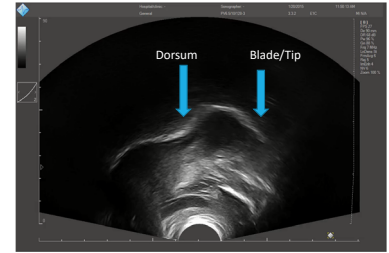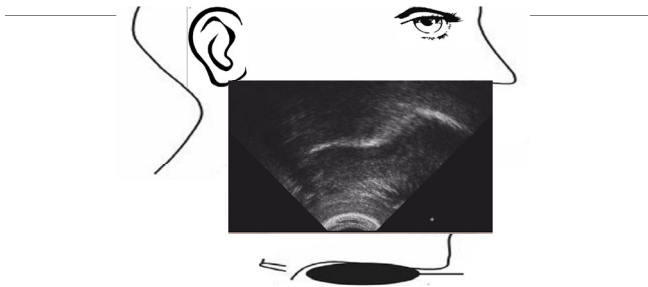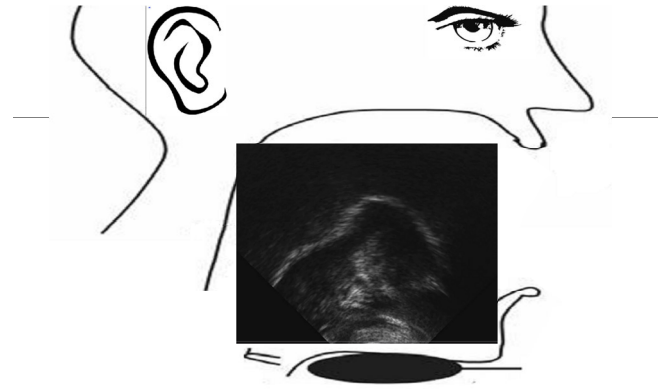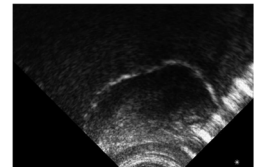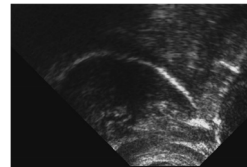

Distortion

Notice low tongue tip/blade, high tongue dorsum

R12 GB1 C   Sagittal view

Which do you think is "correct" /r/?

Which do you think is "correct" /r/?

Which do you think is "correct" /r/?

Which do you think is "correct" /r/?

Tutorial on /r/ (Preston et al, 2020) https://pubs.asha.org/journal/lshss

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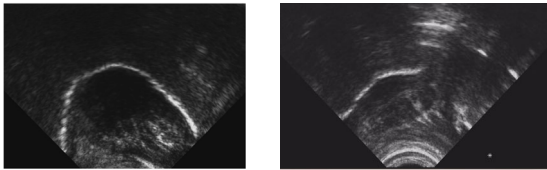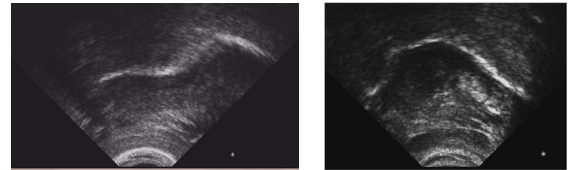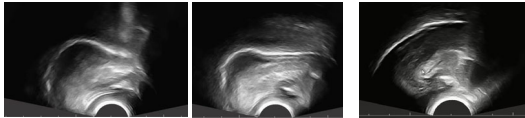
Ongoing efforts

Study in Syracuse testing whether ultrasound biofeedback improves treatment outcomes for kids with CAS
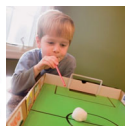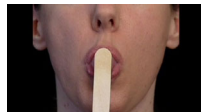
- Visual feedback can be used for /r, l, s, z, k, g, n, t, d, ʤ, ʧ, ʃ/

Also testing the effects of intensive therapy vs. traditional scheduling

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Other current topics in CAS

Non-speech Oral Motor Exercises to address speech?

Summary

Consider incorporating Principles of Motor Learning into treatment to facilitate generalization

- DTTC can be an effective approach for moderate to severe CAS
- ReST may be appropriate to address prosody and transitioning between sounds and syllables in moderate CAS
- Speech motor chaining (with or without ultrasound) may help establish consistent speech sounds or syllable transitions in varied stress patterns for mild or moderate CAS

Keep up the great work!

PhDs are always needed!

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The tools are only as good as the hands that wrap around them; you are the craftsman.
-John Eick