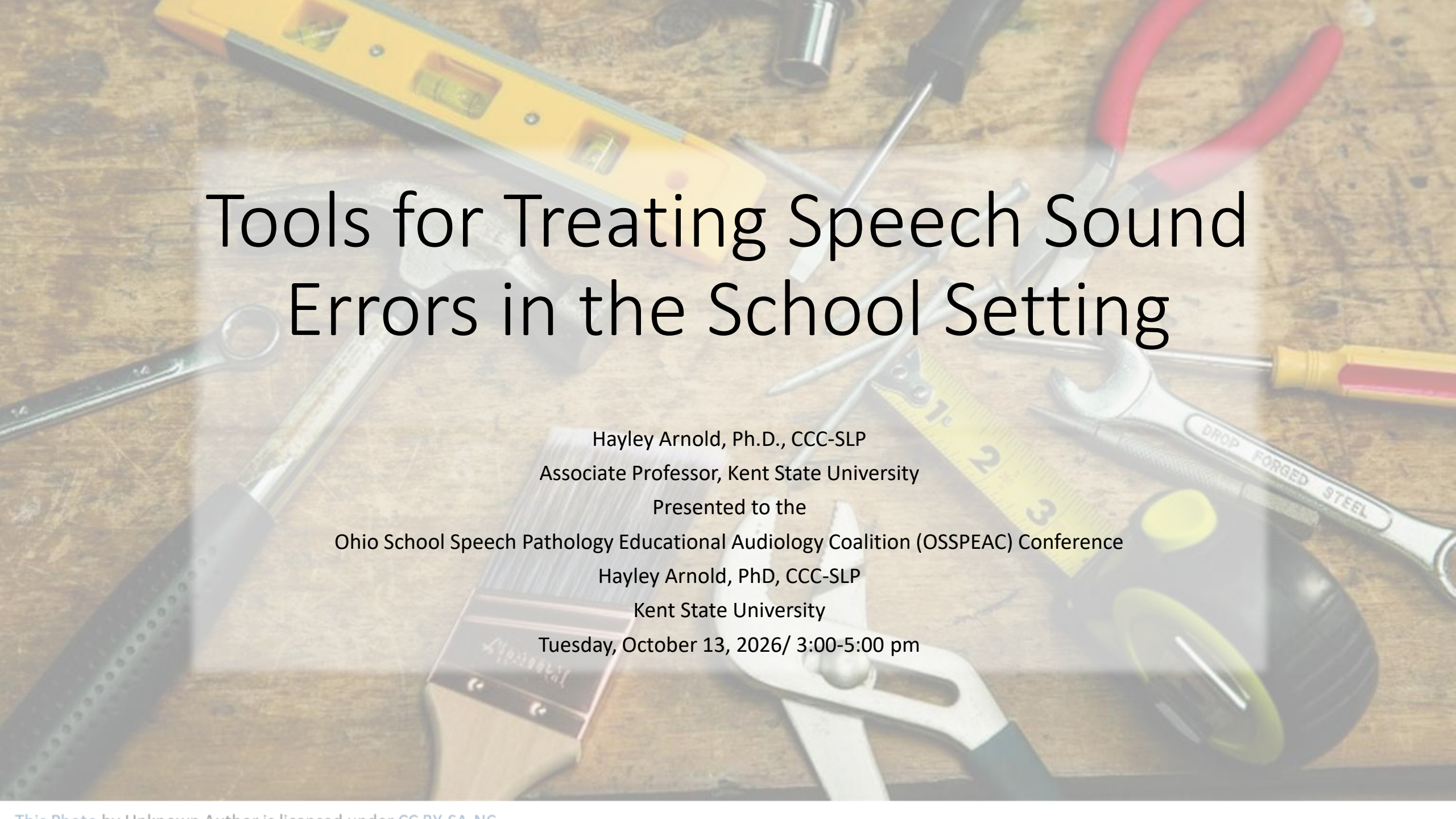




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Tools for Treating Speech Sound Errors in the School Setting

Hayley Arnold, Ph.D., CCC-SLP

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Presented to the

Ohio School Speech Pathology Educational Audiology Coalition (OSSPEAC) Conference

Hayley Arnold, PhD, CCC-SLP

Kent State University

Tuesday, October 13, 2026/ 3:00-5:00 pm

What we'll cover in this session

- Role of school-based speech-language pathologists in treating speech sound errors
- Service delivery model options
- Addressing multiple sound errors and poor intelligibility – target selection and norms
- Tools for eliciting rhotics and sibilants
- Tools for treating childhood apraxia of speech (CAS)

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Why it is important to attend to speech sound errors



- Concerning trend regarding service provision to children with one or a few speech sound errors – not treated if that is their only area of impairment
- However, research shows these children often have encoding, spelling, and social-pragmatic deficits (Fuquharson, 2018)
- Children with one sound error often...
 - have difficulty in the classroom
 - with social relationships (children with errors at 8 and above experience stigma from peers and teachers)
 - with literacy skills
 - with vocational outcomes(see Fuquharson, 2018, for review)
- By denying services for these children or keeping our assessment protocol too narrow, we miss potentially critical skills for educational success.

Consider overlaps and non-overlaps in our
scope of practice

Social Pragmatics

Literacy

Language

Speech Sound Delays and Disorders

Case Study Example (Fuquharson, 2019)

- Six-year-old with single sound of /r/ in error
- Standard score of 85 on the Arizona Articulation and Phonology Scale (AAPS) – Fourth Edition. The test categorizes this as “speech is intelligible, though noticeably in error”
- However,
 - AAPS (and most tests) based on single-word productions, which are not ecologically valid. Measures of conversational (connected speech) are more appropriate for assessing speech intelligibility
 - /r/ is one of the most frequently produced sounds in English (along with /s, t, l, n/), which means errors will have a larger impact on intelligibility than other sounds
 - Continuing to produce the sound incorrectly for years - “Neurons that fire together, wire together” – Hebb. The AAPS does not tell us how the error is impacting the child socially or academically (both social and academic skills are deemed of educational relevance by federal IDEA).
- Federal IDEA law indicates no single measure can be used to determine eligibility for services; however, the practice of using single-word standardized tests for the purpose continues.

Assessment Considerations

- In addition to a single-word naming articulation test, assess a conversational speech sample representative of the child's everyday communication (assess intelligibility, accuracy, phonological process errors).
- Include formal and informal assessments of phonological awareness. Formal tests include the [Comprehensive Test of Phonological Processing-2nd Ed \(CTOPP-2\)](#). Informally, can assess child's ability to rhyme, segment and blend, use elision, repeat nonwords, digit span (memory), rapid symbolic and non-symbolic naming.
- Use this freely available tool to assess social-emotional impact- Speech Participation and Activity of Children (SPAAC) https://arts-ed.csu.edu.au/data/assets/pdf_file/0005/227660/SPAAC2.pdf

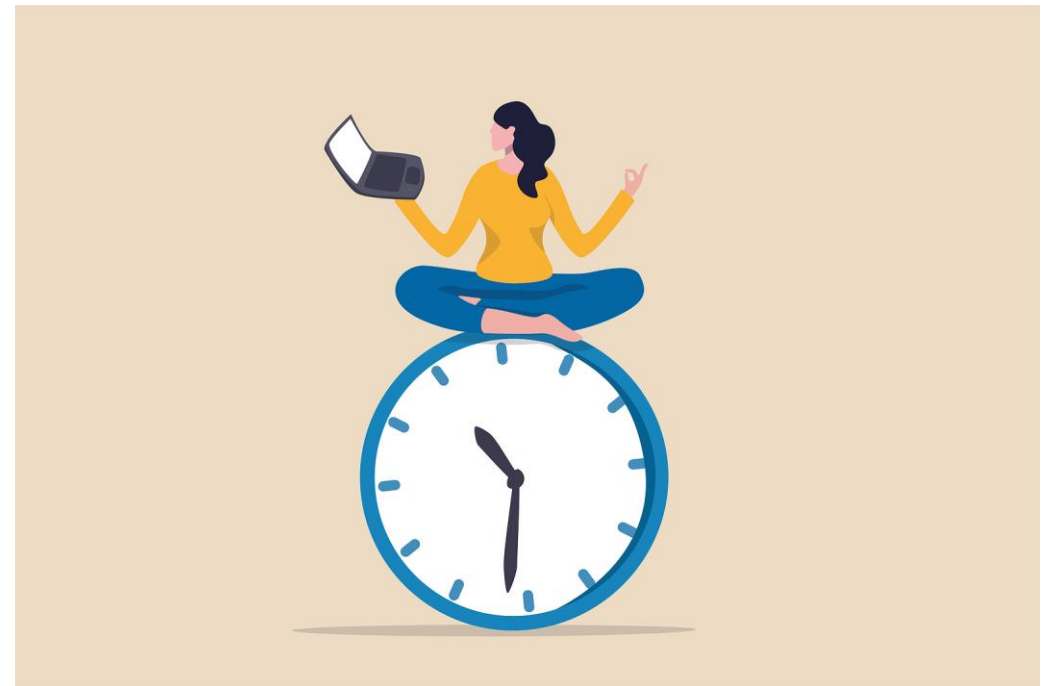
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Challenges in the school setting

- Time management is indicated as the most common challenge for school-based SLPs
- Attempting to meet the varied needs of the entire caseload
- Working around the schedule of each school day
- Making sure students do not miss out on valuable classroom instruction



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Consider dosage rather than time

- Dose: The number of properly administered teaching episodes during a single intervention session (e.g., 50 production trials or 60 mispronunciation detection trials)
- Dose is an aspect of intervention that SLPs have the most control over
 - Studies show that a dose of at least 50 trials per 30-min session is required for the intervention to be effective (double that number to 100 trials for childhood apraxia of speech, CAS)
- Dose frequency: Evidence indicates that shorter, more concentrated intervention sessions are more effective than longer, more dispersed sessions
- Total intervention duration: Studies indicate a total of 20 hours is minimally needed

See for review, Brosseau-Lapre & Greenwell (2019)

Rethinking 20-30 min group sessions

- 2022 ASHA Leader article by BeckyAnn Harker from Austintown, OH, [“Can We Break From 30-Minute Group Sessions in Schools?”](#)
- The 30-min twice a week model resembles private clinics and is not necessarily the best for school settings.
- Research has shown that shorter, more frequent, individual bouts of speech sound therapy are as effective as longer, group-level sessions (Byers et al., 2021).
- One report indicated that mild speech sound errors in 75% of students with mild impairment could be treated effectively within 8-16 weeks, during 4 day a week, 5-7 min individual sessions (Kuhn, 2006).

Research Article

A Comparison of Intervention Intensity and Service Delivery Models With School-Age Children With Speech Sound Disorders in a School Setting

Beth A. Byers,^a Monica L. Bellon-Harn,^{a,b}  Madeline Allen,^a Karen Whisenhunt Saar,^a
Vinaya Manchaiah,^{a,b}  and Hansapani Rodrigo^c

Byers et al. (2020) Method

- Over a six-week period, researchers compared
 - Business as usual (BAU) service delivery model (30 min, 2 x per week, 3-4 participant group)
 - Experimental (EXP) model involving shorter, more frequent, individual bouts (5 min, 3 x per week, individual).
- Participants: 11 K-3rd grade students, with mild to moderate speech sound disorders, were randomly assigned to each group (11 BAU and 11 EXP). These students...
 - Had two or more speech sound errors based on developmental norms and age range of acquisition of sounds
 - Scored a percentile rank of 16 or below on the AAPS-3,
And/or
 - Had below age-level percent consonants correct (PCC) derived from a spontaneous speech sample
 - Normal performance on language assessment, no outside speech tx
- Measures included
 - Gains on pre- post probe measures: 10 exemplars for each target sound
 - Dose, defined as therapeutic input and number of production trials
 - Cumulative intervention intensity, defined as the product of Dose × Session Frequency × Total Treatment Duration

Byers et al. (2020) Results

- Gains on pre- post probe measures: 10 exemplars for each target sound: Both groups made significant gains, but BAU and EXP had similar gains
- Dose, defined as both therapeutic input and number of production trials, was significantly higher for the BAU (Mdn 62 trials per 30 min group session), compared to the EXP group (Mdn 41 trials per 5 min individual session)
- Dose, when only defined by therapeutic input, was not significant different between BAU (Mdn:363) and EXP (Mdn: 513)
- Cumulative intervention intensity, defined as the product of Dose $\times$ Session Frequency $\times$ Total Treatment Duration: BAU (Mdn 702) and EXP (Mdn 762) did not have differences in cumulative intervention intensity.

Bottom Line of Byers et al. (2020)?

- Elementary aged children with mild to moderate SSD receive similar gains from shorter, more frequent, individual sessions compared to longer, less frequent, group sessions.
- This means students can receive comparable benefit without significant removal from other instructional activities. The BAU students missed 4.5 more hours of classroom instruction than the EXP students over the 6-week period.
- Six of the 22 participants in this study had not previously received services – results point to extending these shorter, more frequent sessions to response-to-intervention (RTI) models.

What might this look like?

	Monday	Tuesday	Wednesday	Thursday	Friday
8:30-9:00	Mr. Mustard (5 min artic-JC,VG,AH)	High School	Ms. Ruby (AD, TC artic/RTI artic) (KS - lang pull-out)	High School	Ms. Ruby (AD, TC artic/RTI artic)
8:15					
9:00-9:30	(testing)				(testing)
9:15					
9:30-10:30	Mrs. Peacock (AA, HK, DH, BS, AW artic/lang) in class &/or pull-out		Mrs. Peacock (AA, DH, BS artic or make-up)		Miss. Plum (KR- lang, CC RTI-artic)
9:45					
10:00			Ms. Citrine self-contained (JD, MS, TV, SW, AW - in class, small group)		Miss Scarlet (LB, KB, DJ, TS, DS lang, in-class or pull-out)
10:15					
10:30					
10:45					
10:50-11:20	Mrs. White (JG-artic)		Ms. Buttercup (NK- land pull-out, HH artic, TA RTI-artic)	Mrs. White (JG-artic)	
C wing interv block	Ms. Buttercup (HH-artic)				Ms. Buttercup (HH-artic)

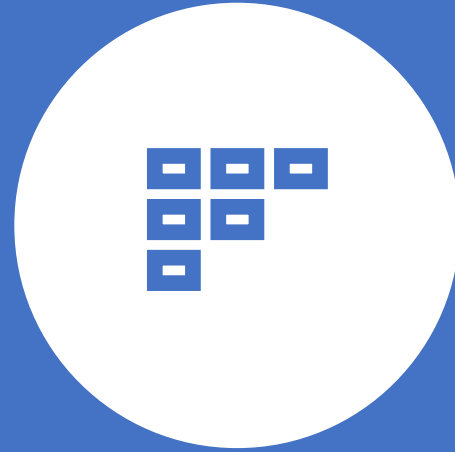
What about inclusion/“push-in” services?

- IDEA policy supports this model as it requires students are served in the least restrictive environment and encourages including them in the regular education environment, if appropriate.
- Inclusive services also dovetail nicely with our field’s increase emphasis on interprofessional practice (IPP).
- However, evidence is scarce and what does exist is mixed on effectiveness.
- Survey data from TX school SLPs in 2019 indicate that inclusion speech-language services are used minimally, with half the respondents reporting that they serve 1-25% of their caseloads with inclusion models, with most being focused on social pragmatics and language skills.
- Challenges to this approach were that SLPs did not perceive them to be effective, found it difficult to find time to plan and collaborate with teachers.

(see Green et al., 2019, for review and survey findings)



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What service delivery models
have worked for you?

What we'll cover in this session

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-  • Addressing multiple sound errors and poor intelligibility – target selection and norms
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Intelligibility – What is typical?

Intelligibility, or ability to understand the speaker, is highly influenced by listener familiarity with the speaker and context (topic). Not to be confused with sound accuracy (e.g., Goldman-Fristoe Intelligibility Index does not measure intelligibility)

What we were always taught –

Norms: To age 4 years (Copland & Gleason, 1988)

Intelligibility = $\text{Age}/4 * 100$

- 50% at age 2
- 75% at age 3
- 100% at age 4

Study by Hustad and colleagues (2021) indicated that above norms are probably about a year ahead of what is accurate.

Hustad et al. (2021) intelligibility norms

Table 4. Mean observed intelligibility scores and standard deviations by age for single-word and multiword intelligibility.

Age (months)	Children <i>n</i>	Single-word intelligibility (%)		Multiword intelligibility	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
30–35	57	51.5	15.8	48.8	19.6
36–47	108	63.5	13.0	67.4	17.0
48–59	112	73.7	10.9	83.2	10.6
60–71	103	79.8	8.8	89.8	6.9
72–83	101	83.6	7.2	94.5	3.8
84–95	23	83.3	8.6	96.0	3.7
96–119	34	86.6	5.9	97.7	1.3

Note. We collapse across older age bands because of sparser sampling in those bands.

Listeners were untrained, unfamiliar adults listening to the samples without context. The models the children repeated after were edited out of the audio – this is hardly practical for most SLPs!

However, the typical SLP may be able to replicate this procedure by audio recording a child producing a standard sample such as telling about a book, then having a colleague transcribe orthographically all that was understood to obtain a roughly comparable sample. Could use Sounds-In-Sentences in the Goldman Fristoe (but not the Intelligibility Index).

Copeland and Gleason would have this group at 100% intelligibility

Speech sound norms

Table 1.7 Comparison of the age of acquisition (90% criterion) for consonants across three studies of English-speaking children

Average age (years;months)	McLeod & Crowe (2018)	Crowe & McLeod (2020)	Shriberg (1993)
Sample	Eight studies of typically developing English-speaking children from 6 countries*	Thirteen studies of 18,187 typically developing English-speaking children from United States	One study of 64 children with speech sound disorder from United States
2;0–2;11	/p/	/b, n, m, p, h, w, d/	
3;0–3;11	/b, m, d, n, h, t, k, g, w, ŋ, f, j/	/g, k, f, t, ŋ, j/	Early 8: /m, b, j, n, w, d, p, h/
4;0–4;11	/l, dʒ, tʃ, s, v, ʃ, z/	/v, dʒ, s, tʃ, l, ʃ, z/	Middle 8: /t, ŋ, k, g, f, v, tʃ, dʒ/
5;0–5;11	/ɹ, ʒ, ð/	/ɹ, ð, ʒ/	Late 8: /ʃ, θ, s, z, ð, l, ɹ, ʒ/
6;0–6;11	/θ/	/θ/	

*This is a subset of the complete sample of 64 studies of children from 31 countries speaking 27 languages.

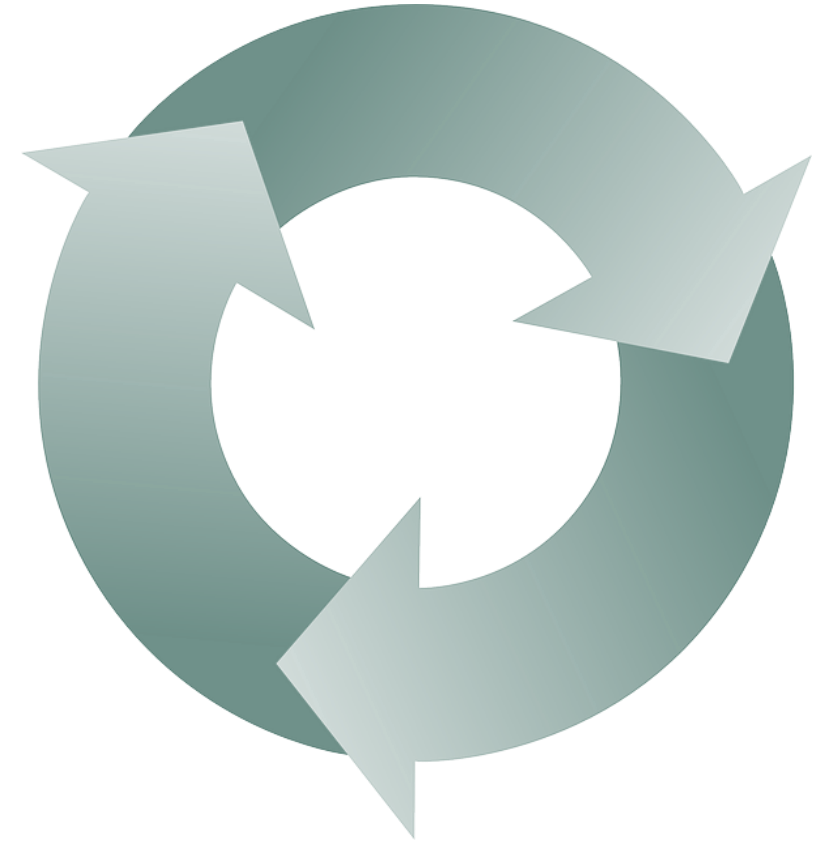
Sources: Crowe & McLeod (2020); McLeod & Crowe (2018); Shriberg (1993).

From Williams et al. (2021)

Cycles Approach

(Hodson and Paden, 1983, 1991)

- Phonological patterns trained in finite period, then a new pattern is trained
- Rotation or cycling of treatment targets is not contingent on mastery (percent accuracy)
- Each period of treatment stimulates emergence of the speech sounds or patterns
- Specifically designed for children with low intelligibility



Cycles Target Selection:

Walk through the steps

1. Frequency of Error Occurrence (>40% frequency of occurrence)
2. Developmental Appropriateness (choose early disappearing processes with /s/ clusters and liquids only late-acquired targets in first round)
3. Phoneme accuracy by word position (eliminate targets if they or their cognates correct at least once)
4. Stimulable sounds (liquids are exceptions)

MOST
KNOWLEDGE
Easy, early
developing
stimulable

LEAST
KNOWLEDGE
Difficult, later
developing,
non-stimulable



Strategic set of targets



Address phonological processing and perceptual skills – critical for literacy

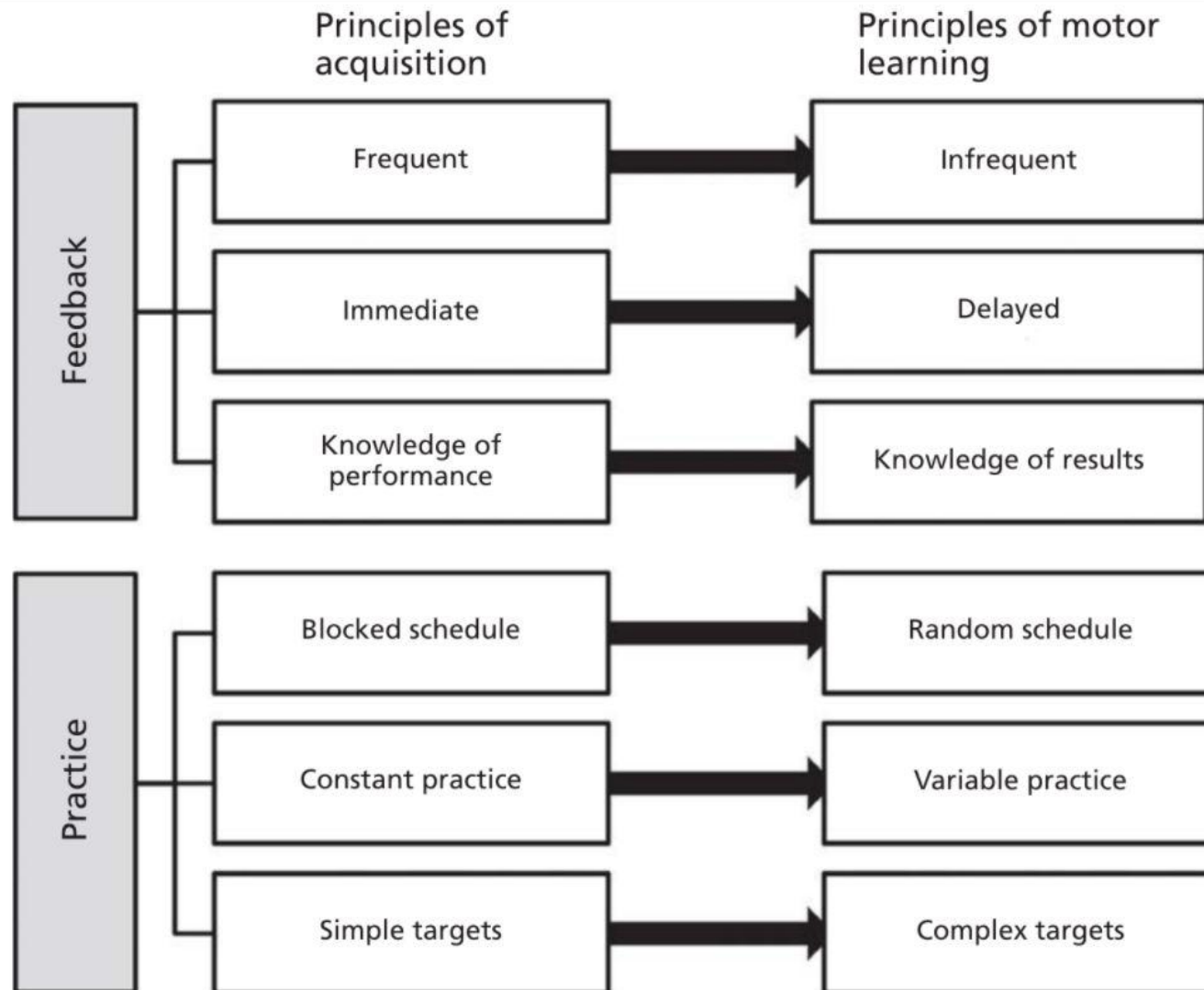
- Phonological processing skills: Rhyming, syllabification, segmentation, blending, elision, nonword repetition, etc.
- Perception of errors, their own as well as your/others' errors.
- Can increase the child's perception of the targets using an FM system (pocket talker) or other amplification – want to avoid modeling a distorted, over-articulated sound (e.g., /s/)

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Principles of Motor Learning

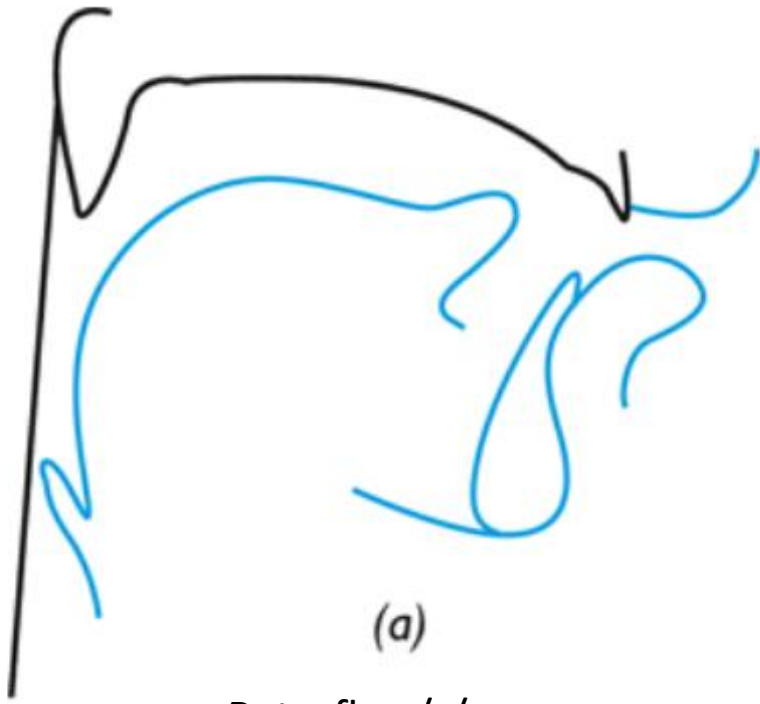


- Acquisition vs. Generalization (check terms)
- Feedback: Knowledge of Results vs. Knowledge of Performance

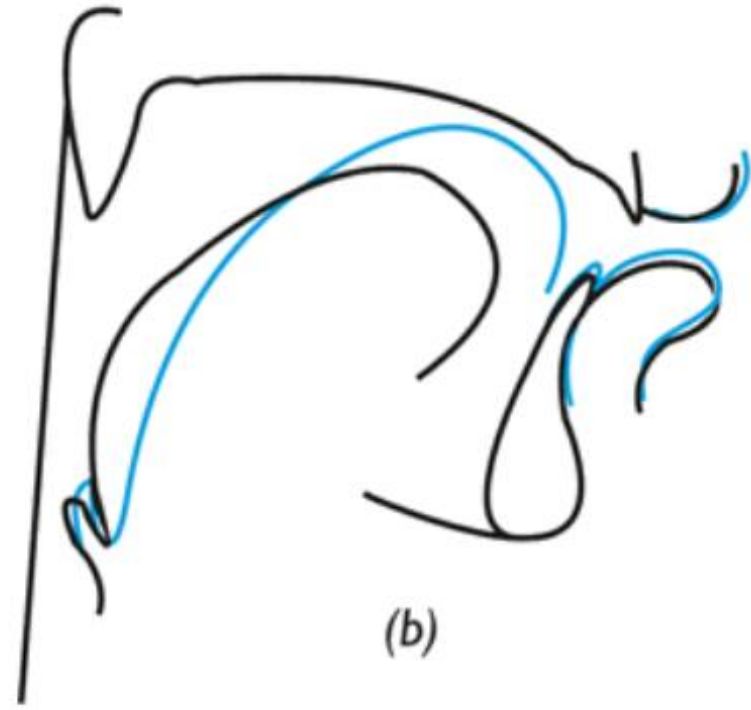
Figure from Preston & Leece (2021)

Strategies for /r/ or /ə/

- What have members of this group found to be effective?



Retroflex /r/



Bunched /r/ in two different vowel contexts

Strategies for vocalic /ə/, /ɜ/, /ɪr/, /ɛr/, /or/, /ɑr/

- Retroflex: lips rounded slightly, tongue tip raised either toward alveolar ridge or curled back toward the alveolar ridge > have client touch or approximate the tongue tip to the alveolar ridge then tip slightly back.
- The sides of the tongue touch the insides of the upper molars > Have them “put the tongue to bed on the ceiling”
- Retroflexed Have them glide or “sweep” the tongue forward and backward between the alveolar ridge and the palatal area. Then, with slightly open mouth posture, have them do so without touching their tongue to the palatal area. May need to encourage more tension in the tongue – can have them push against a table, etc.

From Bleile (2018) and Bauman-Waengler (2020)

Strategies for eliciting the bunched variety

- Bunched: lips rounded slightly, tongue tip lowered, tongue body bunched up near the palate > have client touch or approximate the tongue tip to the lower gums.
- The sides of the tongue touch the insides of the upper molars > Have them “put the tongue to bed on the ceiling” – can also have them articulate /d/ so they can feel the tongue bracing against the upper molars, then lower tongue tip, leaving the back of the tongue in the same position.
- Then move entire body of tongue, including the tip, posteriorly – can use tongue depressor horizontally to assist
- Key environment: Single stressed syllable as in girl. Can also try growling and the “pirate sound” “arr” – avoid labial contexts if client gliding to [w]

From Bleile (2018) and Bauman-Waengler (2020)

- “KARLA” Method: Uses facilitative contexts (see next slide for demonstration)

KARLA Method

Demonstrated by
Pepper Richardson:
<https://youtu.be/yXsf6k5F2l0?si=x0ldlkGC7-gLrsla>



Eliciting rhotics and sibilants

Strategies for consonantal /r/

- Begin teaching /r/ through vocalic /ə/, then “chain” to allow for consonantal, prevocalic /r/ production “air” becomes “arid”, then “rid”
- Key environments:
 - Before a high vowel (e.g., “read”)
 - Beginning of syllable (e.g., “ray”)
 - Between vowels (e.g., “teary”)
 - Clusters with t (e.g., “tree”) or k (e.g., “creak”)
 - Avoid labial contexts (i.e., /f, v, p, b, m/) and rounded vowels if child gliding to [w]

From Bleile (2018) and Bauman-Waengler (2020)

Strategies for eliciting /s/

What have individuals in this group found to be useful?

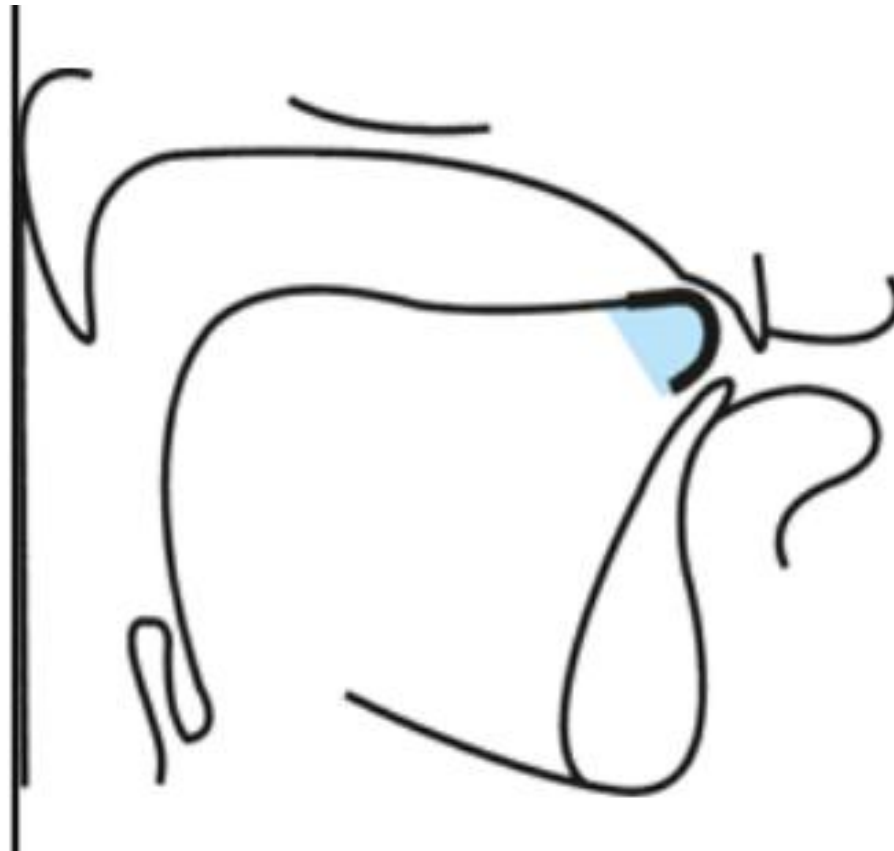


Image from Shriberg et al. (2018)

Eliciting rhotics and sibilants

Additional images for /s/

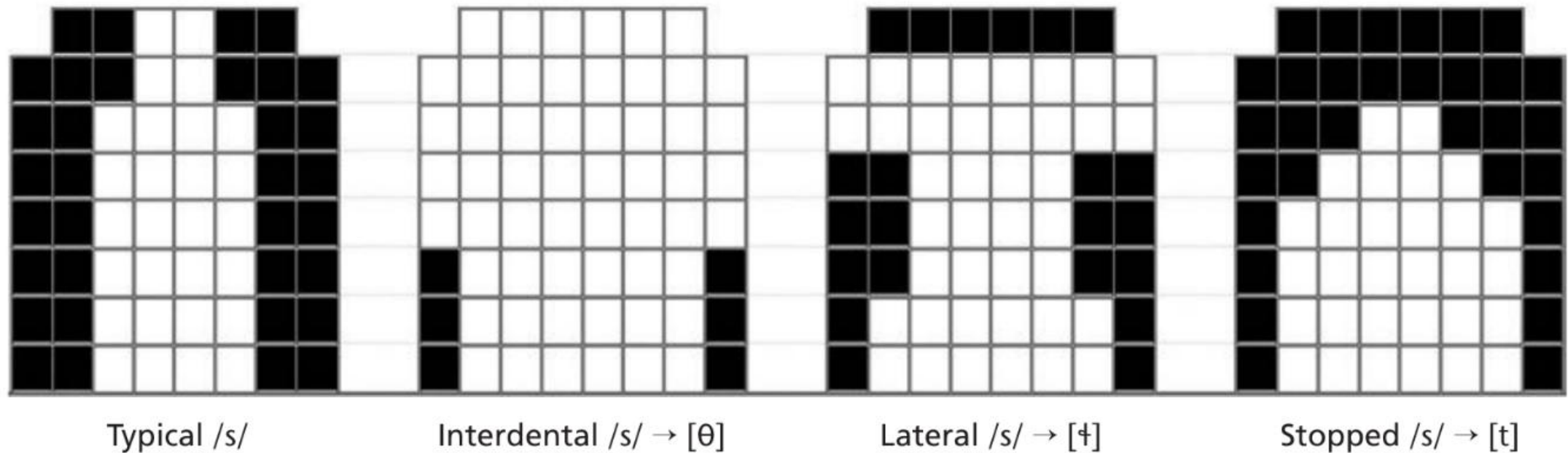


Figure 1.2. Comparison between stylized transverse images of four productions of /s/: typical, interdental, lateral, and stopped. Images represent the hard palate. Dark boxes indicate tongue/palate contact. (Used by permission from Sharynne McLeod.)

From Williams et al. (2021)

Strategies for /s/

- Remember placement options: Tongue tip up **or** down – use tongue depressor, q-tip, sucker to indicate location for tongue placement
- Facilitative contexts:
 - End of a syllable “ice”
 - Before a high front vowel as in “see”
 - After /t/ and before /i/ as in “pizza”
 - After a /t/ occurring in the same syllable “beats”
- Shaping from /t/ or /θ/
- Use object such as drinking straw to encourage central tongue groove, upper and lower teeth should be close together, but not touching

From Bleile (2018)

Use of acoustic measurements for biofeedback



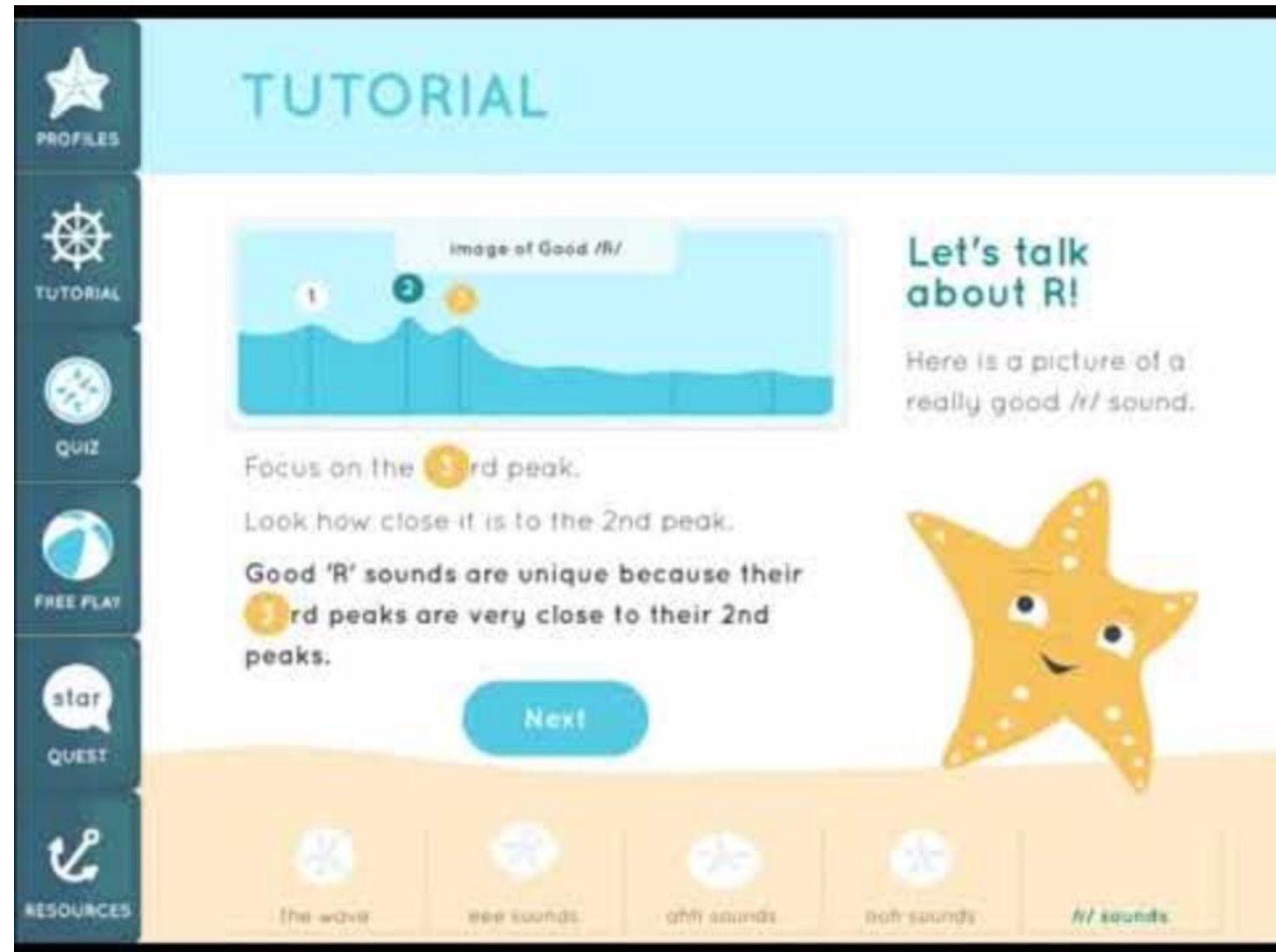
RTGram is a free, online application that works on a PC. <https://www.phon.ucl.ac.uk/resource/sfs/rtgram/>

Eliciting rhotics and sibilants

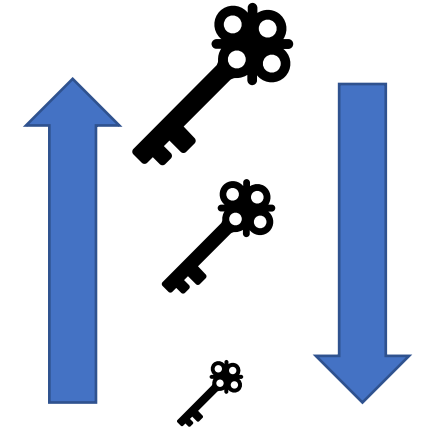
Another visual acoustic biofeedback tool: StaRt app

- (2:43 R sound)

Video by Tara McAllister
<https://youtu.be/NanbZ-AP8TQ?si=j8Nc-R2XH7WwvKHi>



Challenge Point Framework: Flexibly moving up and down hierarchy



- If 8 out of 10 productions are correct, increase difficulty
 - Remove model (e.g., what do you call this?)
 - Increase linguistic complexity (e.g., move from word to carrier phrase “I pick up key”)
 - Introduce a dual task during production practice (e.g., coloring, putting together a puzzle)
- If 5 or fewer out of 10 productions are correct, decrease difficulty
 - Add model (e.g., “say ‘key’” or “say ‘I pick up key’”)
 - Decrease linguistic complexity (e.g., move to nonsense syllable or isolation “say k-”)
 - Use a perceptual task (e.g., “You be the teacher – tell me if I said it the new/right way - ‘tea’”)
- If 6-7 out of 10 productions are correct, stay at that level of difficulty, you are in the zone of proximal development (Vygotsky)

See Preston and Leece (2021) for more motor-based strategies.

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Treatment of CAS – General Principles

- Treatment will be intensive
- Activities and targets progress from easy to difficult (begin with strengths)
- Treatment focuses on sequences of movements – building motor programs



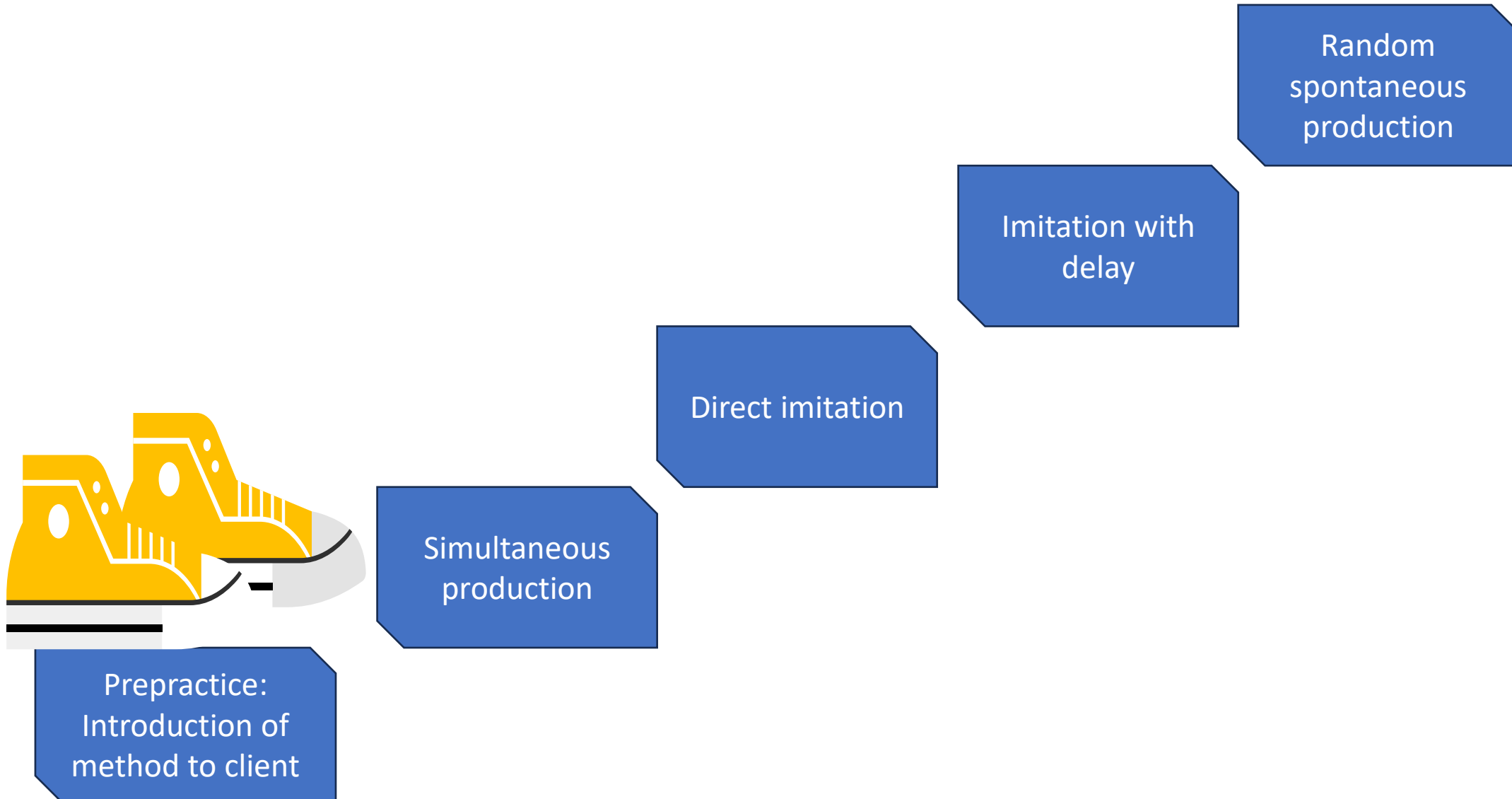
Dynamic Temporal and Tactile Cueing (DTTC, Strand, 2021)

- Designed to address motor speech disorders such as childhood apraxia of speech (CAS)
- Focused on building the motor program of the speech movement gesture at the level of the syllable
- Uses imitation/unison speech, which is faded with a temporal hierarchy (makes it dynamic)
- Visual, gestural, and tactile cueing is used to shape productions

Dynamic Temporal and Tactile Cueing Treatment (DTTC)

- Motor-based treatment
- Focus on improving movement rather than getting rid of errors
- Focus on proprioception (feel what it is like when you say it that way)
- Uses principles of motor learning (PML, see earlier slide re: acquisition and learning)
- Target selection important: Where possible, use real words that are meaningful
- Evidence for DTTC: Three single-subject, multiple baseline studies show effectiveness of this approach (Strand, 2021).

DTTC Hierarchical Model (Strand, 2021)



DTTC Demonstration (start at 29:09)

Treatment Methods and Techniques for CAS

- **There is no single management procedure or program that is most appropriate for CAS**
- There are a number of principles in the literature that are typically accepted as being important.

Edythe Strand, Ph.D. Diagnosis and Management of CAS

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Please find Edyth Strand's Seven Part videos on treating childhood apraxia of speech

<https://youtube.com/playlist?list=PL922IXvEXgbxZRHwq04zZRY6xU7Kn448T&si=lljzLt3651tt8833>

Get ready to
use your tools!

Questions



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