Getting the most bang for your therapy minutes:
Sound and word complexity in the treatment of children with phonological disorders

Holly L. Storkel

KU/KUMC Intercampus Program in Communicative Disorders Speech-Language Pathology Conference
Saturday, February 18, 2017
9:00-12:00
KU Edwards Campus, Overland Park, KS

Conference Resources

KU ScholarWorks

0. Storkel_Slides_2017_Big.pdf

Closed FaceBook Group

SLP Conference: Complexity in Phonological Treatment

Phonological Disorder

- Breakdown in the production and/or knowledge of the sound system of the surrounding speech community

- Focus: Children with functional phonological disorders
  - No obvious cause of their deficit
  - Normal oral-motor function/structure, hearing, intelligence

What Are We Currently Doing For These Kids?

Brumbaugh and Smit (2013) *LSHSS*

Not complexity approach!

Table 2. Number and percentage of the 366 speech-language pathologists (SLPs) who responded to questions about named interventions, arranged by the sum of the *Often* and *Always* responses (i.e., frequently).

	Often+Always 70%–100%		Sometimes 40%–60%		Occasionally 10%–30%		Never 0%		Not familiar	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Traditional	179	49	121	33	52	14	12	3	2	0
Phonological awareness	132	36	140	38	77	21	17	5	0	0
Minimal pairs	120	33	117	32	113	31	15	4	1	0
Cycles	116	32	74	20	67	18	40	11	69	19
Whole language	71	19	94	26	114	31	56	15	31	8
Nonspeech oral motor exercises (NSOME)	53	14	50	14	143	39	110	30	10	3
Distinctive features	47	13	103	28	119	33	46	13	51	14
Multiphonemic	44	12	82	22	73	20	33	9	134	37
Sensory motor	43	12	92	25	124	34	44	12	63	17
PROMPT	42	12	33	9	50	14	84	23	157	43
Commercial program	39	11	94	26	133	36	69	19	31	8
Paired stimuli	23	6	99	27	85	23	46	13	113	31
Maximal oppositions	20	5	38	10	94	26	77	21	137	37
Morphosyntactic	18	5	67	18	92	25	37	10	152	42
Multiple oppositions	16	4	51	14	85	23	64	18	159	41
Complexity/least knowledge	11	3	17	5	43	12	40	11	255	70
Nonlinear	9	2	20	6	24	7	35	10	278	76
Metaphon	4	1	10	3	19	5	30	8	303	83

Note. Data do not include the 106 persons (21.7% of the total survey respondents) who did not respond to any items in this section or the 17 persons (3.4% of the total) who provided only diagnostic services.

Is This A Problem?

Baker & McLeod (2011) *LSHSS*

Yes! Complexity approach has a very large and strong evidence base.

Table 5 (p. 1 of 2). Number of studies, levels of evidence, and example studies associated with the 23 intervention approaches that were examined in more than one study.

Approach	*Number of studies*	*Levels of evidence*[a]	*Study examples and corresponding level of evidence*
1. Minimal pairs	42	Ib, IIb, III	Ruscello, Cartwright, Haynes, & Schuster (1993): Ib Weiner (1981): IIb Grunwell & Dive (1988): III
2-6. Intervention based on principles of complexity (includes five approaches varying according to type and number of targets prioritized for intervention)	16	IIa, IIb, III	2. Maximal oppositions – Gierut (1989): IIb; Mota, Keske-Soares, Bagetti, Ceron, & Melo Filha (2007): IIa 3. Empty set – Gierut (1992): IIb 4. Intervention targeting complex onsets – Gierut (1999): IIb 5. Intervention targeting laryngeal/supralaryngeal distinctions – Gierut (1998b) IIb; Gierut & Morrisette (1996): IIb 6. Intervention targeting complex singleton consonants, such as later acquired phonemes – Gierut, Morrisette, Hughes, & Rowland (1996) IIb; Rvachew & Nowak (2001): IIa
7. Cycles	8	IIb, III	Mota et al. (2007): IIa Hodson, Nonomura, & Zappia (1998): III
8. Morphosyntax intervention for concomitant phonological and morphosyntax difficulties	6	Ib, IIa, IIb	Tyler, Lewis, Haskill, & Tolbert (2003): Ib Tyler, Lewis, Haskill, & Tolbert (2002): IIa Tyler & Lewis (2005): IIb
9. Core vocabulary	6	IIb, III	Crosbie, Holm, & Dodd (2005): IIb Dodd & Bradford (2000): IIb Holm & Dodd (2001): III
10. Traditional articulation therapy[b]	6	1b, IIa, III	Pamplona, Ysunza, & Espinosa (1999): Ib Hesketh, Adams, Nightingale, & Hall (2000): IIa Klein (1996): IIb

What's The Goal Of Phonological Treatment?

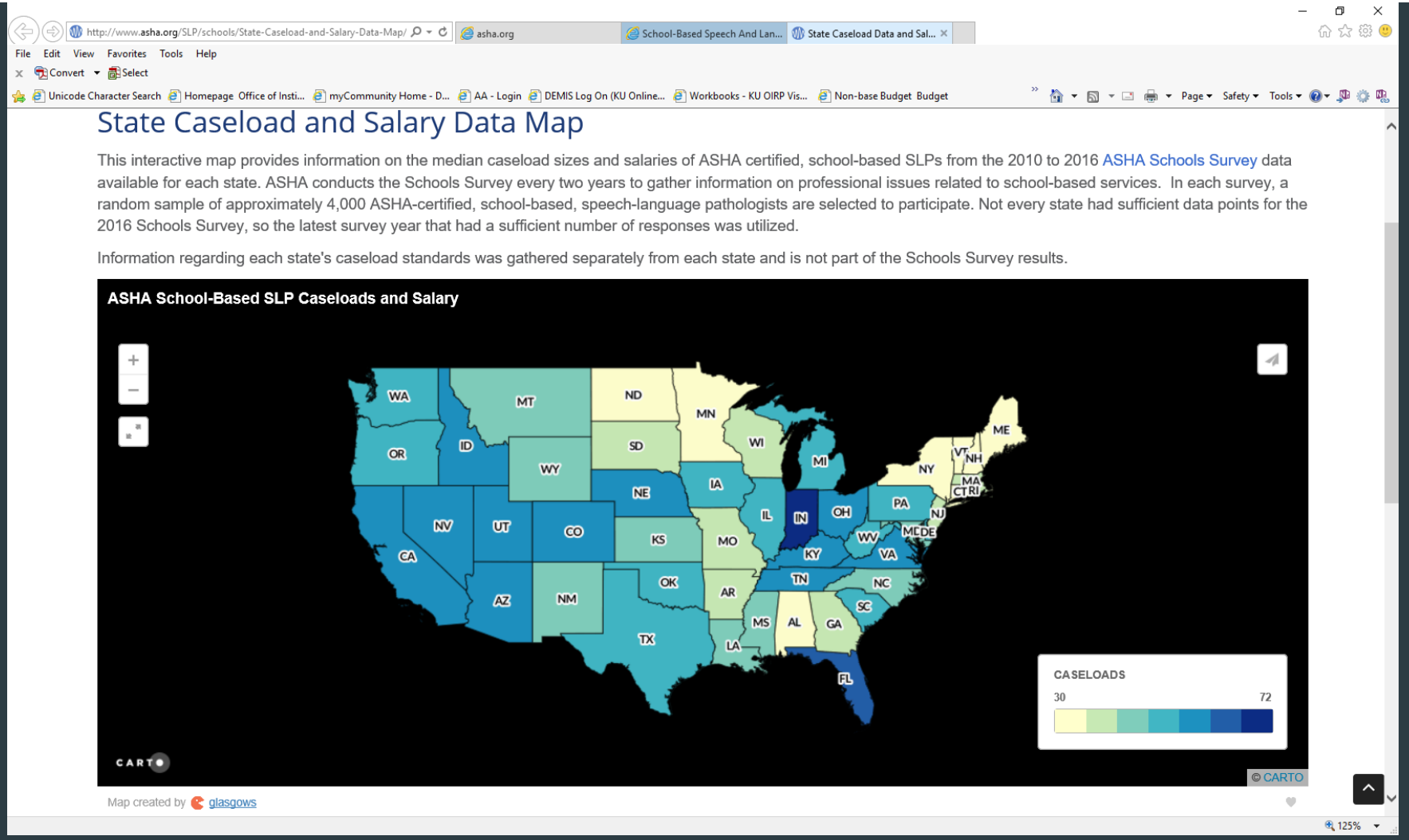
- System-wide change
  - Change in the TREATED sound(s) in UNTREATED words
  - Change in UNTREATED sounds
    - Related to the treated sound
    - Unrelated to the treated sound

  - Goal of system-wide change is efficient
    - Teach a small number of sounds, which will take time
    - Child learns more than just what was taught
    - Implication: Fewer rounds of treatment before the child is dismissed from treatment

Why System-wide Change?
Reduce caseload

2016 ASHA Schools Survey:

Median KS caseload = 45



2016 ASHA Schools Survey:

89% of SLPs regularly serve students with SSD; ~18 kids

Why System-wide Change?
Window For Learning Phonology Is Closing

Speech Perception Evidence: Ear and brain are being tuned to the native language early in development.

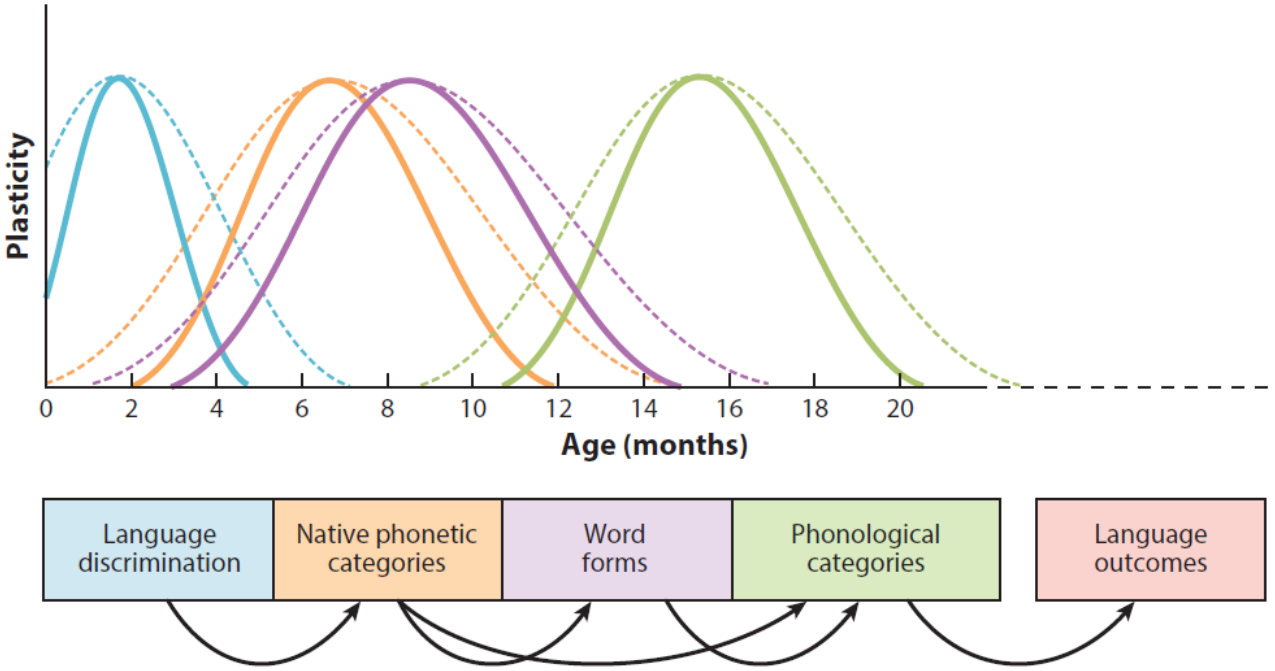


Figure 3

Illustration of the cascading nature (*arrows*) of the steps in perceptual development (*colored boxes*) that guide acquisition of the native language. Each step has a different critical (or sensitive) period (*solid lined curves*). The opening, closing, and duration of each of these periods can be altered by sensory deprivation, pharmacological exposure, and linguistic experience (*dashed lined curves*), ultimately influencing language outcomes (e.g., vocabulary size, reading).

Werker & Hensch (2015) *Annual Review of Psychology*

Why System-wide Change?
Window For Learning Phonology Is Closing

Evidence from Children with Phonological Disorders: Plateaus in phonological learning

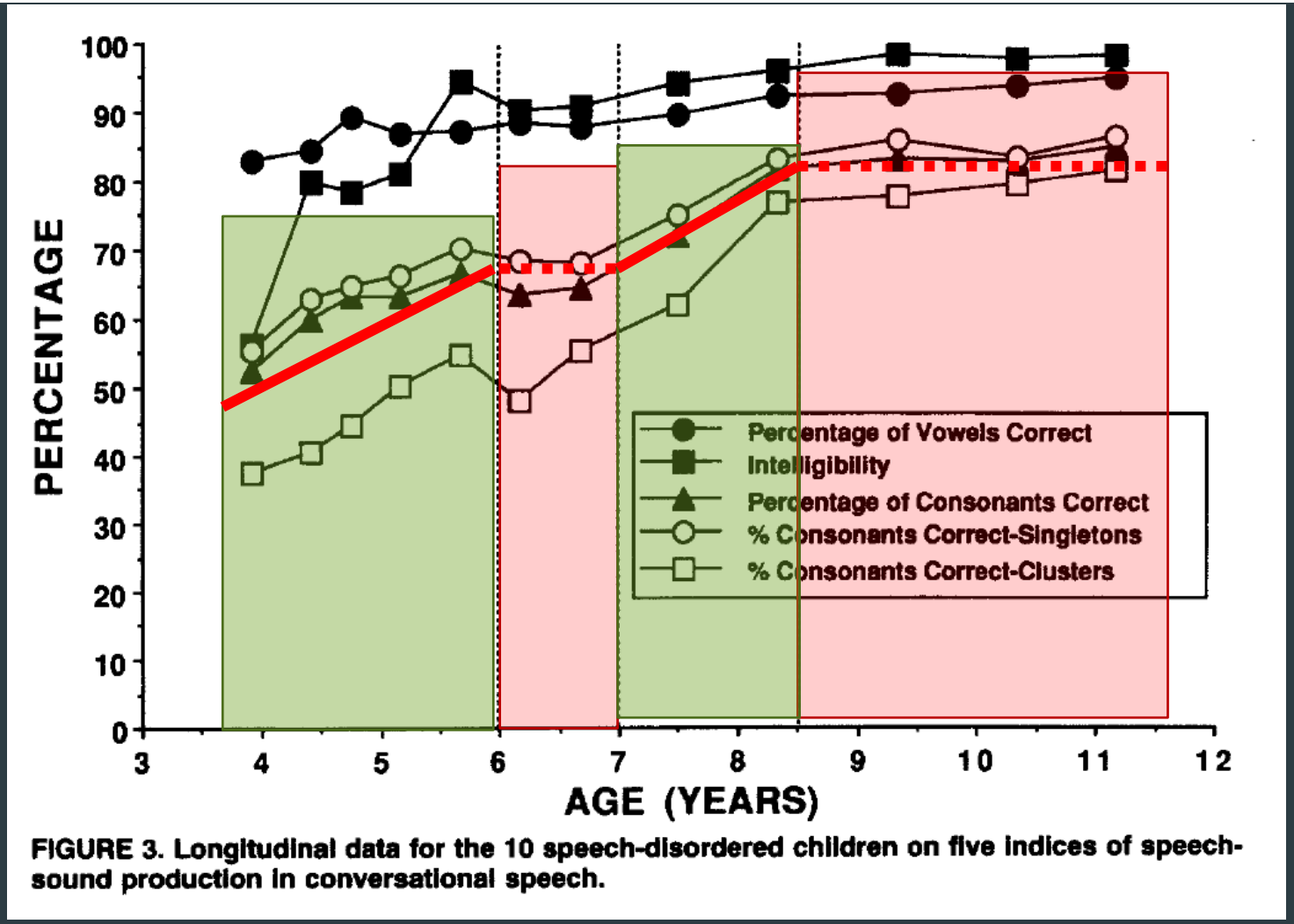


FIGURE 3. Longitudinal data for the 10 speech-disordered children on five indices of speech-sound production in conversational speech.

Shriberg, Gruber, Kwiatkowski (1994) *JSHR*

Why System-wide Change?
Window For Learning Phonology Is Closing

Evidence from Children with Phonological Disorders: Late-8 may not fully normalize

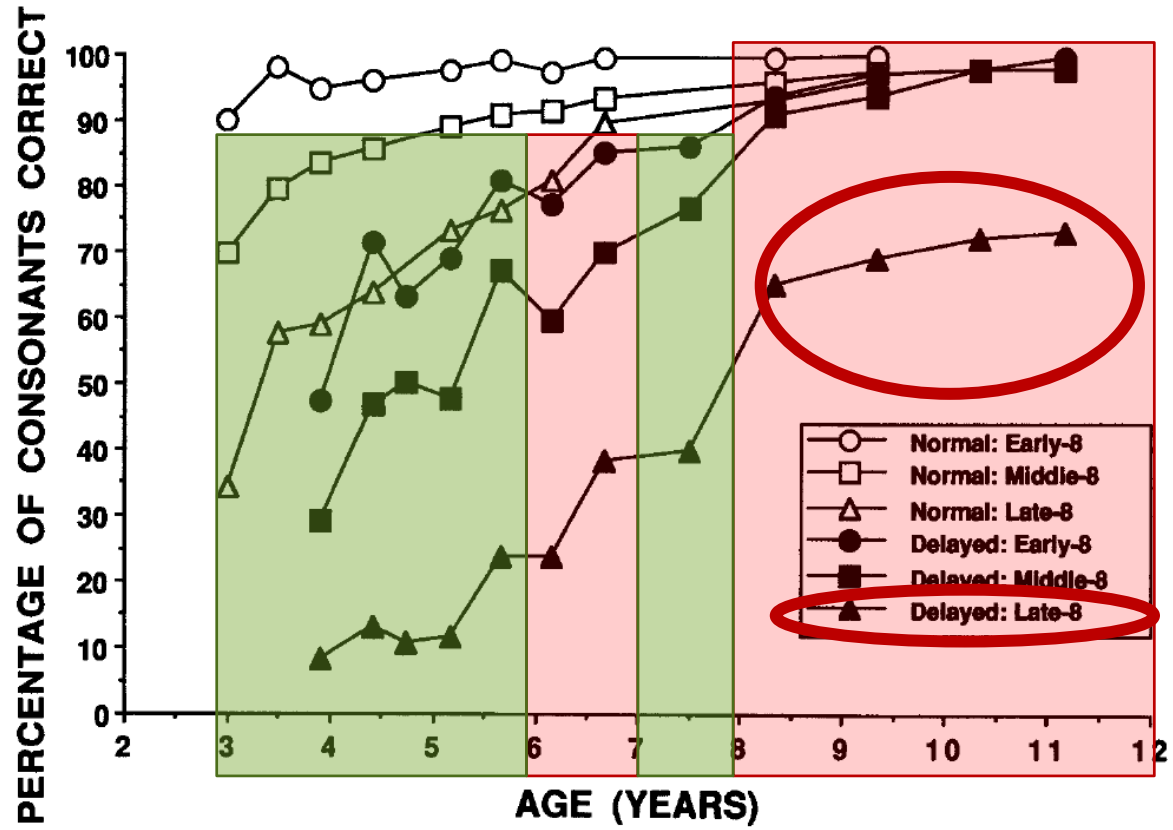


FIGURE 5. Comparison of the longitudinal normalization data for the present speech-delayed subjects with the cross-sectional acquisition data from Smit, Hand, Freilinger, Bernthal, and Bird (1990).

Shriberg, Gruber, Kwiatkowski (1994) *JSHR*

Goal: Phonological treatment during preschool to induce system-wide change in phonology to capitalize on period of rapid phonological learning

Permanently off-caseload by age 6 (i.e., start of first plateau)

[NEED to screen kindergarteners to identify any kids who were not picked-up as preschoolers. Start treatment ASAP before first plateau at age 6]

[If your school is interested in participating in research, my lab will happily screen all your kindergartners for free! Contact: hstorkel@ku.edu]

Also Relevant….Impact On Reading

- Critical Age Hypothesis: Children who still have phonological disorder when reading instruction starts are more at-risk for reading deficits
  - Bishop & Adams (1990) *Journal of Child Psychology and Psychiatry*
  - Nathan, Stackhouse, Goulandris, and Snowling (2004) *JSLHR*

- However, note that those with concomitant language disorders are at highest risk
  - e.g., Peterson, Pennington, Shriberg, & Boada (2009) *JSLHR*

Complexity Approach for Singleton Consonants
Gierut & Hulse (2010) *Clinical Linguistics & Phonetics*

Focus on Sound Selection Along 4 Dimensions

Developmental Norms

Error Patterns

Implicational Universals

Stimulability

1. Developmental Norms

Developmental Norms

- Early 8: m n p b d w j h (anterior nasals, anterior stops, glides)
- Mid 8: ŋ t k g f v ʧ ʤ (velar nasals, velars stops, /f v/, affricates)
- Late 8: θ ð s z ʃ (ʒ) l r (fricatives, liquids)

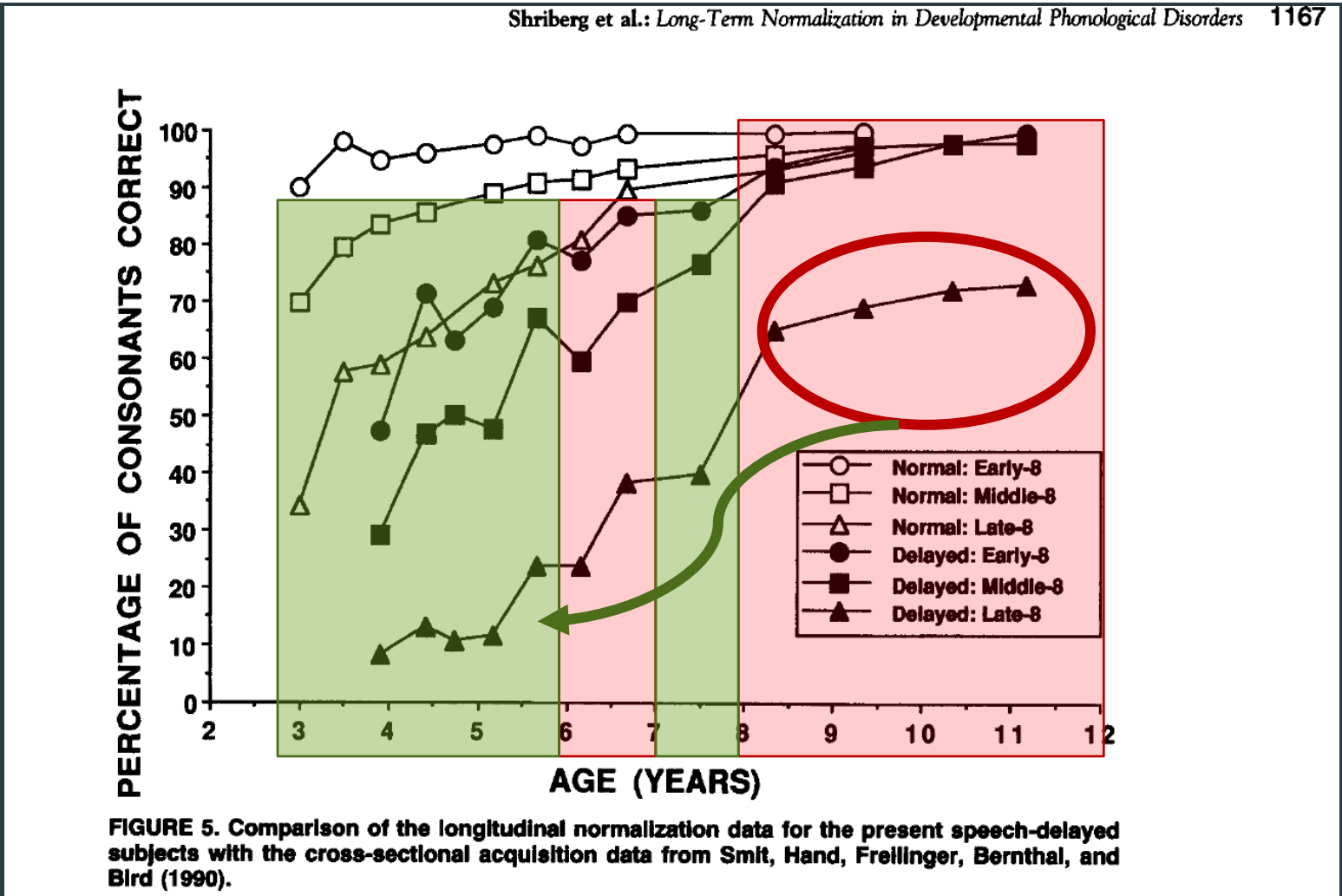
- Treatment of later acquired sounds = learn treated sounds + untreated sounds (both related and unrelated) = system-wide change

- Treatment of earlier acquired sounds = learn treated sounds + untreated sounds (related only) = local change

Explanation:
Treat Late Acquired Sounds Early

Treatment of late acquired sounds early targets the sounds least likely to normalize (late-8) during a period when phonological learning is accelerated (age 4-6)

Shriberg, Gruber, Kwiatkowski (1994) *JSHR*



1. Developmental Norms

Treat Late 8: θ ð s z ʃ (ʒ) l r

2. Error Patterns

Error Patterns

- Low accuracy vs. Mid accuracy

- Treatment of low accuracy sounds = learn treated sounds + untreated sounds (both related and unrelated) + known sounds in new words/word positions = system-wide change

- Treatment of mid accuracy sounds = learn treated sound + untreated sounds (related only) = local change

Explanation

- Low accuracy = Not being learned independently
  - Needs support (i.e., treatmen) to spark change

- Mid accuracy = Learning has started
  - Child may be able to continue to learn without support
  - Hypothesis: Treatment isn't needed for change to continue

2. Error Patterns

Treat Low Accuracy Sounds

Logistical Tangent

Need an adequate sample to determine accuracy

KU ScholarWorks Files:

1. Singleton_Probe_Pictures.pptx

1. Singleton_Probe_Scoresheet.xlsx

Samples

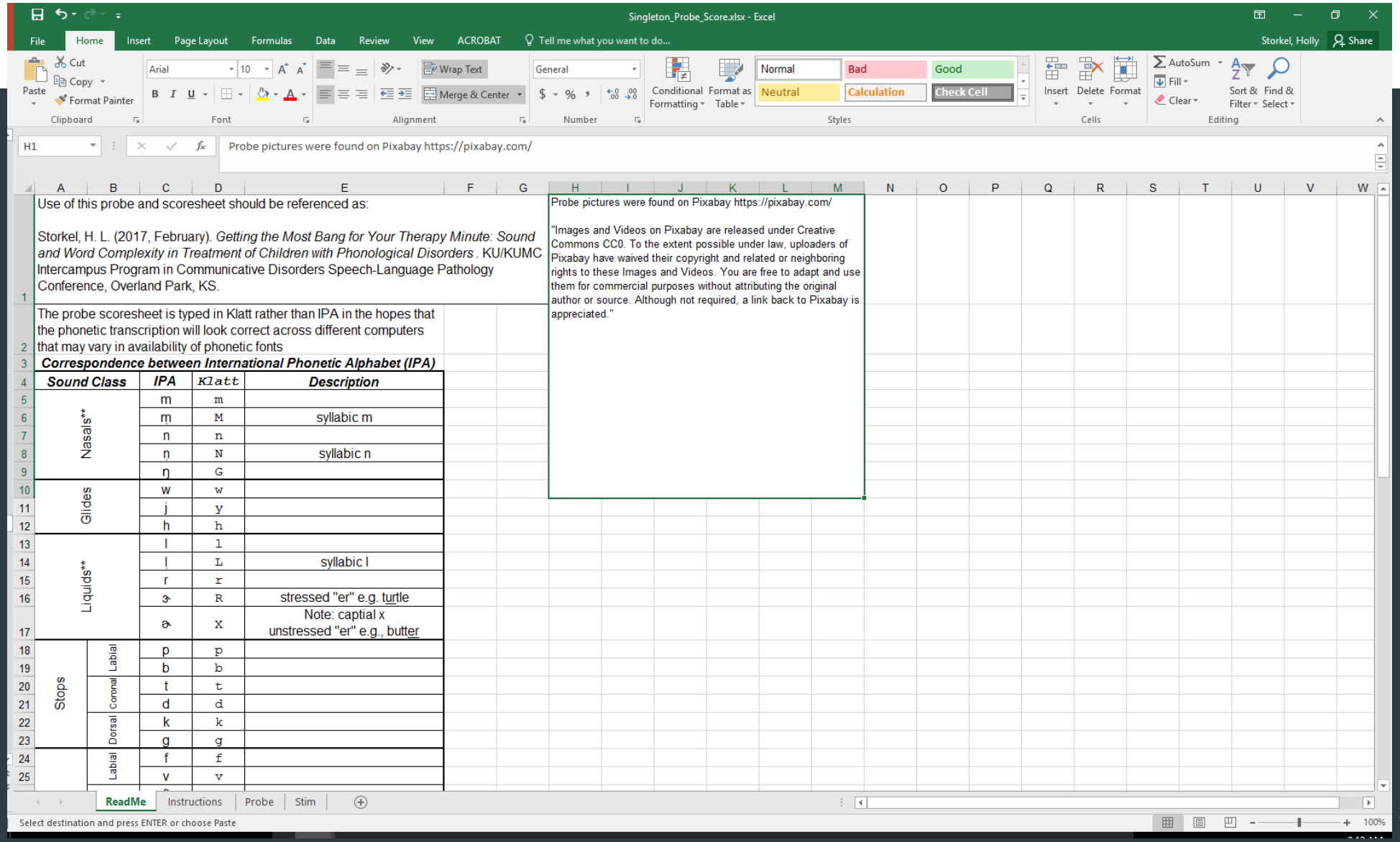
- Broad tests of articulation (e.g., Goldman-Fristoe Test of Articulation, ~53 words)
  - Test all English consonants but only in one word in each word position
  - Inadequate sample for computing accuracy, especially for emerging sounds

- Deep test of articulation
  - Protocol for Evaluation of English Phonotactics (Little PEEP) – 257 words
  - Phonological Knowledge Protocol (PKP) – very long & you'd need to find pictures
  - Conference Singleton Probe – FREE! – 84 words!
    - Samples only some mid-8 and late-8 sounds
    - Initial and Final position only
    - Accompanying scoresheet with automatic accuracy computations

Conference Singleton Probe

Sound	Classification	Onset	Coda	Total
k	mid-8	5	5	10
g	mid-8	5	5	10
f	mid-8	5	5	10
v	mid-8	5	5	10
θ	late-8	5	5	10
ð	late-8	5	3	8
s	late-8	5	5	10
z	late-8	5	5	10
ʃ	late-8	5	5	10
ʧ	mid-8	5	5	10
ʤ	mid-8	5	5	10
ŋ	mid-8	0	5	5
l	late-8	7	5	12
r	late-8	5	5	5

Scoresheet: ReadMe



Scoresheet: Instructions

This probe targets the mid-8 sounds (except /t/) and the late-8 sounds (except /Z/), usually in 5 words in onset/word initial position and 5 words in coda/word final position for a total of 10 productions of each sound. There is an accompanying PowerPoint file containing pictures for administering the probe. The worksheet labeled "Probe" in this workbook is the scoresheet. The scoresheet is formatted for printing.
Show each PowerPoint picture to the child and use the prompt on the scoresheet to elicit the target response.
If the child does not say the target word, given a second level prompt "Is it TARGET or FOIL?" Note that the target response is always the first one given so that the foil inserts a delay before the child's response. This is intended to yield a more typical production by the child. Direct imitation (without a delay) could yield a more accurate response than what is typical.
If the child still does not produce the target response, give a third level prompt: "It's a TARGET. What is it?" Again, this is intended to elicit the target in delayed imitation to get a more typical production from the child.
If the child still does not produce the target, give a level 4 prompt: "Say TARGET." This constitutes direct imitation and it could overestimate the child's ability.
If the child has poor vocabulary, it may become obvious that the child frequently needs more advanced prompting. In this case, it is fine to start at the level of prompting that seems most effective to speec up administration.
The scoresheet is designed for the clinician to write in (or type in) the sound produced for the target sound. It is recommended that you score accuracy after you have administered the whole probe (rather than during the probe).

Scoresheet: Probe

Item #	Word	Adult Target	Prompt	Onset Target	Child Prod	Onset Score	Coda Target	Child Prod	Coda Score
1	cage	keJ	They don't want the bird to fly away so he's in a	k	k	1	J	d	0
2	thing	TIG	They were walking and she found some....	T	t	0	G	n	0
3	cheese	Ciz	The mouse likes to eat....	C	t	0	z	z	1
4	shovel	S^vL	To dig a hole in the sand she's using a	S	s	0	l	-	0
5	there	DEr	We're here and the mountains are way over....	D	d	0	r	-	0
6	rash	r@S	He got into poison ivy and now he has an itchy	r	w	0	S	s	0
7	z	zi	W, X, Y....	z	z	1			
8	bridge	brIJ	To get over the water you have to drive on the ...				J	d	0
9	vine	vYn	The walls on the house are covered with a	v					
10	think	TIGk	She doesn't know the answer so she has to ...	T					
11	sock	sak	The girl is inside a	s			k		

Scoresheet:
Automatic Accuracy Calculations & Production List

Accuracy Analysis		Onset#	Onset %	Coda#	Coda%	Total%	Onset Productions					Coda Productions				
	k	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	g	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	f	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	v	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	T	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	D	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	N/A	N/A
	s	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	z	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	S	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	C	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	J	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	G	N/A	N/A	0	0%	0%	N/A	N/A	N/A	N/A	N/A	0	0	0	0	0
	l	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	r	0	0%	0	0%	0%	0	0	0	0	0	0	0	0	0	0
	ALL	**0**	**0%**	**0**	**0%**	**0%**										

3. Implicational Universals: Language Laws

"Rules" That Apply To All Languages Including Child Language

- If a language has X, then it also will have Y.
  - Treat X = learn X + Y = system-wide change
  - Treat Y = learn Y = local change

Treat X	Learn Y (without direct treatment)
Fricatives	Stops
Affricates	Fricatives
Voiced stops, fricatives, affricates	Voiceless stops, fricatives, affricates
Liquids	Nasals

These can be chained together as well:

Treat affricates – Change in Fricatives – Change in Stops

Explanation

- Teach "complex" skills
  - These are (by definition) more advanced
  - More advanced skills require support (i.e.., treatment) to facilitate growth
  - Learn "simple" skills "for free"
    - General property of learning
- "Simpler" skills
  - These are (by definition) easier
  - Need less support to facilitate growth

3. Implicational Universals: Language Laws

Treat fricatives, affricates, liquids, voiced obstruents

4. Stimulability

Stimulability

- Ability to correctly imitate a sound following a model, instruction or demonstration
- Treat non-stimulable sounds = learn non-stimulable sounds + learn stimulable sounds = system-wide change
- Treat stimulable sounds = learn stimulable sounds = local change

Explanation

- Nonstimulable = Low readiness to learn
  - Needs support (i.e., treatmen) to establish readiness to learn & facilitate learning

- Stimulable = Ready to be learned
  - Child may be able to learn this sound independently
  - Hypothesis: Treatment isn't needed to facilitate learning of this sound

4. Stimulability

Treat non-stimulable sounds

Logistical Tangent

How to assess stimulability?

KU ScholarWorks Files:

1. Singleton_Probe_Scoresheet.xlsx

SLPath Stimulability Task

In-Depth Stimulability Task

Sound	Isolation	#__i	i__i	i__#	#__a	a__a	a__#	#__u	u__u	u__#	Total	%	Stimulable?
p											/10		Yes No
b											/10		Yes No
t											/10		Yes No
d											/10		Yes No
k											/10		Yes No
g											/10		Yes No
f											/10		Yes No
v											/10		Yes No
θ											/10		Yes No
ð											/10		Yes No
s											/10		Yes No
z											/10		Yes No
ʃ											/10		Yes No
ʒ											/7		Yes No
ʧ											/10		Yes No
ʤ											/10		Yes No
m											/10		Yes No
n											/10		Yes No
ŋ											/7		Yes No
w											/7		Yes No
j											/7		Yes No
h											/7		Yes No
l											/10		Yes No
r											/10		Yes No

Adapted from Glaspey, A. & Stoel-Gammon, C. (2005). Dynamic assessment in phonological disorders: The scaffolding scale of stimulability. *Topics in Language Disorders, 25,* 220-230.

*Please note that research suggests that a sound produced with 30% or greater accuracy is considered stimulable.

**Gray boxes indicate impermissible contexts – see #3 on page 2 for more information

Worksheet In Probe Scoresheet: Stim_Score

	Isolation	#_i	i_i	i_#	#_a	a_a	a_#	#_u	u_u	u_#	Correct	Total	%	Stim?
k												10		
g												10		
f												10		
v												10		
T												10		
D												10		
s												10		
z												10		
S												10		
C												10		
J												10		
G												7		
l												10		
r												10		

Pulling It All Together

Using the Gierut & Hulse matrix (Adapted by Storkel)

KU ScholarWorks Files:

2. Singleton_Target_Selection_Worksheet.xlsx

Singleton Target Selection Worksheet: Instructions, Worksheet

This worksheet is an adaptation of a target selection matrix proposed by Gierut and Hulse (2010). When citing this worksheet, please cite both the original and this adapted version:

Gierut, J. A., & Hulse, L. E. (2010) Evidence-based practice: A matrix for predicting phonological generalization. *Clinical Linguistics and Phonetics, 24,* 323-334.

Storkel, H. L. (2017, February). Getting the Most Bang for Your Therapy Minute: Sound and Word Complexity in Treatment of Children with Phonological Disorders. KU/KUMC Intercampus Program in Communicative Disorders Speech-Language Pathology Conference, Overland Park, KS.

NOTE: This worksheet focuses on target sounds that have substitution or deletion errors. Distortion errors do not really apply. Treat distortions as correct for the purpose of marking this worksheet. HOWEVER, distortions may need treatment so do not ignore. The complexity approach is a phonological approach and predicts phonological learning. Distortions are likely motoric in nature and need a motoric approach.

Step 1: Use your probe accuracy data to highlight low accuracy sounds (i.e., 0 or 1 correct production) in Row 3. These WILL be considered as potential treatment targets. Shade all other sounds in gray in row 3 and for the entire column. These will not be considered as potential treatment targets. Score 1 point in row 19 for all sounds that are note shaded gray.

Step 2: Copy and paste ALL of your probe accurady data to Column B. For the sounds that you shaded as high accuracy, shade those here in gray. They do NOT need to be monitored or to be improved because they are high accuracy. Delete all the numbers in the ROWS that are shaded in gray. Give points in Row 20 based on score in Row 18 in the following way -- 2 points for score of 10+, 1 point for score 6-9, 0 points for score 0-5. This represents the sounds that are good to treat based on generalization predicted by language laws. You may need to adjust the scoring for children who have few sounds in error (i.e., few rows).

Step 3: Late acquired targets (i.e., late 8) are already scored for you in row 21.

Step 4: Consult your stimulability probe. Give a point (in row 22) for any of the targets (columns) that are non-stimulable

Step 5: Review the point total in row 23 and select a sound for treatment that has the highest (or one of the highest) totals. Select one sound only, unless selecting a second sound would allow you to target generalization to a different group of sounds. Be sure to look at your options in the context of the other sounds the child is producing in error (e.g., if you have a fricative and liquid target option, what is the child doing for other fricatives and liquids?). Also, consider best word position for treatment based on accuracy in onsets versus codas (i.e., pick the low accuracy position).

Step 6: Note the sounds that need to be monitored. This will be all of the low and mid accuracy sounds (i.e., just exlude the sounds in the rows that you shaded gray)

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s		1	1	1						1		1	1	2
	z				1									1	1
	S		1		1	1					1		1	1	2
	C		1		1						1		1	1	1
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	***3***	***9***	***3***	***9***	***3***	***2***	***2***	***1***	***1***	***7***	***3***	***9***	***10***	***16***
Target Selection Evidence	Least Knowledge														
	Language Laws														
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable														
	Total Points	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
	Treated Sound:														
	Sounds for Monitoring:														

Example Cases

KU ScholarWorks Files:

3. Singleton_Cases.xlsx

Application: PD 50

- Age: 3; 6; Male
- GFTA: Raw = 54; PR = 5
- Hearing Screening: Passed
- OWLS Receptive: WNL
- OWLS Expressive: WNL

Application: PD 50 (3;6 Male)

Item #	Word	Adult Target	Prompt	Onset Target	Child Prod	Onset Score	Coda Target	Child Prod	Coda Score
1	cage	keJ	They don't want the bird to fly away so he's in a	k	t	0	J	J	1
2	thing	TIG	They were walking and she found some....	T	t	0	G	-	0
3	cheese	Ciz	The mouse likes to eat....	C	C	1	z	dent z	0
4	shovel	S^vL	To dig a hole in the sand she's using a	S	S	1	l	-	0
5	there	DEr	We're here and the mountains are way over....	D	d	0	r	-	0
6	rash	r@S	He got into poison ivy and now he has an itchy	r	w	0	S	S	1
7	z	zi	W, X, Y....	z	dent z	0			
8	bridge	brlJ	To get over the water you have to drive on the ...				J	J	1
9	vine	vYn	The walls on the house are covered with a	v	d	0			
10	think	TIGk	She doesn't know the answer so she has to ...	T	t	0			
11	sock	sak	The girl is inside a	s	s	1	k	k	1
12	giraffe	JX@f	It's not a zebra, it's a	J	J	1	f	-	0
13	goldfish	goldflS	What's this?	g	d	0	S	S	1
14	long	lcG	This one is short [point] and this one [point] is	l	y	0	G	-	0
15	cough	kcf	He's sick. He goes [cough]. It's not a sneeze, it's a....	k	t	0	f	dent s	0
16	valentines day	v@l|ntYn zde	This card isn't for Halloween, it's for....	v	v	1			
17	peach	piC	This isn't an apple, it's a				C	C	1
18	thumb	T^m	She's not holding up her finger. She's holding up her ...	T	d	0			
19	legos	lEgoz	What are these?	l	w	0	z	-	0

Application: PD 50 (3;6 Male)

	Onset#	Onset %	Coda#	Coda%	Total%	Onset Productions					Coda Productions						
k	0	0%	2	40%	20%	t	t	t	t	t	k	t	k	-	t		
g	0	0%	0	0%	0%	d	d	d	d	d	-	-	-	-	-		
f	0	0%	1	20%	10%	h	h	h	h	h	-	dent s	dent s	-	f		
v	1	20%	1	20%	20%	d	v	b	w	-	-	-	v	z	z		
T	0	0%	0	0%	0%	t	t	d	t	d	s	s	s	s	f		
D	0	0%	0	0%	0%	d	d	d	d	d	-	-	-	N/A	N/A		
s	4	80%	4	80%	80%	s	s	s	s	dent s	s	s	dent s	s	s		
z	0	0%	0	0%	0%	dent z	w	w	w	w	dent z	-	dent z	-	-		
S	4	80%	4	80%	80%	S	S	S	h	S	S	S	S	Z	S		
C	5	100%	5	100%	100%	C	C	C	C	C	C	C	C	C	C		
J	1	20%	5	100%	60%	J	dz	-	-	Z	J	J	J	J	J		
G	N/A	N/A	0	0%	0%	N/A	N/A	N/A	N/A	N/A	-	-	-	-	-		
l	0	0%	0	0%	0%	y	w	w	w	-	-	-	-	-	-	w	w
r	0	0%	0	0%	0%	w	w	w	w	w	-	-	-	-	-		
ALL	**15**	**22%**	**22**	**32%**	**27%**												

Application: PD 50 (3;6 Male)

Accuracy Analysis		Onset#	Onset %	Coda#	Coda%	Total%	Onset Productions					Coda Productions				
Fronting	k	0	0%	2	40%	20%	t	t	t	t	t	k	t	k	-	t
Fronting in onset; Coda deleted	g	0	0%	0	0%	0%	d	d	d	d	d	-	-	-	-	-
/h/ onset; variable coda	f	0	0%	1	20%	10%	h	h	h	h	h	-	dent s	dent s	-	f
Variable	v	1	20%	1	20%	20%	d	v	b	w	-	-	-	v	z	z
Onset variable; /s/ coda	T	0	0%	0	0%	0%	t	t	d	t	d	s	s	s	s	f
Onset d; Coda deleted	D	0	0%	0	0%	0%	d	d	d	d	d	-	-	-	N/A	N/A
100% if ignore dentalized	s	4	80%	4	80%	80%	s	s	s	s	dent s	s	s	dent s	s	s
Onset /w/; coda deleted (30% acc if ignore dentalized)	z	0	0%	0	0%	0%	dent z	w	w	w	w	dent z	-	dent z	-	-
	S	4	80%	4	80%	80%	S	S	S	h	S	S	S	S	Z	S
	C	5	100%	5	100%	100%	C	C	C	C	C	C	C	C	C	C
Onset variable	J	1	20%	5	100%	60%	J	dz	-	-	Z	J	J	J	J	J
Coda deleted	G	N/A	N/A	0	0%	0%	N/A	N/A	N/A	N/A	N/A	-	-	-	-	-
Onset /w/; Coda deleted	l	0	0%	0	0%	0%	y	w	w	w	-	-	-	-	-	-
Onset /w/; Coda deleted	r	0	0%	0	0%	0%	w	w	w	w	w	-	-	-	-	-
	ALL	15	22%	22	32%	27%										

An aside: Distortions

Complexity approach focuses on substitutions/deletions; Ignores distortions

Complexity = phonology emphasis (abstract mental representations)
Distortions = motoric issue
BUT…we should still consider whether distortions need to be addressed

Smit (1993) *JSHR, 36,* 533-547

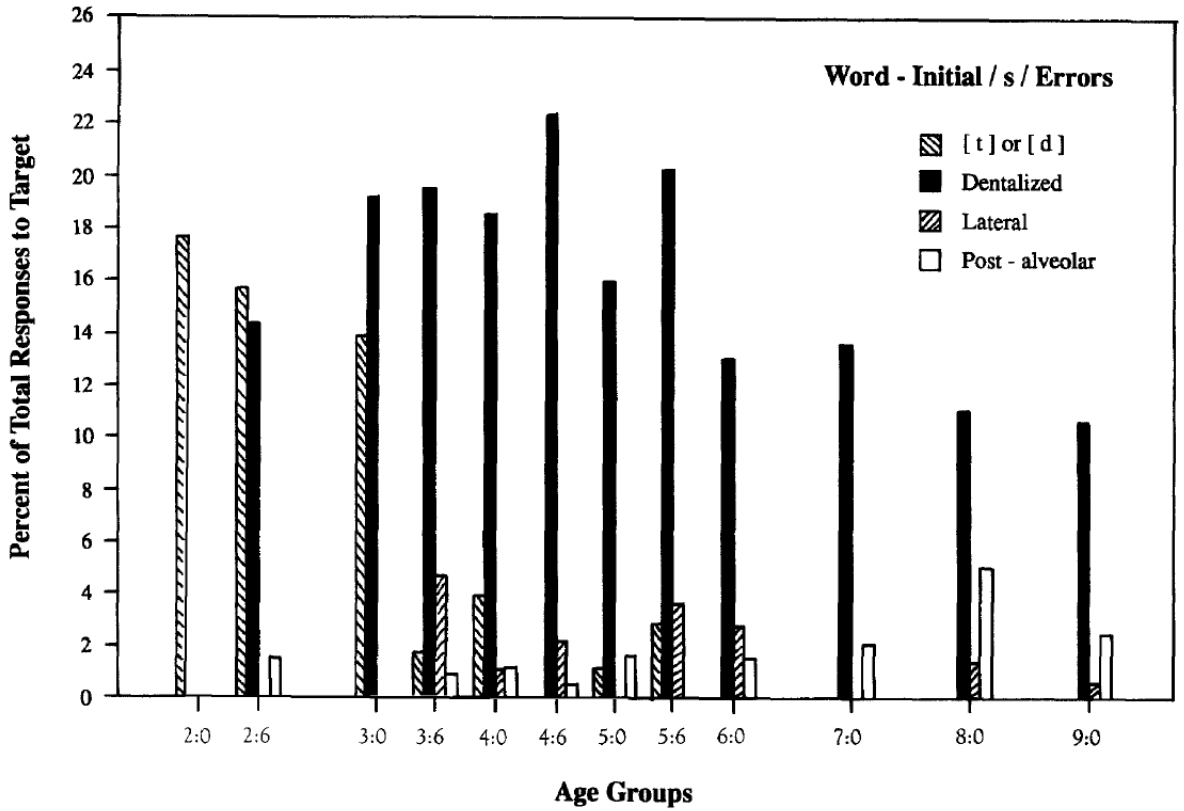


FIGURE 2. Distribution by age group of the most common errors used for word-initial /s/.

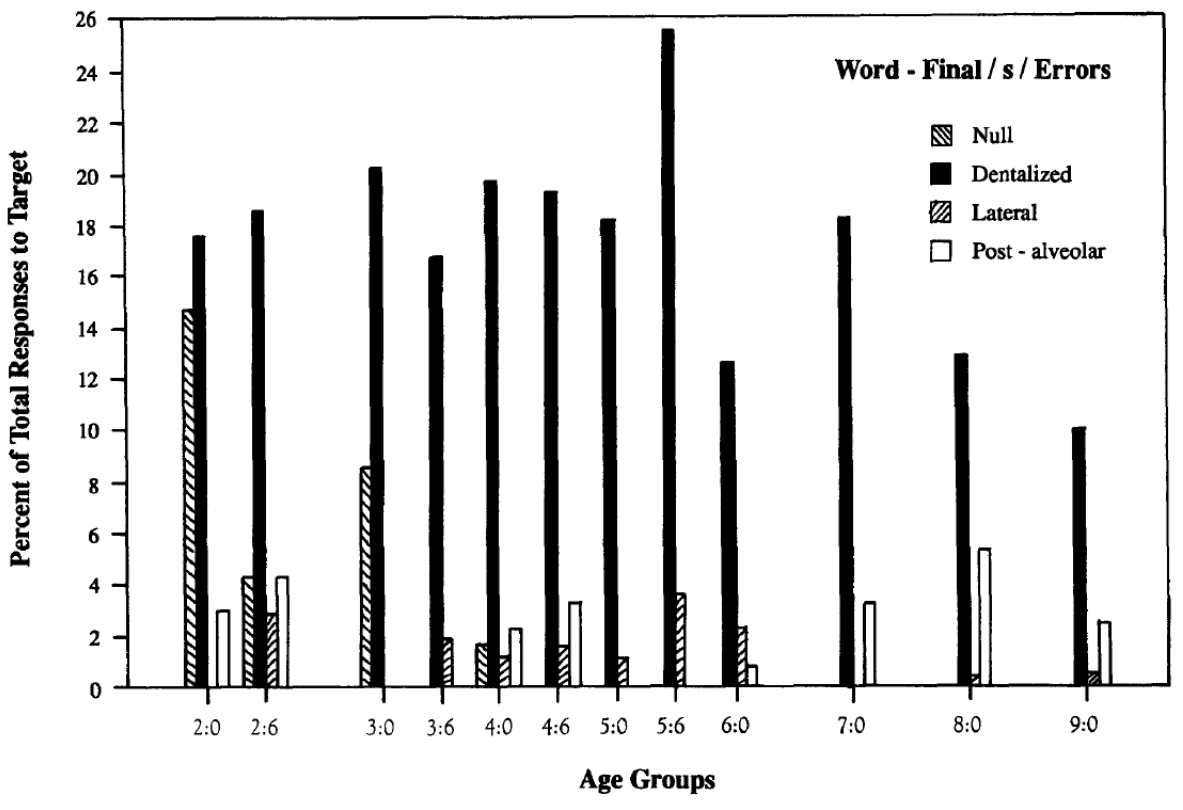


FIGURE 3. Distribution by age group of the most common errors used for word-final /s/.

An aside: Developmental Norms

PD 50 = 3; 6 Male

Non-mastered sounds = G k g f v T D z l r

Smit, Hand, Freilinger, Bernthal, & Bird (1990) *JSHD, 55, 779-798*

Non-mastered sounds
= G k g f v T D z l r

TABLE 7. Recommended ages of acquisition for phonemes and clusters, based generally on 90% levels of acquisition.

Phoneme	Recommended age of acquisition (years:months) Females	Males	Source
/m/	3:0	3:0	Table 4
/n/	3:6	3:0	Table 4
/-ŋ/	7:0–9:0	7:0–9:0	Figure 4[a]
/h-/	3:0	3:0	Table 4
/w-/	3:0	3:0	Table 4
/j-/	4:0	5:0	Figure 6
/p/	3:0	3:0	Table 4
/b/	3:0	3:0	Table 4
/t/	4:0	3:6	Table 4
/d/	3:0	3:6	Table 4
/k/	3:6	3:6	Table 4
/g/	3:6	4:0	Table 4
/f/ /f-/	3:6	3:6	Figure 5
/-f/	5:6	5:6	Figure 7
/v/	5:6	5:6	Figure 8
/θ/	6:0	8:0	Figure 9
/ð-/	4:6	7:0	Figure 11
/s/	7:0–9:0	7:0–9:0	Figure 10[b]
/z/	7:0–9:0	7:0–9:0	Figure 12[b]
/ʃ/	6:0	7:0	Figure 14
/tʃ/	6:0	7:0	Figure 13
/dʒ/	6:0	7:0	Figure 15
/l/ /l-/	5:0	6:0	Figure 16
/-l/	6:0	7:0	Figure 18
/r/ /r-/	8:0	8:0	Figure 17
/-ɚ/	8:0	8:0	Figure 19

Smit, Hand, Freilinger, Bernthal, & Bird (1990) *JSHD, 55, 779-798*

Non-mastered sounds
G – 66
g – 88
v -- 66
D – 52
z -- 69
l (initial) – 69
r (initial) – 52
r (final) -- 68

TABLE 4. Percentages of responses to each target that were considered "acceptable."

Phoneme (# of test items)	Age[a] group 3:0 F (n = 22)	3:0 M (n = 25)	3:6 F (n = 26)	3:6 M (n = 29)	4:0 F (n = 37)	4:0 M (n = 54)	4:6 F (n = 51)	4:6 M (n = 44)	5:0 F (n = 45)	5:0 M (n = 50)	5:6 F (n = 45)	5:6 M (n = 47)	6:0 F (n = 68)	6:0 M (n = 72)	7:0[b] (n: F = 62 M = 73)	8:0[b] (n: F = 62 M = 68)	9:0[b] (n: F = 65 M = 52)
m-	91	100	100	100	97	100	98	100	100	98	100	100	100	96	100	98	99
-m (2)	89	92	98	98	96	98	100	98	100	98	97	99	99	94	98	97	98
n-	82	100	100	97	97	98	100	93	98	98	100	100	100	94	99	98	98
-n (2)	80	90	100	95	93	95	99	94	98	97	100	98	99	96	99	97	99
-ŋ	50	72	69	66	70	70	73	66	73	72	82	72	81	75	72	82	88
h- (2)	98	90	96	100	96	94	99	98	100	100	100	100	100	99	100	100	100
w- (2)	100	94	96	100	99	97	100	99	100	100	100	100	100	99	100	100	100
j-	59	68	77	93	95	81	92	84	93	92	100	96	97	94	99	100	100
p-	95	88	100	97	97	96	98	98	100	92	100	96	100	99	100	100	99
-p (2)	93	94	98	100	99	97	98	99	99	94	100	99	96	98	97	98	98
b- (3)	98	99	100	100	100	99	99	98	100	100	100	100	100	100	100	100	100
-b	91	92	88	97	95	89	98	93	100	94	98	98	99	94	99	99	98
t-	95	88	92	93	100	100	100	100	100	98	100	100	100	99	99	100	100
-t (3)	85	80	82	87	91	93	90	95	87	92	90	91	93	90	95	96	95
d- (3)	97	95	99	100	98	98	100	98	100	99	100	100	99	99	99	99	100
-d	91	80	96	93	97	96	96	100	98	96	98	96	97	93	99	98	100
k- (3)	77	76	92	89	100	90	99	95	99	91	100	99	100	99	99	99	100
-k (3)	92	97	94	92	99	97	97	98	99	99	99	99	100	98	99	99	100
g- (2)	82	80	92	88	100	93	96	98	100	96	100	100	100	98	98	99	100
-g (2)	82	90	88	88	96	93	96	92	99	98	97	96	96	94	96	97	97
f-	86	64	92	93	100	96	100	100	98	96	100	98	100	100	100	100	100
-f	82	72	77	86	81	76	76	84	78	88	93	94	91	90	96	97	99
v-	41	52	62	66	78	76	90	80	91	84	98	96	99	94	99	99	100
-v	64	56	54	66	86	72	90	75	87	86	91	91	93	90	95	99	97
θ-	30	34	50	43	59	44	68	56	71	56	78	60	93	78	91	98	100
-θ	27	24	54	38	59	48	67	50	71	54	82	77	91	78	90	96	98
ð-	32	20	58	52	76	43	90	64	91	74	98	87	97	83	96	100	100
s- (2)	75	48	75	71	69	71	74	69	83	79	81	69	89	79	86	85	90
-s (2)	77	46	79	83	72	64	77	70	83	79	77	66	87	79	79	83	90
z-	41	44	50	69	54	65	71	68	76	64	80	64	84	75	81	88	92
-z (2)	48	38	65	47	58	59	60	66	76	69	69	63	83	75	80	80	87
ʃ- (2)	68	44	75	69	88	70	85	76	86	87	89	81	90	88	94	94	97
-ʃ	64	44	69	69	86	70	86	66	84	86	80	85	90	88	94	92	99
tʃ- (2)	66	42	67	67	80	69	87	77	89	89	90	82	91	89	91	96	98
-tʃ	64	36	69	66	76	78	88	73	80	82	89	85	93	89	93	95	95
dʒ-	73	52	73	72	86	78	90	80	91	88	91	89	94	92	96	95	98
-dʒ (2)	61	46	77	69	74	73	86	76	83	84	86	85	90	87	93	97	95
l- (2)	77	36	79	69	82	58	86	75	93	74	94	86	98	96	97	98	100
-l (2)	36	14	54	38	53	49	75	53	64	64	86	74	90	76	90	96	98
-l̩	36	20	54	41	51	46	71	50	62	66	78	68	87	75	88	93	98
-l-	59	28	73	72	84	69	80	73	87	78	91	87	94	90	95	94	99
r- (2)	25	26	46	52	62	56	67	47	63	71	69	78	79	76	87	92	96
-ɚ (4)	45	43	61	68	85	68	71	61	74	84	76	81	85	82	86	96	97
-r-	45	36	46	55	70	54	71	59	71	70	71	79	79	76	87	95	97

Back to Our Case!
Treatment Sound Selection

PD 50 = 3; 6 Male

Singleton Target Selection Worksheet: Instructions, Worksheet

This worksheet is an adaptation of a target selection matrix proposed by Gierut and Hulse (2010). When citing this worksheet, please cite both the original and this adapted version:

Gierut, J. A., & Hulse, L. E. (2010) Evidence-based practice: A matrix for predicting phonological generalization. *Clinical Linguistics and Phonetics, 24,* 323-334.

Storkel, H. L. (2017, February). Getting the Most Bang for Your Therapy Minute: Sound and Word Complexity in Treatment of Children with Phonological Disorders. KU/KUMC Intercampus Program in Communicative Disorders Speech-Language Pathology Conference, Overland Park, KS.

NOTE: This worksheet focuses on target sounds that have substitution or deletion errors. Distortion errors do not really apply. Treat distortions as correct for the purpose of marking this worksheet. HOWEVER, distortions may need treatment so do not ignore. The complexity approach is a phonological approach and predicts phonological learning. Distortions are likely motoric in nature and need a motoric approach.

Step 1: Use your probe accuracy data to highlight low accuracy sounds (i.e., 0 or 1 correct production) in Row 3. These WILL be considered as potential treatment targets. Shade all other sounds in gray in row 3 and for the entire column. These will not be considered as potential treatment targets. Score 1 point in row 19 for all sounds that are note shaded gray.

Step 2: Copy and paste ALL of your probe accurady data to Column B. For the sounds that you shaded as high accuracy, shade those here in gray. They do NOT need to be monitored or to be improved because they are high accuracy. Delete all the numbers in the ROWS that are shaded in gray. Give points in Row 20 based on score in Row 18 in the following way -- 2 points for score of 10+, 1 point for score 6-9, 0 points for score 0-5. This represents the sounds that are good to treat based on generalization predicted by language laws. You may need to adjust the scoring for children who have few sounds in error (i.e., few rows).

Step 3: Late acquired targets (i.e., late 8) are already scored for you in row 21.

Step 4: Consult your stimulability probe. Give a point (in row 22) for any of the targets (columns) that are non-stimulable

Step 5: Review the point total in row 23 and select a sound for treatment that has the highest (or one of the highest) totals. Select one sound only, unless selecting a second sound would allow you to target generalization to a different group of sounds. Be sure to look at your options in the context of the other sounds the child is producing in error (e.g., if you have a fricative and liquid target option, what is the child doing for other fricatives and liquids?). Also, consider best word position for treatment based on accuracy in onsets versus codas (i.e., pick the low accuracy position).

Step 6: Note the sounds that need to be monitored. This will be all of the low and mid accuracy sounds (i.e., just exlude the sounds in the rows that you shaded gray)

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s		1	1	1						1		1	1	2
	z				1									1	1
	S		1		1	1					1		1	1	2
	C		1		1						1		1	1	1
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	***3***	***9***	***3***	***9***	***3***	***2***	***2***	***1***	***1***	***7***	***3***	***9***	***10***	***16***
Target Selection Evidence	Least Knowledge														
	Language Laws														
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable														
	Total Points	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
	Treated Sound:														
	Sounds for Monitoring:														

Application: PD 50 (3;6 Male)

	Onset#	Onset %	Coda#	Coda%	Total%
k	0	0%	2	40%	20%
g	0	0%	0	0%	0%
f	0	0%	1	20%	10%
v	1	20%	1	20%	20%
T	0	0%	0	0%	0%
D	0	0%	0	0%	0%
s	4	80%	4	80%	80%
z	0	0%	0	0%	0%
S	4	80%	4	80%	80%
C	5	100%	5	100%	100%
J	1	20%	5	100%	60%
G	N/A	N/A	0	0%	0%
l	0	0%	0	0%	0%
r	0	0%	0	0%	0%
ALL	15	22%	22	32%	27%

		Potential Treatment Targets (Low Accuracy Only)														
		Late 8							Mid 8							
		T	D	s	z	S	l	r	G	k	g	f	v	C	J	
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2	
	g	1	1	1	1	1					1	1	1	1	1	
	f		1		1						1	1	1	1	2	
	v												1	1	1	
	T	1	1		1						1		1	1	2	
	D		1											1	1	
	s		1	1	1						1		1	1	2	
	z				1									1	1	
	S		1		1	1					1		1	1	2	
	C		1		1						1		1	1	1	
	J														1	
	G						1	1	1							
	l						1									
	r							1								
	Total Points	*3*	*9*	*3*	*9*	*3*	*2*	*2*	*1*	*1*	*7*	*3*	*9*	*10*	*16*	
Target Selection Evidence	Least Knowledge	1	1	0	1	0	1	1	1	0	1	1	0	0	0	
	Language Laws															
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0	
	Non-Stimulable															
	Total Points	*2*	*2*	*1*	*2*	*1*	*2*	*2*	*1*	*0*	*1*	*1*	*0*	*0*	*0*	
	Treated Sound:															
	Sounds for Monitoring:															

Application: PD 50 (3;6 Male)

	Onset#	Onset %	Coda#	Coda%	Total%
k	0	0%	2	40%	20%
g	0	0%	0	0%	0%
f	0	0%	1	20%	10%
v	1	20%	1	20%	20%
T	0	0%	0	0%	0%
D	0	0%	0	0%	0%
s	4	80%	4	80%	80%
z	0	0%	0	0%	0%
S	4	80%	4	80%	80%
C	5	100%	5	100%	100%
J	1	20%	5	100%	60%
G	N/A	N/A	0	0%	0%
l	0	0%	0	0%	0%
r	0	0%	0	0%	0%
ALL	15	22%	22	32%	27%

		Potential Treatment Targets (Low Accuracy Only)														
		Late 8							Mid 8							
		T	D	s	z	S	l	r	G	k	g	f	v	C	J	
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2	
	g	1	1	1	1	1					1	1	1	1	1	
	f		1		1						1	1	1	1	2	
	v												1	1	1	
	T	1	1		1						1		1	1	2	
	D		1											1	1	
	s															
	z				1									1	1	
	S															
	C															
	J														1	
	G						1	1	1							
	l						1									
	r							1								
	Total Points	3	6	2	6	2	2	2	1	1	4	3	6	7	11	
Target Selection Evidence	Least Knowledge	1	1	0	1	0	1	1	1	0	1	1	0	0	0	
	Language Laws															
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0	
	Non-Stimulable															
	Total Points	2	2	1	2	1	2	2	1	0	1	1	0	0	0	
	Treated Sound:															
	Sounds for Monitoring:															

Application: PD 50 (3;6 Male)

This worksheet is an adaptation of a target selection matrix proposed by Gierut and Hulse (2010). When citing this worksheet, please cite both the original and this adapted version:

Gierut, J. A., & Hulse, L. E. (2010) Evidence-based practice: A matrix for predicting phonological generalization. *Clinical Linguistics and Phonetics, 24,* 323-334.

Storkel, H. L. (2017, February). Getting the Most Bang for Your Therapy Minute: Sound and Word Complexity in Treatment of Children with Phonological Disorders. KU/KUMC Intercampus Program in Communicative Disorders Speech-Language Pathology Conference, Overland Park, KS.

NOTE: This worksheet focuses on target sounds that have substitution or deletion errors. Distortion errors do not really apply. Treat distortions as correct for the purpose of marking this worksheet. HOWEVER, distortions may need treatment so do not ignore. The complexity approach is a phonological approach and predicts phonological learning. Distortions are likely motoric in nature and need a motoric approach.

Step 1: Use your probe accuracy data to highlight low accuracy sounds (i.e., 0 or 1 correct production) in Row 3. These WILL be considered as potential treatment targets. Shade all other sounds in gray in row 3 and for the entire column. These will not be considered as potential treatment targets. Score 1 point in row 19 for all sounds that are note shaded gray.

Step 2: Copy and paste ALL of your probe accurady data to Column B. For the sounds that you shaded as high accuracy, shade those here in gray. They do NOT need to be monitored or to be improved because they are high accuracy. Delete all the numbers in the ROWS that are shaded in gray. Give points in Row 20 based on score in Row 18 in the following way -- 2 points for score of 10+, 1 point for score 6-9, 0 points for score 0-5. This represents the sounds that are good to treat based on generalization predicted by language laws. You may need to adjust the scoring for children who have few sounds in error (i.e., few rows).

Step 3: Late acquired targets (i.e., late 8) are already scored for you in row 21.

Step 4: Consult your stimulability probe. Give a point (in row 22) for any of the targets (columns) that are non-stimulable

Step 5: Review the point total in row 23 and select a sound for treatment that has the highest (or one of the highest) totals. Select one sound only, unless selecting a second sound would allow you to target generalization to a different group of sounds. Be sure to look at your options in the context of the other sounds the child is producing in error (e.g., if you have a fricative and liquid target option, what is the child doing for other fricatives and liquids?). Also, consider best word position for treatment based on accuracy in onsets versus codas (i.e., pick the low accuracy position).

Step 6: Note the sounds that need to be monitored. This will be all of the low and mid accuracy sounds (i.e., just exlude the sounds in the rows that you shaded gray)

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s														
	z				1									1	1
	S														
	C														
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	*3*	*6*	*2*	*6*	*2*	*2*	*2*	*1*	*1*	*4*	*3*	*6*	*7*	*11*
Target Selection Evidence	Least Knowledge	1	1	0	1	0	1	1	1	0	1	1	0	0	0
	Language Laws	0	1		1		0	0	0		0	0			
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable														
	Total Points	*2*	*3*	*1*	*3*	*1*	*2*	*2*	*1*	*0*	*1*	*1*	*0*	*0*	*0*
	Treated Sound:														
	Sounds for Monitoring:														

Application: PD 50 (3;6 Male)

This worksheet is an adaptation of a target selection matrix proposed by Gierut and Hulse (2010). When citing this worksheet, please cite both the original and this adapted version:

Gierut, J. A., & Hulse, L. E. (2010) Evidence-based practice: A matrix for predicting phonological generalization. *Clinical Linguistics and Phonetics, 24,* 323-334.

Storkel, H. L. (2017, February). Getting the Most Bang for Your Therapy Minute: Sound and Word Complexity in Treatment of Children with Phonological Disorders. KU/KUMC Intercampus Program in Communicative Disorders Speech-Language Pathology Conference, Overland Park, KS.

NOTE: This worksheet focuses on target sounds that have substitution or deletion errors. Distortion errors do not really apply. Treat distortions as correct for the purpose of marking this worksheet. HOWEVER, distortions may need treatment so do not ignore. The complexity approach is a phonological approach and predicts phonological learning. Distortions are likely motoric in nature and need a motoric approach.

Step 1: Use your probe accuracy data to highlight low accuracy sounds (i.e., 0 or 1 correct production) in Row 3. These WILL be considered as potential treatment targets. Shade all other sounds in gray in row 3 and for the entire column. These will not be considered as potential treatment targets. Score 1 point in row 19 for all sounds that are note shaded gray.

Step 2: Copy and paste ALL of your probe accurady data to Column B. For the sounds that you shaded as high accuracy, shade those here in gray. They do NOT need to be monitored or to be improved because they are high accuracy. Delete all the numbers in the ROWS that are shaded in gray. Give points in Row 20 based on score in Row 18 in the following way -- 2 points for score of 10+, 1 point for score 6-9, 0 points for score 0-5. This represents the sounds that are good to treat based on generalization predicted by language laws. You may need to adjust the scoring for children who have few sounds in error (i.e., few rows).

Step 3: Late acquired targets (i.e., late 8) are already scored for you in row 21.

Step 4: Consult your stimulability probe. Give a point (in row 22) for any of the targets (columns) that are non-stimulable

Step 5: Review the point total in row 23 and select a sound for treatment that has the highest (or one of the highest) totals. Select one sound only, unless selecting a second sound would allow you to target generalization to a different group of sounds. Be sure to look at your options in the context of the other sounds the child is producing in error (e.g., if you have a fricative and liquid target option, what is the child doing for other fricatives and liquids?). Also, consider best word position for treatment based on accuracy in onsets versus codas (i.e., pick the low accuracy position).

Step 6: Note the sounds that need to be monitored. This will be all of the low and mid accuracy sounds (i.e., just exlude the sounds in the rows that you shaded gray)

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s														
	z				1									1	1
	S														
	C														
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	*3*	*6*	*2*	*6*	*2*	*2*	*2*	*1*	*1*	*4*	*3*	*6*	*7*	*11*
Target Selection Evidence	Least Knowledge	1	1	0	1	0	1	1	1	0	1	1	0	0	0
	Language Laws	0	1		1		0	0	0		0	0			
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable														
	Total Points	*2*	*3*	*1*	*3*	*1*	*2*	*2*	*1*	*0*	*1*	*1*	*0*	*0*	*0*
	Treated Sound:														
	Sounds for Monitoring:														

Application: PD 50 (3;6 Male)

	Isolation	#_i	i_i	i_#	#_a	a_a	a_#	#_u	u_u	u_#	Correct	Total	%	Stim?
k	+	-	-	+	-	-	+	-	-	+	4	10	40%	YES
g	-	+	-	+	-	-	-	-	-	+	3	10	30%	YES
f	+	-	-	-	-	-	-	-	-	-	1	10	10%	NO
v	+	-	-	-	-	-	-	-	-	-	1	10	10%	NO
T	-	-	-	-	-	-	-	-	-	-	0	10	0%	NO
D	-	-	-	-	-	-	-	-	-	-	0	10	0%	NO
s												10		
z	+	+	-	+	-	-	+	+	-	+	6	10	60%	YES
S												10		
C												10		
J												10		
G	-		-	-		-	-		-	-	0	7	0%	NO
l	-	+	-	+	-	-	-	+	-	-	3	10	30%	YES
r	+	+	-	-	-	-	-	-	-	-	2	10	20%	NO

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s														
	z				1									1	1
	S														
	C														
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	3	6	2	6	2	2	2	1	1	4	3	6	7	11
Target Selection Evidence	Least Knowledge	1	1	0	1	0	1	1	1	0	1	1	0	0	0
	Language Laws	0	1		1		0	0	0		0	0			
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable	1	1		0		0	1	1		0	1			
	Total Points	3	4	1	3	1	2	3	2	0	1	2	0	0	0
	Treated Sound:														
	Sounds for Monitoring:														

Application: PD 50 (3;6 Male)

This worksheet is an adaptation of a target selection matrix proposed by Gierut and Hulse (2010). When citing this worksheet, please cite both the original and this adapted version:

Gierut, J. A., & Hulse, L. E. (2010) Evidence-based practice: A matrix for predicting phonological generalization. *Clinical Linguistics and Phonetics, 24,* 323-334.

Storkel, H. L. (2017, February). Getting the Most Bang for Your Therapy Minute: Sound and Word Complexity in Treatment of Children with Phonological Disorders. KU/KUMC Intercampus Program in Communicative Disorders Speech-Language Pathology Conference, Overland Park, KS.

NOTE: This worksheet focuses on target sounds that have substitution or deletion errors. Distortion errors do not really apply. Treat distortions as correct for the purpose of marking this worksheet. HOWEVER, distortions may need treatment so do not ignore. The complexity approach is a phonological approach and predicts phonological learning. Distortions are likely motoric in nature and need a motoric approach.

Step 1: Use your probe accuracy data to highlight low accuracy sounds (i.e., 0 or 1 correct production) in Row 3. These WILL be considered as potential treatment targets. Shade all other sounds in gray in row 3 and for the entire column. These will not be considered as potential treatment targets. Score 1 point in row 19 for all sounds that are note shaded gray.

Step 2: Copy and paste ALL of your probe accurady data to Column B. For the sounds that you shaded as high accuracy, shade those here in gray. They do NOT need to be monitored or to be improved because they are high accuracy. Delete all the numbers in the ROWS that are shaded in gray. Give points in Row 20 based on score in Row 18 in the following way -- 2 points for score of 10+, 1 point for score 6-9, 0 points for score 0-5. This represents the sounds that are good to treat based on generalization predicted by language laws. You may need to adjust the scoring for children who have few sounds in error (i.e., few rows).

Step 3: Late acquired targets (i.e., late 8) are already scored for you in row 21.

Step 4: Consult your stimulability probe. Give a point (in row 22) for any of the targets (columns) that are non-stimulable

Step 5: Review the point total in row 23 and select a sound for treatment that has the highest (or one of the highest) totals. Select one sound only, unless selecting a second sound would allow you to target generalization to a different group of sounds. Be sure to look at your options in the context of the other sounds the child is producing in error (e.g., if you have a fricative and liquid target option, what is the child doing for other fricatives and liquids?). Also, consider best word position for treatment based on accuracy in onsets versus codas (i.e., pick the low accuracy position).

Step 6: Note the sounds that need to be monitored. This will be all of the low and mid accuracy sounds (i.e., just exlude the sounds in the rows that you shaded gray)

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s														
	z				1									1	1
	S														
	C														
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	3	6	2	6	2	2	2	1	1	4	3	6	7	11
Target Selection Evidence	Least Knowledge	1	1	0	1	0	1	1	1	0	1	1	0	0	0
	Language Laws	0	1		1		0	0	0		0	0			
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable	1	1		0		0	1	1		0	1			
	Total Points	3	4	1	3	1	2	3	2	0	1	2	0	0	0
	Treated Sound:														
	Sounds for Monitoring:														

Application: PD 50 (3;6 Male)

Accuracy Analysis		Onset#	Onset %	Coda#	Coda%	Total%
Fronting	k	0	0%	2	40%	20%
Fronting in onset; Coda deleted	g	0	0%	0	0%	0%
/h/ onset; variable coda	f	0	0%	1	20%	10%
Variable	v	1	20%	1	20%	20%
Onset variable; /s/ coda	T	0	0%	0	0%	0%
Onset d; Coda deleted	D	0	0%	0	0%	0%
100% if ignore dentalized	s	4	80%	4	80%	80%
Onset /w/; coda deleted (30% acc if ignore dentalized)	z	0	0%	0	0%	0%
	S	4	80%	4	80%	80%
	C	5	100%	5	100%	100%
Onset variable	J	1	20%	5	100%	60%
Coda deleted	G	N/A	N/A	0	0%	0%
Onset /w/; Coda deleted	l	0	0%	0	0%	0%
Onset /w/; Coda deleted	r	0	0%	0	0%	0%
	ALL	15	22%	22	32%	27%

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s														
	z				1									1	1
	S														
	C														
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	*3*	*6*	*2*	*6*	*2*	*2*	*2*	*1*	*1*	*4*	*3*	*6*	*7*	*11*
Target Selection Evidence	Least Knowledge	1	1	0	1	0	1	1	1	0	1	1	0	0	0
	Language Laws	0	1		1		0	0	0		0	0			
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable	1	1		0		0	1	1		0	1			
	Total Points	*3*	*4*	*1*	*3*	*1*	*2*	*3*	*2*	*0*	*1*	*2*	*0*	*0*	*0*
	Treated Sound: D in onset (many fricatives low accuracy; only one target -- child age 3;6). Could make an argument for /r/ though (no liquids but some accuracy for fricatives)														
	Sounds for Monitoring: k g f v T D z J G l r														

Application: PD 51

- Age: 4; 10; Male
- GFTA: Raw = 49; PR = 2
- Hearing Screening: Passed
- OWLS Receptive: WNL
- OWLS Expressive: LOW
  [Note: Shy initially. Later observation in conversation suggested more age-appropriate language skills]

Application: PD 51 (4;10, Male)

Accuracy Analysis		Onset#	Onset %	Coda#	Coda%	Total%	Onset Productions					Coda Productions				
Fronting	k	0	0%	0	0%	0%	d	t	t	d	t	t	t	t	t	t
Fronting	g	0	0%	1	20%	10%	d	d	d	d	d	d	d	d	d	d
/w/ onset	f	0	0%	5	100%	50%	w	h	w	w	w	f	f	f	f	f
variable onset	v	1	20%	5	100%	60%	w	b	v	-	b	v	v	v	v	v
Variable onset, Coda /f v/	T	0	0%	2	40%	20%	t	d	h	w	h	T	T	f	f	v
Onset /d/; Coda /v/	D	0	0%	0	0%	0%	v	d	d	d	d	v	v	v	N/A	N/A
Onset /h/	s	0	0%	5	100%	50%	d	h	h	h	h	s	s	s	s	s
Onset variable	z	0	0%	5	100%	50%	s	y	h	w	h	z	z	z	z	z
Onset /h/, Coda /s/	S	0	0%	0	0%	0%	h	h	h	h	h	s	s	s	s	s
Onset /t d/, Coda fronting	C	0	0%	0	0%	0%	t	d	d	d	d	ts	ts	ts	ts	ts
Onset variable; Coda fronting	J	0	0%	0	0%	0%	b	d	w	d	d	dz	dz	dz	dz	dz
fronting	G	N/A	N/A	0	0%	0%	N/A	N/A	N/A	N/A	N/A	n	n	n	n	n
Onset w; Coda deleted	l	0	0%	0	0%	0%	w	w	w	w	w	-	-	-	-	-
Onset w; Coda deleted	r	0	0%	0	0%	0%	w	w	w	w	w	-	-	-	-	-
	ALL	**1**	**1%**	23	34%	18%										

Application: PD 51 (4;10, Male)

Accuracy Analysis		Onset#	Onset %	Coda#	Coda%	Total%
Fronting	k	0	0%	0	0%	0%
Fronting	g	0	0%	1	20%	10%
/w/ onset	f	0	0%	5	100%	50%
variable onset	v	1	20%	5	100%	60%
Variable onset, Coda /f v/	T	0	0%	2	40%	20%
Onset /d/; Coda /v/	D	0	0%	0	0%	0%
Onset /h/	s	0	0%	5	100%	50%
Onset variable	z	0	0%	5	100%	50%
Onset /h/, Coda /s/	S	0	0%	0	0%	0%
Onset /t d/, Coda fronting	C	0	0%	0	0%	0%
Onset variable; Coda fronting	J	0	0%	0	0%	0%
fronting	G	N/A	N/A	0	0%	0%
Onset w; Coda deleted	l	0	0%	0	0%	0%
Onset w; Coda deleted	r	0	0%	0	0%	0%
	ALL	1	1%	23	34%	18%

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s		1	1	1						1		1	1	2
	z				1									1	1
	S		1		1	1					1		1	1	2
	C		1		1						1		1	1	1
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	*3*	*9*	*3*	*9*	*3*	*2*	*2*	*1*	*1*	*7*	*3*	*9*	*10*	*16*
Target Selection Evidence	Least Knowledge	0	1	0	0	1	1	1	1	1	1	0	0	1	1
	Language Laws														
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable														
	Total Points	*1*	*2*	*1*	*1*	*2*	*2*	*2*	*1*	*1*	*1*	*0*	*0*	*1*	*1*
	Treated Sound:														
	Sounds for Monitoring:														

Application: PD 51 (4;10, Male)

Accuracy Analysis		Onset#	Onset %	Coda#	Coda%	Total%
Fronting	k	0	0%	0	0%	0%
Fronting	g	0	0%	1	20%	10%
/w/ onset	f	0	0%	5	100%	50%
variable onset	v	1	20%	5	100%	60%
Variable onset, Coda /f v/	T	0	0%	2	40%	20%
Onset /d/; Coda /v/	D	0	0%	0	0%	0%
Onset /h/	s	0	0%	5	100%	50%
Onset variable	z	0	0%	5	100%	50%
Onset /h/, Coda /s/	S	0	0%	0	0%	0%
Onset /t d/, Coda fronting	C	0	0%	0	0%	0%
Onset variable; Coda fronting	J	0	0%	0	0%	0%
fronting	G	N/A	N/A	0	0%	0%
Onset w; Coda deleted	l	0	0%	0	0%	0%
Onset w; Coda deleted	r	0	0%	0	0%	0%
	ALL	1	1%	23	34%	18%

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s		1	1	1						1		1	1	2
	z				1									1	1
	S		1		1	1					1		1	1	2
	C		1		1						1		1	1	1
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	*3*	*9*	*3*	*9*	*3*	*2*	*2*	*1*	*1*	*7*	*3*	*9*	*10*	*16*
Target Selection Evidence	Least Knowledge	0	1	0	0	1	1	1	1	1	1	0	0	1	1
	Language Laws		1			0	0	0	0	0	1			2	2
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable														
	Total Points	*1*	*3*	*1*	*1*	*2*	*2*	*2*	*1*	*1*	*2*	*0*	*0*	*3*	*3*
	Treated Sound:														
	Sounds for Monitoring:														

Application: PD 51 (4;10, Male)

	Isolation	#_i	i_i	i_#	#_a	a_a	a_#	#_u	u_u	u_#	Correct	Total	%	Stim?
k	-	-	-	-	-	-	-	-	-	-	0	10	0%	No
g	-	-	-	-	-	-	-	-	-	-	0	10	0%	No
f												10		
v												10		
T	+	-	-	-	-	-	+	-	-	+	3	10	30%	YES
D	+	-	-	-	-	-	-	-	-	+	2	10	20%	No
s												10		
z												10		
S	+	+	+	+	+	+	+	+	+	+	10	10	100%	YES
C	+	-	-	-	-	-	+	-	-	-	2	10	20%	No
J	-	-	-	+	-	-	+	-	-	+	3	10	30%	YES
G												7		
l	+	+	-	-	+	-	-	-	-	-	3	10	30%	YES
r	+	+	-	-	+	-	-	+	-	-	4	10	40%	YES

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s		1	1	1						1		1	1	2
	z				1									1	1
	S		1		1	1					1		1	1	2
	C		1		1						1		1	1	1
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	***3***	***9***	***3***	***9***	***3***	***2***	***2***	***1***	***1***	***7***	***3***	***9***	***10***	***16***
Target Selection Evidence	Least Knowledge	0	1	0	0	1	1	1	1	1	1	0	0	1	1
	Language Laws		1			0	0	0	0	0	1			2	2
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable														
	Total Points	***1***	***3***	***1***	***1***	***2***	***2***	***2***	***1***	***1***	***2***	***0***	***0***	***3***	***3***
	Treated Sound:														
	Sounds for Monitoring:														

Application: PD 51 (4;10, Male)

	Isolation	#_i	i_i	i_#	#_a	a_a	a_#	#_u	u_u	u_#	Correct	Total	%	Stim?
k	-	-	-	-	-	-	-	-	-	-	0	10	0%	No
g	-	-	-	-	-	-	-	-	-	-	0	10	0%	No
f												10		
v												10		
T	+	-	-	-	-	-	+	-	-	+	3	10	30%	YES
D	+	-	-	-	-	-	-	-	-	+	2	10	20%	No
s												10		
z												10		
S	+	+	+	+	+	+	+	+	+	+	10	10	100%	YES
C	+	-	-	-	-	-	+	-	-	-	2	10	20%	No
J	-	-	-	+	-	-	+	-	-	+	3	10	30%	YES
G												7		
l	+	+	-	-	+	-	-	-	-	-	3	10	30%	YES
r	+	+	-	-	+	-	-	+	-	-	4	10	40%	YES

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s		1	1	1						1		1	1	2
	z				1									1	1
	S		1		1	1					1		1	1	2
	C		1		1						1		1	1	1
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	***3***	***9***	***3***	***9***	***3***	***2***	***2***	***1***	***1***	***7***	***3***	***9***	***10***	***16***
Target Selection Evidence	Least Knowledge	0	1	0	0	1	1	1	1	1	1	0	0	1	1
	Language Laws		1			0	0	0	0	0	1			2	2
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable		1			0	0	0	N/A	0	0			1	0
	Total Points	***1***	***4***	***1***	***1***	***2***	***2***	***2***	***1***	***1***	***2***	***0***	***0***	***4***	***3***
	Treated Sound:														
	Sounds for Monitoring:														

Application: PD 51 (4;10, Male)

Accuracy Analysis		Onset#	Onset %	Coda#	Coda%	Total%
Fronting	k	0	0%	0	0%	0%
Fronting	g	0	0%	1	20%	10%
/w/ onset	f	0	0%	5	100%	50%
variable onset	v	1	20%	5	100%	60%
Variable onset, Coda /f v/	T	0	0%	2	40%	20%
Onset /d/; Coda /v/	D	0	0%	0	0%	0%
Onset /h/	s	0	0%	5	100%	50%
Onset variable	z	0	0%	5	100%	50%
Onset /h/, Coda /s/	S	0	0%	0	0%	0%
Onset /t d/, Coda fronting	C	0	0%	0	0%	0%
Onset variable; Coda fronting	J	0	0%	0	0%	0%
fronting	G	N/A	N/A	0	0%	0%
Onset w; Coda deleted	l	0	0%	0	0%	0%
Onset w; Coda deleted	r	0	0%	0	0%	0%
	ALL	1	1%	23	34%	18%

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s		1	1	1						1		1	1	2
	z				1									1	1
	S		1		1	1					1		1	1	2
	C		1		1						1		1	1	1
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	3	9	3	9	3	2	2	1	1	7	3	9	10	16
Target Selection Evidence	Least Knowledge		1			1	1	1	1	1	1			1	1
	Language Laws		1			0	0	0	0	0	1			2	2
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable		1			0	0	0	N/A	0	0			1	0
	Total Points	1	4	1	1	2	2	2	1	1	2	0	0	4	3

Application: PD 51 (4;10, Male)

Accuracy Analysis		Onset#	Onset %	Coda#	Coda%	Total%
Fronting	k	0	0%	0	0%	0%
Fronting	g	0	0%	1	20%	10%
/w/ onset	f	0	0%	5	100%	50%
variable onset	v	1	20%	5	100%	60%
Variable onset, Coda /f v/	T	0	0%	2	40%	20%
Onset /d/; Coda /v/	D	0	0%	0	0%	0%
Onset /h/	s	0	0%	5	100%	50%
Onset variable	z	0	0%	5	100%	50%
Onset /h/, Coda /s/	S	0	0%	0	0%	0%
Onset /t d/, Coda fronting	C	0	0%	0	0%	0%
Onset variable; Coda fronting	J	0	0%	0	0%	0%
fronting	G	N/A	N/A	0	0%	0%
Onset w; Coda deleted	l	0	0%	0	0%	0%
Onset w; Coda deleted	r	0	0%	0	0%	0%
	ALL	1	1%	23	34%	18%

		Potential Treatment Targets (Low Accuracy Only)													
		Late 8							Mid 8						
		T	D	s	z	S	l	r	G	k	g	f	v	C	J
Sounds in Error (Probe Sounds) (Language Laws Coded in Matrix)	k	1	2	1	2	1				1	1	1	2	1	2
	g	1	1	1	1	1					1	1	1	1	1
	f		1		1						1	1	1	1	2
	v												1	1	1
	T	1	1		1						1		1	1	2
	D		1											1	1
	s		1	1	1						1		1	1	2
	z				1									1	1
	S		1		1	1					1		1	1	2
	C		1		1						1		1	1	1
	J														1
	G						1	1	1						
	l						1								
	r							1							
	Total Points	*3*	*9*	*3*	*9*	*3*	*2*	*2*	*1*	*1*	*7*	*3*	*9*	*10*	*16*
Target Selection Evidence	Least Knowledge		1			1	1	1	1	1	1			1	1
	Language Laws		1			0	0	0	0	0	1			2	2
	Late Acquired	1	1	1	1	1	1	1	0	0	0	0	0	0	0
	Non-Stimulable		1			0	0	0	N/A	0	0			1	0
	Total Points	*1*	*4*	*1*	*1*	*2*	*2*	*2*	*1*	*1*	*2*	*0*	*0*	*4*	*3*
	Treated Sound: C in onset (child is starting to produce T and other fricatives; All palatals low accuracy); Liquids??														
	Sounds for Monitoring: k g f v T D s z S C J G l r														

Application: PD 49

- Age: 5;9; Male
- GFTA: Raw = 36; PR = 3
- Hearing Screening: Passed
- OWLS Receptive: WNL (actually high)
- OWLS Expressive: WNL (actually high)

Application: PD 49 (5;9 Male)

Accuracy Analysis		Onset#	Onset %	Coda#	Coda%	Total%	Onset Productions					Coda Productions				
**Note: Backing of /t d/ in onset; correct production emerging in coda	k	5	100%	5	100%	100%	k	k	k	k	k	k	k	k	k	k
	g	5	100%	5	100%	100%	g	g	g	g	g	g	g	g	g	g
	f	5	100%	5	100%	100%	f	f	f	f	f	f	f	f	f	f
stopping	v	3	60%	4	80%	70%	v	b	v	v	b	b	v	v	v	v
	T	4	80%	4	80%	80%	T	T	t	T	T	f	T	T	T	T
stopping	D	1	20%	0	0%	13%	d	d	D	d	d	d	d	d	N/A	N/A
Distortion-lateralized	s	1	20%	0	0%	10%	lat	lat	s	lat	lat	lat	lat	lat	lat	lat
Distortion-lateralized	z	0	0%	0	0%	0%	lat	lat	lat	lat	lat	lat	lat	lat	lat	lat
Distortion-lateralized	S	0	0%	0	0%	0%	lat	lat	lat	lat	lat	lat	lat	lat	lat	lat
Distortion-lateralized	C	0	0%	0	0%	0%	lat	lat	lat	lat	lat	lat	lat	lat	lat	lat
Distortion-lateralized	J	0	0%	0	0%	0%	lat	lat	lat	lat	lat	lat	lat	lat	lat	lat
	G	N/A	N/A	5	100%	100%	N/A	N/A	N/A	N/A	N/A	G	G	G	G	G
/w/ in onset; deletion in coda	l	6	86%	2	40%	67%	l	l	l	w	l	-	l	-	-	l
/w/ in onset; deletion in coda	r	0	0%	0	0%	0%	w	w	w	w	w	-	0	-	-	-
	ALL	30	45%	30	44%	44%										

An aside: Distortions

Do we worry about lateralized productions?

Smit (1993) *JSHR, 36, 533-547*
Lateralized Productions </= 5%

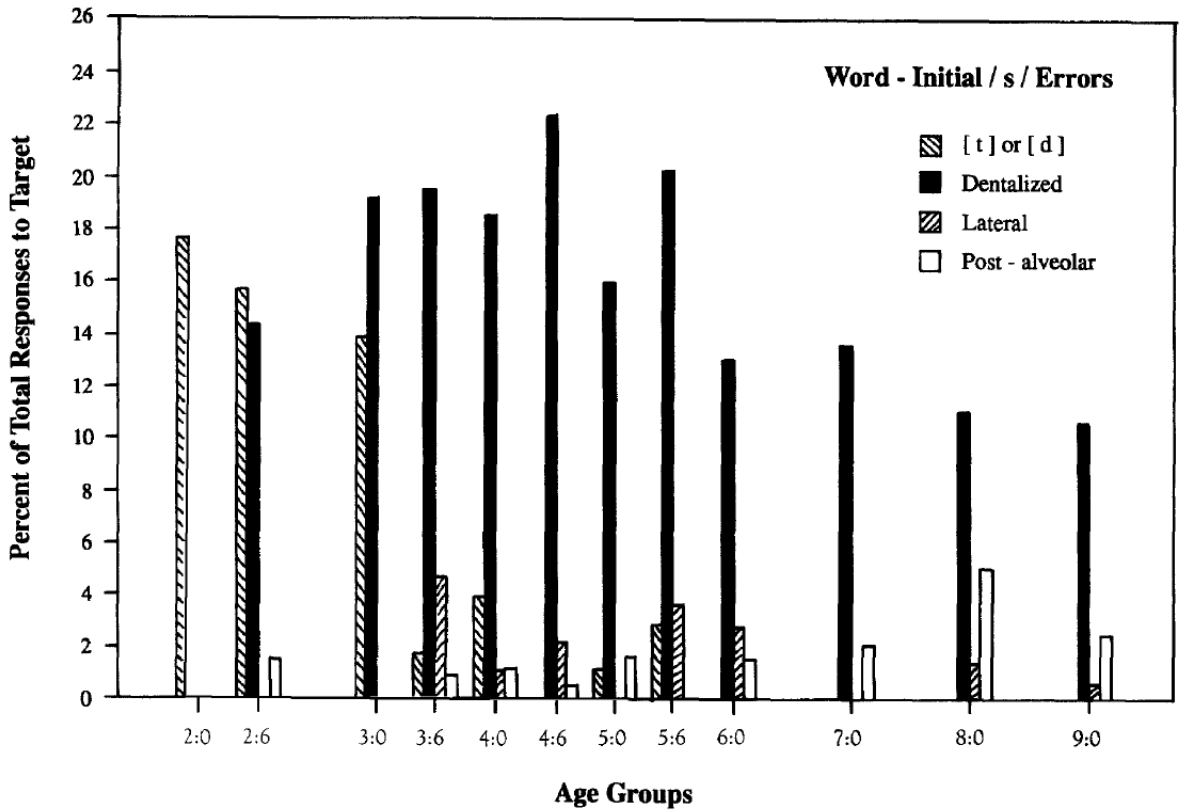


FIGURE 2. Distribution by age group of the most common errors used for word-initial /s/.

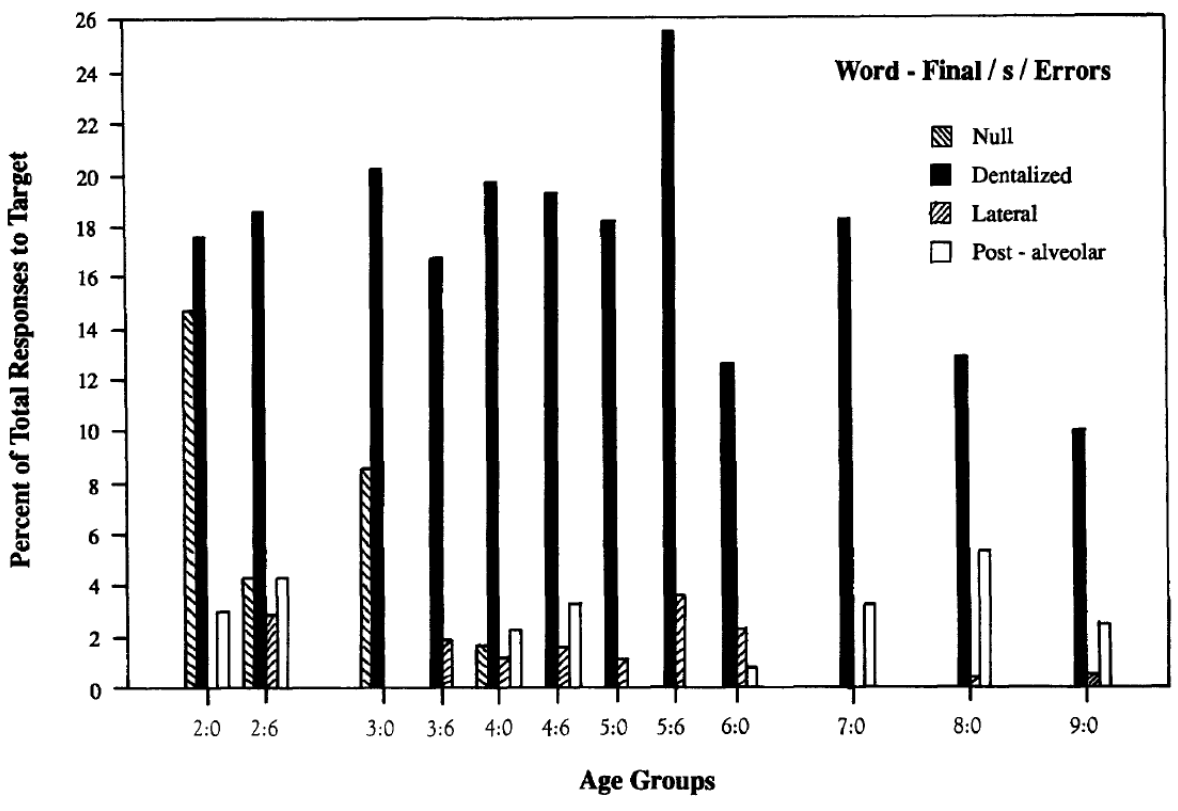


FIGURE 3. Distribution by age group of the most common errors used for word-final /s/.

Word Characteristics

Gierut & Morrisette (2012) Applied Psycholinguistics

Gierut & Morrisette (2012) Journal of Child Language

Frequency

- Number of times a word occurs in a language
  - Typically, it's the number of times a word occurs in a SAMPLE of a language

- Treatment of sounds in **high frequency** words (>100 occurrences in a million word sample) tends to lead to greater phonological learning than treatment of sounds in low frequency words
  - Gierut, Morrisette, & Champion (1999)
  - Morrisette & Gierut (2002)
  - Gierut & Morrisette (2012)

Neighborhood Density

- The number of words that are phonologically similar to a given word
  - Example neighbors: Cat – Hat, Cot, Cap, Scat, At
- Influence of density on phonological treatment has been variable
- When frequency was balanced, treatment of sounds in **low density** words tends to lead to greater phonological learning than treatment of sounds in high density words
  - Morrisette & Gierut (2002)
- When frequency was crossed with density, treatment of sounds in **high frequency high density** words lead to greater phonological learning than any other combination of frequency and density
  - Gierut & Morrisette, 2012

Freq x Density Explanation

- High density offers high contrast
  - E.g., Treat /k/ in "cat" and /k/ is contrasted (mentally) with many other sounds
  - Cat – Hat, Cot, Cap, Scat, At
  - So…high density is ~minimal pair treatment but without having to explicitly present minimal pairs
  - Contrast may enhance insights about the phonological system as a whole
  - Supports system-wide generalization

- BUT, high frequency is needed to guard against confusion
  - Greater repetition in the environment
  - Reinforce correct input
  - Easier to access

Age-of-Acquisition (AoA)

- AoA = the estimated age when a word was learned
  - AoA databases typically ask adults to rate when they think a word was likely learned
  - May not be actual age of acquisition

- Treatment of sounds in **late AoA** words tends to lead to greater phonological learning than treatment of sounds in early AoA words
  - Gierut & Morrisette (2012)

- **Late AoA and low frequency** words were the best combination of AoA and frequency

AoA Explanation

- Late AoA are novel words OR recently learned words
  - Child has not said these words incorrectly for as long as early AoA words
  - Child's current production is not as entrenched as for early AoA words
  - May be easier to adopt a new way of producing these words

Logistical tangent

How do we know the characteristics of words?

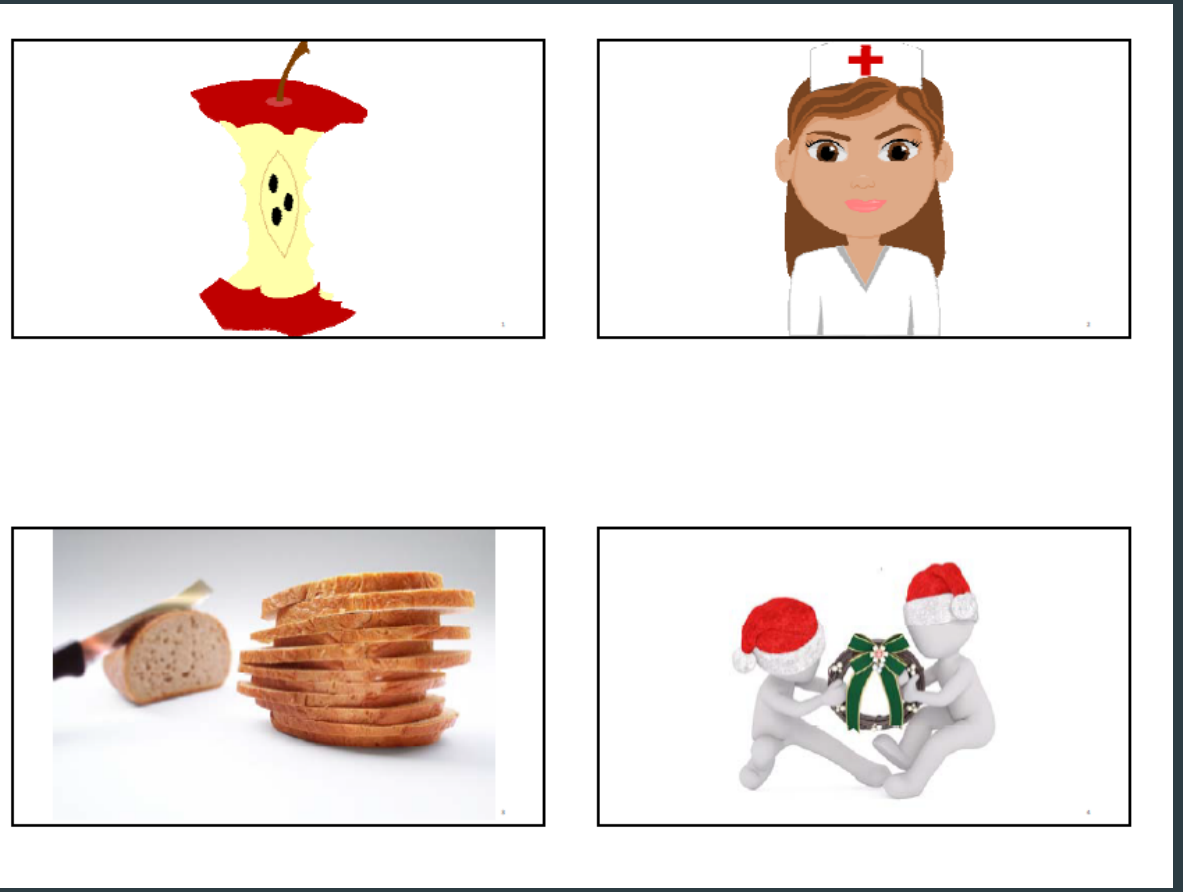
High Frequency Word List from SLPath.com – Select density 10+ for High Density

KU ScholarWorks Files:

4. HighF_HighD_List.xlsx
4. HighF_HighD_Pictures.pptx
4. HighF_HighD_Pictures_Print.pdf

5. Late_AoA_List.xlsx
5. Late_AoA_Pictures.pptx
5. Late_AoA_Pictures_Print.pdf

HighF HighF – List & Pics
*No stimuli for /v T D z S C J/



Trans	C1	C1 Dev	C2	C2 Dev	HML_Word	HML_N_Nbors	KF_Freq	CML_Word	Slide #	Prompt
kor	k	mid-8	r	late-8	core	36	146	Not Found	1	The middle of the apple is the …
kEr	k	mid-8	r	late-8	care	23	162	care	2	This is a nurse. When people are sick she takes…
k^t	k	mid-8	t	mid-8	cut	25	192	cut	3	Here is the loaf of bread. To make the pieces you have to …
kip	k	mid-8	p	early-8	keep	21	264	keep	4	They were sharing but now he doesn't want to give up the wreath. He wants to…
kar	k	mid-8	r	late-8	car	24	274	car	5	You drive a ….
kes	k	mid-8	s	late-8	case	22	362	case	6	This is a wallet. This is a purse. This is a …
g^n	g	mid-8	n	early-8	gun	20	118	gun	7	This is a squirt…
gem	g	mid-8	m	early-8	game	20	123	game	8	Do you want to play a …
gcn	g	mid-8	n	early-8	gone	17	195	gone	9	Here's the dandelion. Someone blew it and now it's…
gRl	g	mid-8	l	late-8	girl	16	220	girl	10	She's not a boy. She's a…
gev	g	mid-8	v	mid-8	gave	18	285	gave	11	It's his birthday so his friend…
gUd	g	mid-8	d	early-8	good	12	807	good	12	This cupcake doesn't taste bad. It tastes…
fid	f	mid-8	d	early-8	feed	19	123	feed	13	The puppy is hungry. She has to …

Late AoA– List & Pics
*No stimuli for /D z/

Word	Slide#	Prompt	7-point G&L	7-point BF&H	K&F Frequency	HML Density B	Onset
chipmunk	1	This animal isn't a squirrel, it's a…		5.64	1	0	C
charm	2	This is a bracelet for a..	4.56		26	7	C
chow	3	This type of dog is a …	5.61		2	10	C
chart	4	You can show numbers on a …		5.06	22	12	C
check	5	She doesn't know the time so she needs to ..		3.83	88	15	C
chill	6	This cat isn't excited. He's …		3.76	14	22	C
Mean				4.74	26	11	
Minimum				3.76	1	0	
Maximum				5.64	88	22	
Word	**Slide#**	**Prompt**	**7-point G&L**	**7-point BF&H**	**K&F Frequency**	**HML Density B**	**Onset**
jaguar	7	This type of cat is a …		4.93	5	0	J
judo	8	They aren't practicing boxing. They are practicing…		5.36	1	1	J
jingle	9	When you shake this instrument, it makes a..	3.86		1	9	J
jade	10	This jewelry is made out of ..	5.72		1	11	J

Case Examples

PD 50 – /D/ or /r/

PD 51 -- /C/

High Frequency, High Density Options

Late AoA, Low Frequency Options

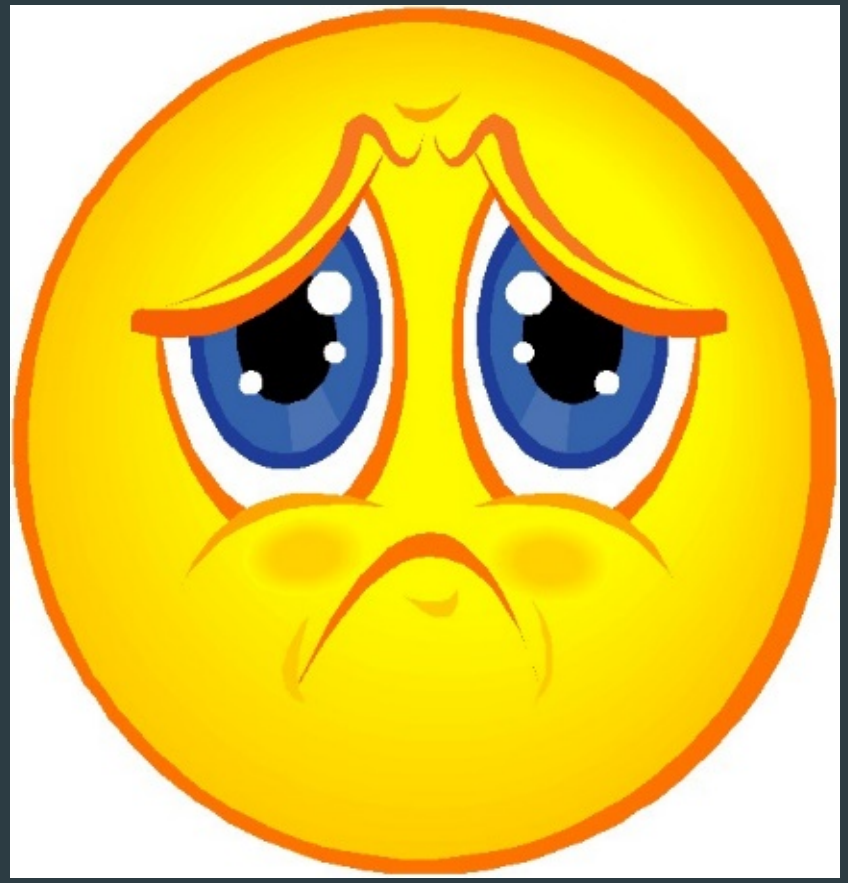
PD 50 – /D r/ -- High Density, High Frequency

Trans	C1	C1 Dev	C2	C2 Dev	HML_Word	HML_N_Nbors	KF_Freq	CML_Word	Slide #
res	r	late-8	s	late-8	race	29	103	race	1
riC	r	late-8	C	mid-8	reach	20	106	reach	2
rid	r	late-8	d	early-8	read	28	178	read	3
rEd	r	late-8	d	early-8	red	29	197	red	4
r^n	r	late-8	n	early-8	run	26	212	run	5
rod	r	late-8	d	early-8	road	29	237	road	6

PD 50 – /D r/ -- Late AoA, Low Frequency

Word	Slide#	Prompt	7-point G&L	7-point BF&H	K&F Frequency	HML Density B	Onset
rhinoceros	55	This animal is a…		4.24	3	0	r
ranch	56	A farm for animals/horses is sometimes called a ..	4.03		27	5	r
round	57	This ball isn't square, it's…		4.69	81	12	r
roof	58	The top part of the house is called a..		5.19	59	13	r
rung	59	The part of the ladder that you step on is called a ..	4.14		3	17	r
rust	60	This chain is very old. It's covered in…	3.8		10	19	r
Mean				4.35	31	11	
Minimum				3.80	3	0	
Maximum				5.19	81	19	

PD 51 – /C / -- High Density, High Frequency



PD 51 – /C / -- Late AoA, Low Frequency

Word	Slide#	Prompt	7-point G&L	7-point BF&H	K&F Frequency	HML Density B	Onset
chipmunk	1	This animal isn't a squirrel, it's a…		5.64	1	0	C
charm	2	This is a bracelet for a..	4.56		26	7	C
chow	3	This type of dog is a …	5.61		2	10	C
chart	4	You can show numbers on a …		5.06	22	12	C
check	5	She doesn't know the time so she needs to ..		3.83	88	15	C
chill	6	This cat isn't excited. He's …		3.76	14	22	C
Mean				4.74	26	11	
Minimum				3.76	1	0	
Maximum				5.64	88	22	

Case Insights

For certain sounds, real word options are limited

High Frequency, High Density CVCs: k g f (no v T D) s (no z S C J) l r

Late AoA, Low Frequency: k g f v T (no D) s (no z) S C J l r

Complexity Approach: Clusters

Gierut (1999) *JSLHR*

Sequences Of Sounds

- Canonical structure
  - Shows the sequence of vowels and consonants
  - E.g., “key” = /ki/ = consonant + vowel = CV
- Syllable
  - Parts of words
  - E.g., “keynote” = /ki.not/ = 2 syllables = CV.CVC
- Syllable parts
  - Onset: Everything before the vowel
  - Nucleus: Vowel
  - Coda: Everything after the vowel

Consonant Cluster

- Two (or more) consonants in the same syllable part (i.e., onset or coda)
  - /ki.not/ = 2 syllables = CV.CVC: Any clusters here?
  - /brid/ = 1 syllable = CCVC: Any clusters here?
  - /tost/ = 1 syllable = CVCC: Any clusters here?

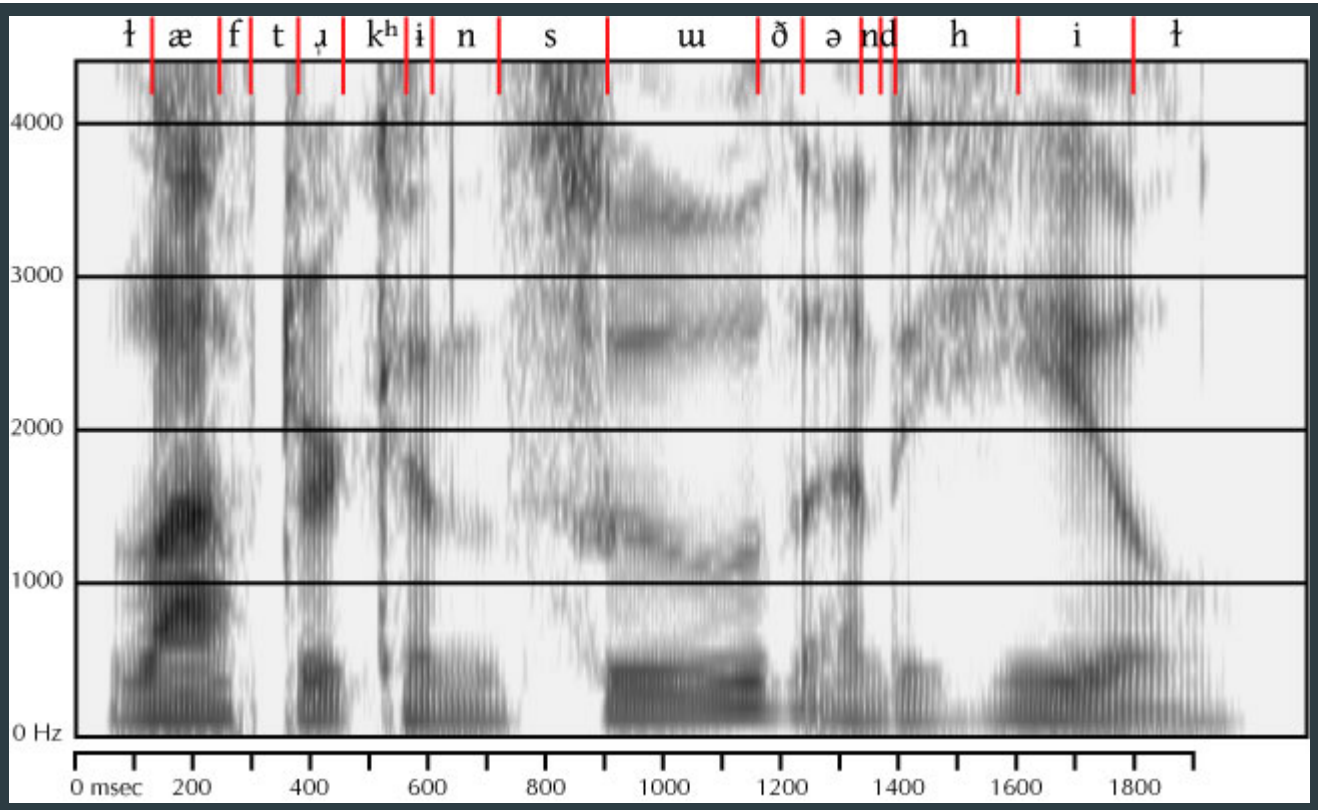
Large Variety Of English Clusters

- /pl/ -- plate
- /tr/ -- tree
- /sw/ -- swing
- /sm/ -- smoke
- /spl/ -- splash
- /str/ -- stripe
- /nd/ -- hand
- /ks/ -- box
- /lt/ -- belt
- /rm/ -- arm
- /rb/ -- curb
- /lf/ -- wolf

Sonority Sequencing Principle (SSP)

- Sonority = resonance; degree of constriction
- In a syllable, sonority should rise to a peak & then fall
  - Onset = rising sonority
  - Nucleus = sonority peak
  - Coda = falling sonority

Resonance On Spectrogram



- "Laughter can soothe and heal."
- Image taken from: http://home.cc.umanitoba.ca/~robh/archives/arc0601.html

Sonority Hierarchy

- Least sonorous

  7 = voiceless stops/affricates: /p t k ʧ /
  6 = voiced stops/affricates: /b d g ʤ/
  5 = voiceless fricatives: /f θ s ʃ /
  4 = voiced fricatives: /v ð z ʒ ʤ/
  3 = nasals: /m n ŋ/
  2 = liquids: /l r/
  1 = glides: /w j h/
  0 = vowels

- Most sonorous

Sonority Difference (SD)

- /brænd/

- Onset /br/
  b = voiced stop = 6
  r = liquid = 2
  SD = 6-2 = +4 (+ = rising, as expected for onset)

- Coda /nd/
  n = nasal = 3
  d = voiced stop = 6
  SD = 3-6 = -3 (- = falling, as expected for coda)

Application: Computing SD -- Onsets

- /θri/
- /mjuzIk/
- /trIp/
- /stap/
- /kwæk/

Application: Computing SD -- Onsets

- /θri/ = 5 – 2 = 3
- /mjuzIk/ = 3 – 1 = 2
- /trIp/ = 7 – 2 = 5
- /stap/ = 5 – 7 = -2
- /kwæk/ = 7 – 1 = 6

Onsets By SD

- 6 = voiceless stop + glide /tw kw pj kj/
- 5 = voiced stop + glide /bj/
  5 = voiceless stop + liquid /pl kl pr tr kr/
- 4 = voiced stop + liquid /bl gl br dr gr/
  4 = voiceless fricative + glide /sw fj/
- 3 = voiced fricative + glide /vj/
  3 = voiceless fricative + liquid /ʃr fl sl fr θr/
- 2 = /s/ + nasal /sm sn/
  2 = nasal + glide /mj/
- -2 = /s/ + stop /sp st sk/

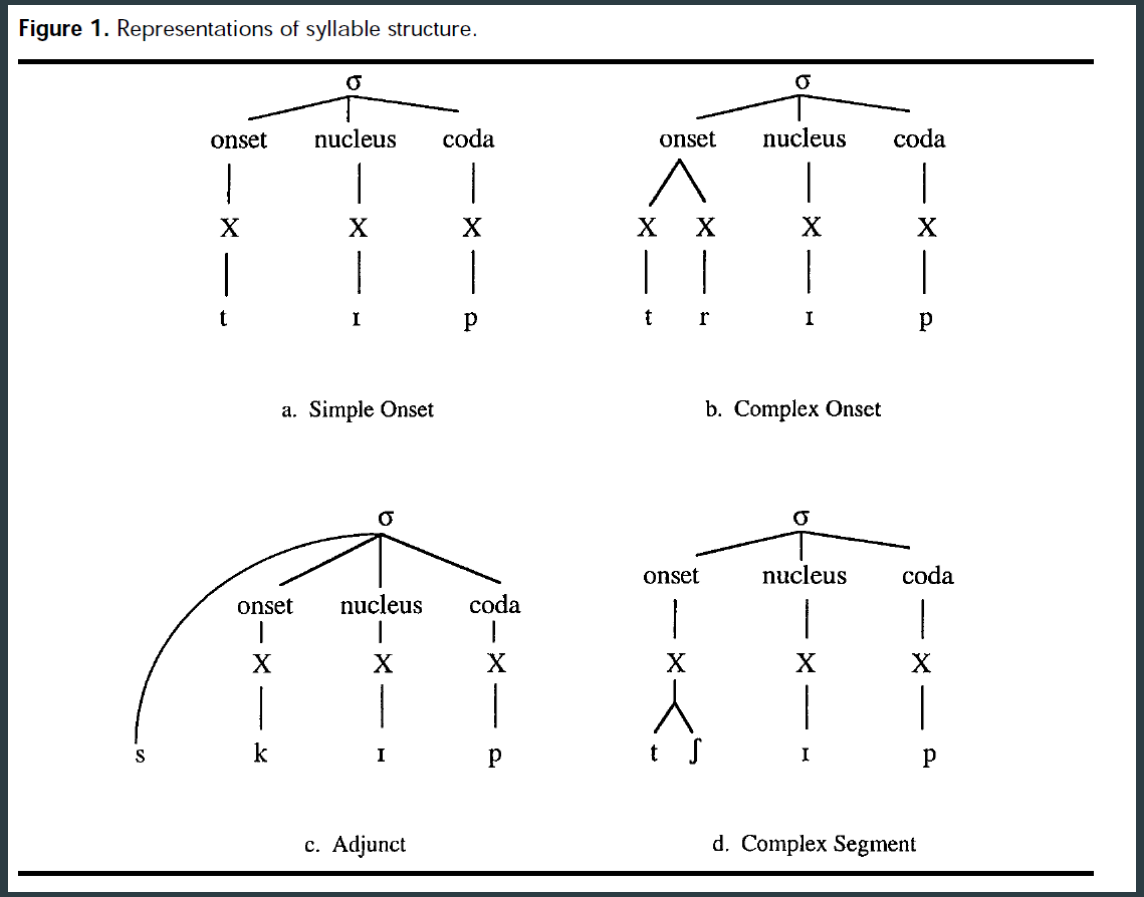
FYI -- Codas By SD

- -5 = liquid + voiceless stop /lp lt lk rp rt rk rʧ/
- -4 = liquid + voiced stop /ld rb rd rg rʤ/
  -4 = nasal + voiceless stop /mp nt ŋk nts nʧ/
- -3 = nasal + voiced stop /nd nʤ/
  -3 = liquid + voiceless fricative /lf l θ rf rθ rs/
- -2 = nasal + fricative /n θ/
  -2 = liquid + voiced fricative /rv rz/
  -2 = voiceless fricative + stop /ft sp st sk/
- -1 = liquid + nasal /rm rn/
- 0 = liquid + liquid /rl/
- +2 = voiceless stop + voiceless fricative /ks/

Classification Of Onsets

Gierut (1999), *JSLHR, 42, 708-726*

- Simple onset = singleton
- Complex onset = true cluster; follows SSP
  - +6 to +2 clusters on previous slide
- Adjunct onset = clusters that violate SSP
  - -2 = /s/ + stop /sp st sk/ on previous slide
- Complex segments = affricates = ʧ ʤ



"Rules" That Apply To All Languages Including Child Language

- If a language has X, then it also will have Y.
  - Treat X = learn X + Y = system change
  - Treat Y = learn Y = local change

Treat X	Learn Y (without direct treatment)
Affricates	Fricatives
True Clusters	Affricates
True Clusters	Adjunct Clusters
True Clusters with Small SD	True Clusters with Large SD

Recall that we can chain these:

Treat true clusters with small SD – Change in true clusters with large SD, adjunct cluster, affricates, fricatives

Which Clusters To Treat? Small Or Large SD?

- Gierut (1999), *JSLHR, 42*, 708-726
- Study 1
  - Taught 3 children true clusters of SD 5 – 6
  - Taught 3 children true clusters of SD 3-4
  - Children's age was 3;2-7;8
  - All children reduced treated cluster to singleton at pre-treatment
- Study 1 Result
  - Children taught SD 5-6 learned some clusters but not broad change
  - Children taught SD 3-4 learned many clusters, including those with SD 3-4 and those with higher SDs
    - Also showed generalization. For example, if taught /fl/, learned /fl/, other /l/-clusters, and "unrelated" clusters (e.g., r-clusters)

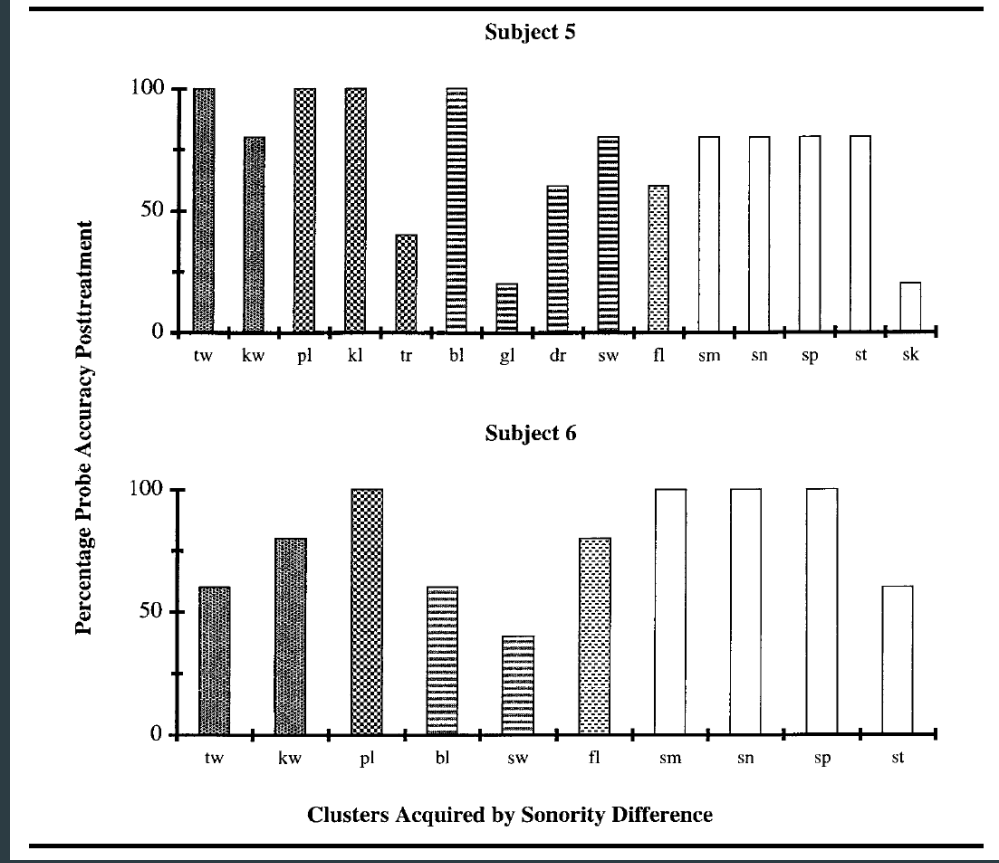
Gierut (1999), *JSLHR, 42, 708-726*

Note:
S5 (Age 7;8; [bw] pre-tx) taught /fl/ (SD_3)

S6 (Age 3;8; no CC pre-tx) taught /bl/ (SD_4)

Both children reduced target cluster to C1 at pre-tx

Figure 4. Ambient clusters acquired posttreatment by children treated on marked clusters. Differential shadings from left to right are indicative of sonority differences 6 (shaded), 5 (hatched), 4 (striped), 3 (dotted), and 2 or less (open).



Take-home: Treat Clusters With Small SD – See Change In Small SD And Large SD

- 6 = voiceless stop + glide /tw kw pj kj/
- 5 = voiced stop + glide /bj/
  5 = voiceless stop + liquid /pl kl pr tr kr/
- 4 = voiced stop + liquid /bl gl br dr gr/
  4 = voiceless fricative + glide /sw fj/
- 3 = voiced fricative + glide /vj/
  3 = voiceless fricative + liquid /ʃr fl sl fr θr/
- 2 = /s/ + nasal /sm sn/
  2 = nasal + glide /mj/
- -2 = /s/ + stop /sp st sk/

Logistical Tangent

How to assess clusters?

See slpath.com – will need to request a PIN – Little PEEP (257 Words)

Gierut Learnability Project cluster probe word list (~150 Words; Need to find pictures)

McLeod & Hand Cluster Probe (72 Words)

KU ScholarWorks Files:

6. Cluters_Probe_Pictures.pptx

6. Cluster_Probe_Scoresheet.xlsx

Conference Cluster Probe (56 words):

SD	Onsets	# of Words
6	kw, tw	4
5	kl, pl, kr, pr, tr	10
4	bl, gl, br, dr, gr, sw	12
3	fl, sl, fr, Sr, Tr	10
2	sm, sn	4
-2	sk, sp, st	6
3s	skw, spl, skr, spr, str	10

Sound	Onsets	# of Words
w-clusters	kw, tw, sw	6
l-clusters	kl, pl, bl, gl, fl, sl	12
r-clusters	kr, pr, tr, br, dr, gr, fr, Sr, Tr	18
s-clusters	sw, sl, sm, sn, sk, sp, st	14
3s	skw, spl, skr, spr, str	10

Conference Cluster Probe

#	SD	Snd	word	prompt	Snd	Child Prod	Onset Score
1	4	l	glasses		gl	gw	0
2	-2	s	stove		st	t	0
3	3	l/s	sleep		sl	s	0
4	-2	s	stop		st	t	0
5	4	l	black		bl	bw	0
6	3	r	fruit		fr	h	0
7	5	r	crayon		kr	kw	0
8	3s	3s	straw		str	Cw	0
9	5	r	princess		pr	p	0
10	5	l	cloud		kl	kw	0
11	4	r	dress		dr	J	0
12	-2	s	space		sp	p	0
13	6	w	twig		tw	tw	1
14	-2	s	school		sk	k	0
15	3	r	three		Tr	h	0
16	3s	3s	spray		spr	p	0
17	5	r	cry		kr	kw	0
18	4	r	brush		br	b	0
19	5	r	truck		tr	C	0
20	3s	3s	square		skw	w	0

Cluster Selection

KU ScholarWorks Files:

7. Cluster_Selection_Worksheet.xlsx

Conference Cluster Selection Worksheet

Use of these materials should be referenced as: Storkel, H. L. (2017, February). Getting the Most Bang for Your Therapy Minute: Sound and Word Complexity in Treatment of Children with Phonological Disorders. KU/KUMC Intercampus Program in Communicative Disorders Speech-Language Pathology Conference, Overland Park, KS.
This selection worksheet lists singletons that are related to clusters based on implicational universals/language laws (i.e., fricatives and affricates). It also lists target clusters in English by SD in black font. The two SDs (3 & 4) shown to be effective in clinical treatment by Gierut (1999) are highlighted in blue. Clusters that children may produce as errors (e.g., [bw] for target /br/) also are shown in teh appropriate SD category but are noted in red font
Step 1: Highlight low accuracy singletons in orange, mid accuracy in yellow, and high accuracy in blue. If the Cis accurate EXCEPT for a distortion, highlight in green (e.g., dentalized /s/ for target /s/)
Step 2: Highlight low accuracy CC and CCC in orange, mid accuracy in yellow, and high accuracy in blue. If the CC or CCC is accurate EXCEPT for a distortion, highlight in green (e.g., dentalized /sl/ for target /sl/).
Step 3: Look at the child's errors. Highlight in blue any CC or CCC combinations that occur as an error (e.g., [bw] for target /br/) in the red listing of clusters.
Step 4: Examine child's knowledge by SD for both correct (black font) and erred productions (red font). Consider whether treatment of an SD 3 or SD 4 cluster is appropriate based on the child's knowledge.

fricatives	affricates	6	5	4	3	2	-2		CCC
f	C	kw	kl	bl	fl	sm	sk		skw
v	J	tw	pl	gl	sl	sn	sp		spl
T			kr	br	fr		st		skr
D			pr	dr	Sr				spr
s			tr	gr	Tr				str
z				sw					
S									
		pw	bw	fw					
		tw	dw	sw					
		kw	gw	Sw					
				Tw					

Case Examples

KU ScholarWorks Files:

8. Cluster_Cases.xlsx

Application: PD 50 (3;6 Male)
Singleton Options: /D r/

SD	#	%	Accuracy Analysis by SD	Productions																	
6	4	100%	kw, tw	kw	kw	tw	tw														
5	0	0%	kl, pl, kr, pr, tr	kw	kw	p	p	kw	kw	p	p	C	w								
4	0	0%	bl, gl, br, dr, gr, sw	bw	bw	gw	gw	b	b	J	J	w	w	w	w						
3	0	0%	fl, sl, fr, Sr, Tr	h	w	s	s	h	h	h	h	h	t								
2	0	0%	sm, sn	s	m	n	n														
-2	0	0%	sk, sp, st	k	k	p	p	t	t												
3s	0	0%	skw, spl, skr, spr, str	w	w	p	p	t	kw	p	p	Cw	t								

Snd	#	%	Accuracy Analysis by Sound	Productions																	
w-cluster	4	67%	kw, tw, sw	kw	kw	tw	tw	w	w												
l-cluster	0	0%	kl, pl, bl, gl, fl, sl	kw	kw	p	p	bw	bw	gw	gw	h	w	s	s						
r-cluster	0	0%	kr, pr, tr, br, dr, gr, fr, Sr, Tr	kw	kw	p	p	C	w	b	b	J	J	w	w	h	h	h	h	h	t
s-cluster	0	0%	sw, sl, sm, sn, sk, sp, st	w	w	s	s	s	m	n	n	k	k	p	p	t	t				
3s	0	0%	skw, spl, skr, spr, str	w	w	p	p	t	kw	p	p	Cw	t								

Summary		
True CC	4	10%
Adjunct	0	0%
CCC	0	0%
All	4	7%

Cluster Reduction	42	81%

An Aside: Developmental Norms For CC

Smit, Hand, Freilinger, Bernthal, & Bird (1990) *JSHD, 55, 779-798*

PD 50 (3; 6 male) – tw, kw

TABLE 6. Comparisons of 75% levels of acquisition for word-initial clusters as determined in the Iowa-Nebraska Articulation Norms Project and by Templin (1957).

Clusters	Age (years:months)		
	Iowa-Nebraska		
	Females	Males	Templin
tw-	3:6	3:6	4:0
kw-	3:6	3:6	4:0
sp-	4:6	5:0[a]	4:0[a]
st-	4:6	5:0[a]	4:0
sk-	4:6	6:0	4:0[a]
sm-	5:6	7:0	4:0[a]
sn-	5:6	5:0[a]	4:0[a]
sw-	4:6[a]	6:0	7:0
sl-	6:0	7:0	7:0
pl-	4:0	5:6	4:0[a]
bl-	4:0	5:0	4:0
kl-	4:0	5:6	4:0
gl-	4:6	4:6	4:0
fl-	4:6	5:6	5:0
pr-	6:0	5:6	4:0[a]
br-	6:0	6:0	4:0[a]
tr-	6:0	5:6	4:0
dr-	6:0	5:0[a]	4:0
kr-	4:6[a]	5:6	4:0[a]
gr-	6:0	5:6	4:6
fr-	6:0	5:6	4:6
θr-	7:0	7:0	7:0
skw-	4:6[a]	7:0	6:0
spl-	6:0	7:0	7:0
spr-	8:0	8:0	7:0
str-	8:0	8:0	5:0
skr-	8:0	8:0	7:0

[a] A reversal occurs in older age groups.

TABLE 7. Recommended ages of acquisition for phonemes and clusters, based generally on 90% levels of acquisition.

Phoneme	Recommended age of acquisition (years:months)		Source
	Females	Males	
Word-initial clusters			
/tw kw/	4:0	5:6	Figure 20
/sp st sk/	7:0–9:0	7:0–9:0	Figure 21[b]
/sm sn/	7:0–9:0	7:0–9:0	Figure 22[b]
/sw/	7:0–9:0	7:0–9:0	Figure 23[b]
/sl/	7:0–9:0	7:0–9:0	Figure 24[b]
/pl bl kl gl fl/	5:6	6:0	Figure 26
/pr br tr dr kr gr fr/	8:0	8:0	Figure 25
/θr/	9:0	9:0	Figure 27
/skw/	7:0–9:0	7:0–9:0	Figure 28[b]
/spl/	7:0–9:0	7:0–9:0	Figure 29[b]
/spr str skr/	7:0–9:0	7:0–9:0	Figure 30[b]

Smit, Hand, Freilinger, Bernthal, & Bird (1990) *JSHD, 55, 779-798*

PD 50 (3; 6 male)

sp-66
st-62
sk-66
sm-72
sn-69
sw-69

TABLE 4. Percentages of responses to each target that were considered "acceptable."

TABLE 4. (Continued)

Phoneme (# of test items)	Age[a] group 3:0 F (n = 22)	3:0 M (n = 25)	3:6 F (n = 26)	3:6 M (n = 29)	4:0 F (n = 37)	4:0 M (n = 54)	4:6 F (n = 51)	4:6 M (n = 44)	5:0 F (n = 45)	5:0 M (n = 50)	5:6 F (n = 45)	5:6 M (n = 47)	6:0 F (n = 68)	6:0 M (n = 72)	7:0[b] (n: F = 62 M = 73)	8:0[b] (n: F = 62 M = 68)	9:0[b] (n: F = 65 M = 52)
Clusters																	
tw-	59	56	88	90	92	83	96	86	91	90	98	89	97	93	99	96	96
kw-	68	52	85	83	97	87	86	89	93	84	98	91	97	96	99	94	99
sp-	45	28	58	66	62	63	76	61	80	76	80	64	78	81	81	84	91
st-	55	24	58	62	62	57	76	59	78	80	78	66	84	81	82	80	93
sk-	41	24	58	66	62	59	78	70	78	74	80	68	81	79	83	85	89
sm-	36	24	65	72	59	59	71	59	73	74	80	70	84	71	82	80	89
sn- (2)	34	20	60	69	58	61	68	64	72	77	79	59	84	76	79	82	89
sw-	45	28	69	69	54	63	76	64	73	74	80	70	82	78	80	78	87
sl-	41	12	62	41	62	39	59	52	71	64	71	57	81	72	80	84	91
pl-	50	24	65	55	76	52	84	70	87	74	91	85	99	94	96	99	98
bl-	50	28	58	55	76	56	82	73	84	80	87	85	93	93	92	98	98
kl- (2)	41	24	58	40	77	55	83	74	90	72	92	83	96	92	97	99	97
gl-	41	20	62	55	70	52	82	75	80	78	89	89	97	93	95	96	98
fl-	36	16	54	52	73	52	78	66	87	72	91	83	93	89	95	98	99
pr-	23	20	46	52	70	50	63	55	69	70	69	77	84	75	87	94	97
br-	34	28	52	55	62	52	62	53	63	68	68	71	83	76	81	93	87
tr-	32	24	54	59	70	48	67	43	67	74	64	77	78	76	86	92	93
dr-	45	16	46	62	65	56	71	52	71	76	60	70	84	78	84	95	93
kr-	27	20	46	55	65	50	75	55	67	70	64	79	82	78	86	96	97
gr-	36	24	50	55	65	46	63	50	71	70	67	77	82	75	87	95	97
fr-	14	24	50	55	65	59	65	52	71	70	71	77	87	75	87	95	97
θr-	23	8	27	21	46	22	59	32	60	50	60	64	72	60	78	84	87
skw-	32	20	58	59	59	59	76	64	71	68	78	62	81	74	82	85	91
spl-	23	12	35	34	57	37	61	45	62	54	67	60	78	64	79	83	91
spr-	14	12	31	45	46	31	55	41	60	56	58	57	71	60	69	82	89
str-	32	8	31	41	46	30	57	41	51	52	58	53	69	57	65	75	88
skr-	23	8	35	38	46	30	55	36	58	52	53	55	65	56	71	81	88

Note. "Acceptable" = either "fully correct" or "marginal"; see text for definitions.
[a]Age expressed in years:months. [b]These data represent the average for males and females weighted by their relative numbers.

McLeod, VanDoorn, & Reed (2001), *AJSLP*, 10, 99-110

TABLE 1. Percent occurrence of cluster reduction in English-speaking children.

Study	*N*	1;6	2;0	2;3	2;6	2;9	3;0	3;6	4;0	4;6	5;0	6;0	7;0	8;0
Haelsig & Madison (1986)	50						30	18	10	15	7			
McCormack & Knighton (1996)	22 F				39									
McCormack & Knighton (1996)	28 M				59									
Preisser et al. (1988)[a]	60	93	76	51										
Roberts et al. (1990)	145				68		42	25	15		10	7	3	3
Watson & Scukanec (1997a)	12		46	48	34	25	17							

Note. Blank spaces indicate that children of that age group were not studied. F = female, M = male.

[a] Preisser et al. (1988) used age ranges 1;6–1;9, 1;10–2;1, and 2;2–2;5.

TABLE 2. Comparison between the percentage occurrence of cluster reduction and cluster simplification reported by Watson and Scukanec (1997a).

	2;0	2;3	2;6	2;9	3;0
% cluster reduction	45.5	47.6	33.6	24.7	16.9
% cluster simplification	16.6	25.5	45.8	33.3	30.8

9. There is an interrelationship between cluster reduction, cluster simplification, and correct productions of consonant clusters. Initially, most children reduce consonant clusters. Over time, the occurrence of cluster reduction diminishes, whereas the occurrence of cluster simplification increases. Simultaneously, the occurrence of correct productions increases, until eventually production is mastered.

Back to Our Case!

Conference Cluster Selection Worksheet

fricatives	affricates	6	5	4	3	2	-2		CCC
f	C	kw	kl	bl	fl	sm	sk		skw
v	J	tw	pl	gl	sl	sn	sp		spl
T			kr	br	fr		st		skr
D			pr	dr	Sr				spr
s			tr	gr	Tr				str
z				sw					
S									
		pw	bw	fw					
		tw	dw	sw					
		kw	gw	Sw					
				Tw					

k
g
f
v
T
D
s
z
S
C
J
G
l
r

6	4	100%	kw, tw
5	0	0%	kl, pl, kr, pr, tr
4	0	0%	bl, gl, br, dr, gr, sw
3	0	0%	fl, sl, fr, Sr, Tr
2	0	0%	sm, sn
-2	0	0%	sk, sp, st
3s	0	0%	skw, spl, skr, spr, str

Use of these materials should be referenced as:

Storkel, H. L. (2017, February). Getting the Most Bang for Your Therapy Minute: Sound and Word Complexity in Treatment of Children with Phonological Disorders. KU/KUMC Intercampus Program in Communicative Disorders Speech-Language Pathology Conference, Overland Park, KS.

This selection worksheet lists singletons that are related to clusters based on implicational universals/language laws (i.e., fricatives and affricates). It also lists target clusters in English by SD in black font. The two SDs (3 & 4) shown to be effective in clinical treatment by Gierut (1999) are highlighted in blue. Clusters that children may produce as errors (e.g., [bw] for target /br/) also are shown in teh appropriate SD category but are noted in red font

Step 1: Highlight low accuracy singletons in orange, mid accuracy in yellow, and high accuracy in blue. If the Cis accurate EXCEPT for a distortion, highlight in green (e.g., dentalized /s/ for target /s/)

Step 2: Highlight low accuracy CC and CCC in orange, mid accuracy in yellow, and high accuracy in blue. If the CC or CCC is accurate EXCEPT for a distortion, highlight in green (e.g., dentalized /sl/ for target /sl/).

Step 3: Look at the child's errors. Highlight in blue any CC or CCC combinations that occur as an error (e.g., [bw] for target /br/) in the red listing of clusters.

Step 4: Examine child's knowledge by SD for both correct (black font) and erred productions (red font). Consider whether treatment of an SD 3 or SD 4 cluster is appropriate based on the child's knowledge.

Productions											
kw	kw	tw	tw								
kw	kw	p	p	kw	kw	p	p	C	w		
bw	bw	gw	gw	b	b	J	J	w	w	w	w
h	w	s	s	h	h	h	h	h	t		
s	m	n	n								
k	k	p	p	t	t						
w	w	p	p	t	kw	p	p	Cw	t		

Application: PD 50 (3;6 Male)
Singleton Options: /D r/

fricatives	affricates	6	5	4	3	2	-2		CCC
f	C	kw	kl	bl	fl	sm	sk		skw
v	J	tw	pl	gl	sl	sn	sp		spl
T			kr	br	fr		st		skr
D			pr	dr	Sr				spr
s			tr	gr	Tr				str
z				sw					
S									
		pw	bw	fw					
		tw	dw	sw					
		kw	gw	Sw					
				Tw					

Application: PD 51 (4;10 Male)
Singleton Option: /C/

SD	#	%	Accuracy Analysis by SD	Productions															
6	0	0%	kw, tw	w	w	t	w												
5	0	0%	kl, pl, kr, pr, tr	t	t	p	p	w	w	p	p	w	w						
4	0	0%	bl, gl, br, dr, gr, sw	b	b	d	d	b	b	w	w	w	w	w	w				
3	0	0%	fl, sl, fr, Sr, Tr	fw	fw	w	w	fw	fw	h	h	h	h						
2	0	0%	sm, sn	m	m	n	n												
-2	0	0%	sk, sp, st	d	t	p	p	d	t										
3s	0	0%	skw, spl, skr, spr, str	w	w	p	p	w	w	p	p	t	w						

Snd	#	%	Accuracy Analysis by Sound	Productions																	
w-cluster	0	0%	kw, tw, sw	w	w	t	w	w	w												
l-cluster	0	0%	kl, pl, bl, gl, fl, sl	t	t	p	p	b	b	d	d	fw	fw	w	w						
r-cluster	0	0%	kr, pr, tr, br, dr, gr, fr, Sr, Tr	w	w	p	p	w	w	b	b	w	w	w	w	fw	fw	h	h	h	h
s-cluster	0	0%	sw, sl, sm, sn, sk, sp, st	w	w	w	w	m	m	n	n	d	t	p	p	d	t				
3s	0	0%	skw, spl, skr, spr, str	w	w	p	p	w	w	p	p	t	w								

Summary			Cluster Reduction	52	93%
True CC	0	0%			
Adjunct	0	0%			
CCC	0	0%			
All	0	0%			

Application: PD 51 (4;10 Male)
Singleton Option: /C/

fricatives	affricates	6	5	4	3	2	-2		CCC
f	C	kw	kl	bl	fl	sm	sk		skw
v	J	tw	pl	gl	sl	sn	sp		spl
T			kr	br	fr		st		skr
D			pr	dr	Sr				spr
s			tr	gr	Tr				str
z				sw					
S									
		pw	bw	fw					
			dw	fw					
			gw	Sw					
				Tw					

Application: PD 49 (5;9 Male)
Singleton Option: Lateralized /s z S C J/

SD	#	%	Accuracy Analysis by SD	Productions											
6	2	50%	kw, tw	kw	kw	kw	kw								
5	3	30%	kl, pl, kr, pr, tr	kl	kw	pl	pl	kw	kw	pw	pw	kw	kw		
4	5	42%	bl, gl, br, dr, gr, sw	bl	bl	gl	gw	bw	bw	gw	gw	gw	gw	sw-lat	sw-lat
3	4	40%	fl, sl, fr, Sr, Tr	fl	fl	sl-lat	sl-lat	fw	fw	Sw	Sw	Tw	Tw		
2	4	100%	sm, sn	sm	sm	sn	sn								
-2	4	67%	sk, sp, st	sk-lat	sk-lat	p	sp-lat	st-lat	sk-lat						
3s	4	40%	skw, spl, skr, spr, str	skw-lat	skw-lat	spl	spl-lat	skw-lat	sw-lat	spw-lat	spw-lat	skw-lat	skw-lat		

Snd	#	%	Accuracy Analysis by Sound	Productions																	
w-cluster	4	67%	kw, tw, sw	kw	kw	kw	kw	sw-lat	sw-lat												
l-cluster	10	83%	kl, pl, bl, gl, fl, sl	kl	kw	pl	pl	bl	bl	gl	gw	fl	fl	sl-lat	sl-lat						
r-cluster	0	0%	kr, pr, tr, br, dr, gr, fr, Sr, Tr	kw	kw	pw	pw	kw	kw	bw	bw	gw	gw	gw	gw	fw	fw	Sw	Sw	Tw	Tw
s-cluster	12	86%	sw, sl, sm, sn, sk, sp, st	sw-lat	sw-lat	sl-lat	sl-lat	sm	sm	sn	sn	sk-lat	sk-lat	p	sp-lat	st-lat	sk-lat				
3s	4	40%	skw, spl, skr, spr, str	skw-lat	skw-lat	spl	spl-lat	skw-lat	sw-lat	spw-lat	spw-lat	skw-lat	skw-lat								

Summary		
True CC	18	45%
Adjunct	4	67%
CCC	4	40%
All	26	46%

Application: PD 49 (5;9 Male)
Singleton Option: Lateralized /s z S C J/

fricatives	affricates	6	5	4	3	2	-2		CCC
f	C*	kw	kl	bl	fl	sm	sk*		skw*
v	J*	tw	pl	gl	sl*	sn	sp*		spl*
T			kr	br	fr		st*		skr*
D			pr	dr	Sr				spr*
s*			tr	gr	Tr				str*
z*				sw*					
S*									
		pw	bw	fw					
*Distorted		tw	dw	sw					
		kw	gw	Sw					
				Tw					

Real Words Vs. Nonwords?

Gierut, Morrisette & Ziemer (2010)

Gierut & Morrisette (2010)

Nonwords vs. Real Words

- **Previous studies have examined treatment outcomes retrospectively (Gierut, Morrisette, & Ziemer, 2010), and experimentally (Gierut & Morrisette, 2010)**
  - During treatment & immediately post-treatment
    - Greater learning in the nonword than real word condition
  - At longitudinal follow-up
    - Learning was equivalent
    - Real word condition "caught up"
  - Change was slower with real words than nonwords but eventually outcomes were equivalent

Explanation: Nonwords vs. Real Words

- **<u>BOTH</u> approaches appear efficacious, but through differing mechanisms of change.**
  - Real words through highlighting known contrasts
    - New word can be contrasted with existing known words
    - See prior comments about density
  - Nonwords through creating a novel representation to build upon, rather than relying on potentially entrenched forms.
    - Similar to the explanation of late AoA effects
  - So….can use either real words or nonwords

Logistical Tangent

How to find nonwords?

KU ScholarWorks Files:

9. NSW_List.xlsx

10. NSW_Story_Narrative.docx

10. NSW_Story_Pictures.pptx

10. NSW_Story_Pictures_Printing.pdf

Conference Nonword List
All singletons and CC with SD 3 or 4

Trans	C1	C1 Dev	V	C2	C2 Dev
CEb	C	mid-8	E	b	early-8
Cad	C	mid-8	a	d	early-8
CIm	C	mid-8	I	m	early-8
C@n	C	mid-8	@	n	early-8
Con	C	mid-8	o	n	early-8
Cup	C	mid-8	u	p	early-8
f^b	f	mid-8	^	b	early-8
fod	f	mid-8	o	d	early-8
fIm	f	mid-8	I	m	early-8
fin	f	mid-8	i	n	early-8
fun	f	mid-8	u	n	early-8
f@p	f	mid-8	@	p	early-8

Trans	C1	C1 Dev	V	C2	C2 Dev
D@b	D	late-8	@	b	early-8
Did	D	late-8	i	d	early-8
Dem	D	late-8	e	m	early-8
Dan	D	late-8	a	n	early-8
Dun	D	late-8	u	n	early-8
Dop	D	late-8	o	p	early-8
lIb	l	late-8	I	b	early-8
l^d	l	late-8	^	d	early-8
lam	l	late-8	a	m	early-8
l@n	l	late-8	@	n	early-8
lWn	l	late-8	W	n	early-8
lep	l	late-8	e	p	early-8

Trans	CC1	SD	V	C2	C2 Dev
blib	bl	SD4	i	b	early-8
blad	bl	SD4	a	d	early-8
blom	bl	SD4	o	m	early-8
blun	bl	SD4	u	n	early-8
bl@n	bl	SD4	@	n	early-8
blep	bl	SD4	e	p	early-8
glub	gl	SD4	u	b	early-8
glid	gl	SD4	i	d	early-8
glem	gl	SD4	e	m	early-8
glon	gl	SD4	o	n	early-8
glan	gl	SD4	a	n	early-8
gl@p	gl	SD4	@	p	early-8

Trans	CC1	SD	V	C2	C2 Dev
flEb	fl	SD3	E	b	early-8
fl@d	fl	SD3	@	d	early-8
flim	fl	SD3	i	m	early-8
flun	fl	SD3	u	n	early-8
fl^n	fl	SD3	^	n	early-8
flop	fl	SD3	o	p	early-8
fr@b	fr	SD3	@	b	early-8
frId	fr	SD3	I	d	early-8
frEm	fr	SD3	E	m	early-8
fron	fr	SD3	o	n	early-8
fran	fr	SD3	a	n	early-8
frup	fr	SD3	u	p	early-8

See also SLPath Nonword Activities

Note: Nonwords have practical advantages (e.g., can create nonwords with early acquired sounds in the other positions)

- Can really focus efforts on the target sound
- Avoid reinforcing incorrect production of non-target sounds

Conference Nonword Story

- Need to pair these nonwords with meanings so that children accept them as words
- We don't want children to think of this as "funny" language only used in the speech room!
- A story narrative and pictures are available in the conference materials

Slide #	Meaning	NSW	Picture Source
1	[girl's name]	Srib	Pixabay
2	[toy name]	Srod	Item 2010 in NOUN Dababse[1]
3	[monster's name]	Sram	Pixabay
4	[hobbit house]	Sr@n	Pixabay
5	[rickshaw]	Srup	Pixabay
6	[goofy toy]s	Sren	Items 2010, 2021, 2012, 2048, 2038, 2060, 2061, 2062 in NOUN Dababse[1]

[Srib]

Once upon a time, there was a little girl named [Srib]. [Srib] was 3 years old. [Srib] had the best friend in the whole world. Her best friend was [Sram].They had been friends forever. [Srib] and [Sram] liked to play together every day! One day they were sitting and talking and [Srib] told [Sram]. There is a toy I really, really want. What is it? Asked [Sram].

[Srod]

It's a [Srod]. A [Srod] is a beautiful red color. A [Srod] is bumpy and bouncy. I really, really want a [Srod]!

[Sram]

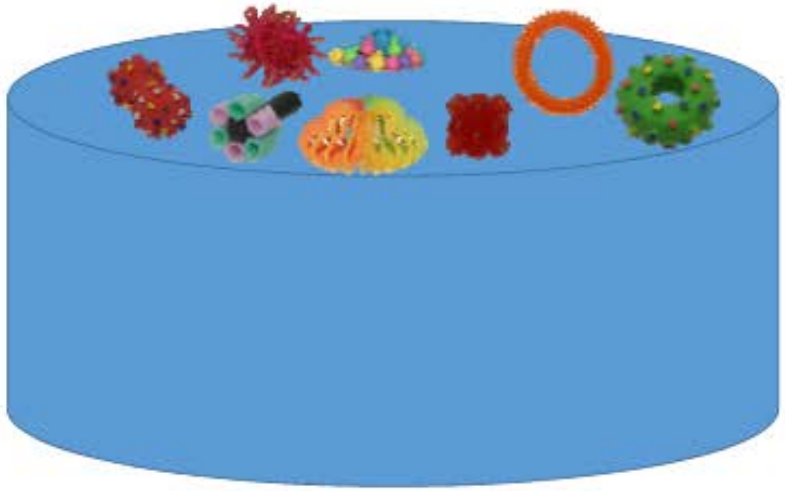
So, [Sram] decided that he would find [Srib] a [Srod]. He set out on his journey to find the [Srod].

[Sr@n]

[Sram] went to the [Sr@n]. He thought "Surely I can find a [Srod] at the [Sr@n]. The [Sr@n] has everything you could ever think of! But no. The [Sr@n] did not have a [Srod]! [Sram] said "I will keep looking!" [Srib] is my best friend! I must find her a [Srod]! With that, he left the [Sr@n].

[Srup]

[Sram] decided to take a [Srup] to the mall. Surely the mall will have a [Srod]! [Sram] walked down to the [Srup] stop and waited for the [Srup]. The [Srup] showed up. [Sram] jumped into the [Srup] and headed down the road.



[Sren]s

At the mall, [Sram] went in every store looking for the [Srod]. Finally, he saw a store with a table full of [Sren]s. There were so many [Sren]s! Surely, they would have a [Srod]. [Sram] walked over to the [Sren]s. There were so many [Sren]s that it was hard to see them all! [Sram] looked through the [Sren]s. Do you see a [Srod]? Ha! There it is! [Sram] found a [Srod]! He was so happy!

[Sram] ran straight home and gave the [Srod] to [Srib]. [Srib] was so happy! [Srib] loved the [Srod] and she loved Sram] for working so hard to find her a [Srod].

Treatment Potpourri

(Time Permitting)

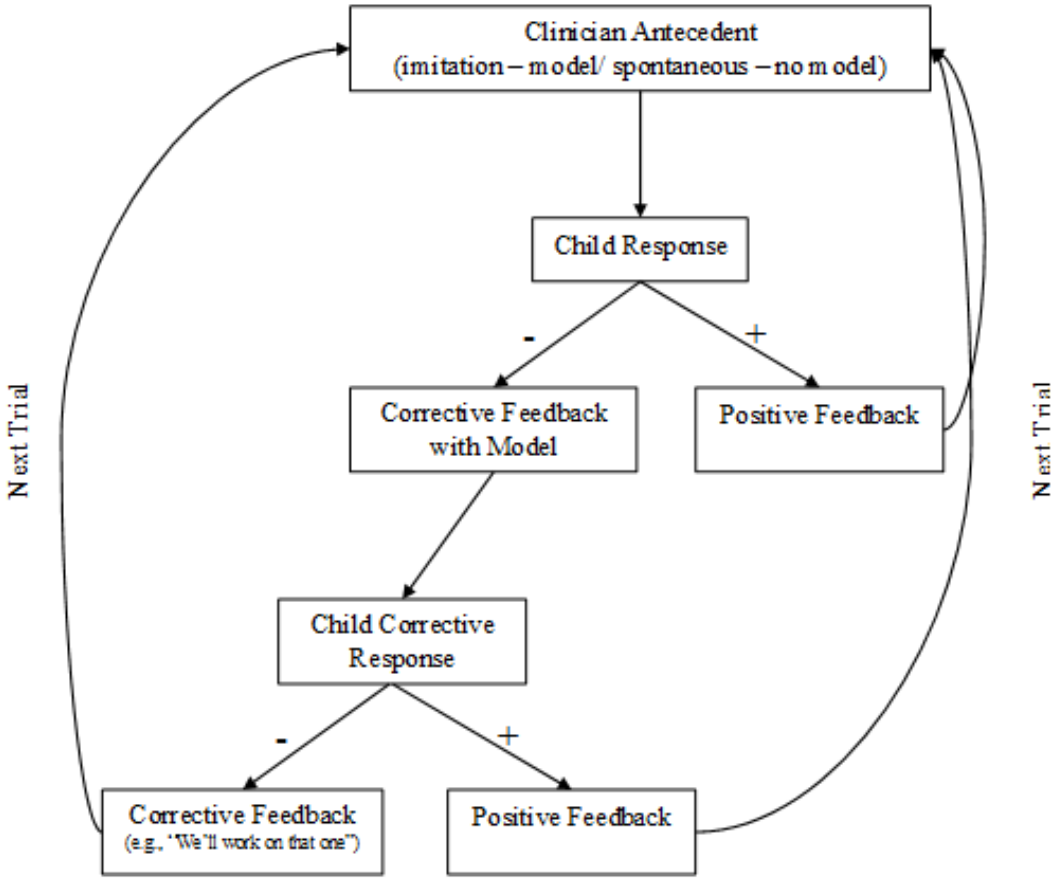
Gierut Treatment Protocol

- Imitation Phase
  - 75% accuracy x 2 consecutive sessions OR 7 sessions maximum
- Spontaneous Phase
  - 90% accuracy x 3 consecutive sessions OR 12 sessions maximum
- Intensity
  - Three 1-hour individual sessions per week
  - ~100 production trials per treatment session
  - Maximum of 19 hours of therapy or ~1900 production trials
- NOTE: SLPath (Jennifer Taps Richards) has implemented the complexity treatment successfully with a more “standard” intensity schedule (e.g., shorter sessions, twice per week, in groups)

	T1	T2	T3	T4	T5	T6	T7	T8	T9
san	+	+	+						
sep	-	+	+						
sib	+	-	+						
som	-	-	-						

- What if child uses nonword incorrectly?
  - e.g., names a picture card with the wrong nonword
  - Correct the error
    - E.g., That's not /san/. This is /san/.
  - You may want to track nonword accuracy
- +/- in box reflects accuracy of the child's production of that nonword
  - Regardless of whether the production was for the correct picture
  - If child says /san/ score production accuracy of /san/ no matter what he/she said it for
- Circle indicates that the nonword was said for the wrong picture
  - Vocabulary error
  - T3 -- /san/ produced correctly but for wrong picture

Feedback Loop



NOTE : Feedback must be clear and precise. That is, the child must be able to (1) unequivocally interpret the feedback as positive or negative; (2) understand what to do to correct his/her production. Feedback such as "That was pretty good" or "That one was ok" is difficult to interpret as positive or negative, and there is no information about what aspect of the production was correct or incorrect. Better feedback would be "Terrific! Your tongue was up!" "Excellent! You stuck your tongue between your teeth!" "I didn't like that one. You kept your tongue down. Put it up like me. [model]" "Oh no you forgot to stick your tongue out on that one. Watch me. [model]." REMEMBER, imprecise feedback ensures the failure of a well constructed therapy program!!

Teaching Sounds

- SLPath Sound Placement Resources – A list of books
- SLPath Sound Placement Strategies – Specific placement strategies
- SLPath Sound Placement Brochures – More placement strategies

- A great resource for many aspects of phonology – www.speech-language-therapy.com (Caroline Bowen)

Successive Approximations

This technique is used when teaching nonstimulable sounds and/or when the child can not obtain an adult-like production on ~half of the production trials. Successive approximation helps to minimize the child's frustration. In successive approximation, an intermediate target that the child can produce on command, namely an approximation, is accepted as correct. When this approximation is consistently produced for the target sound, then the production is again modified to be more in-line with the adult production. This process continues until an adult-like production is obtained. One key for success in using this technique is to avoid over-practicing the approximation. That is, you do NOT want to replace an incorrect production with another incorrect production permanently. Rather, you want to establish one component of a sound, then the next component, and so on until the production is perfect.

Example

Target = /k/ in #___ in 8 real words
Child substitute = /t/
In each session, child completes 10 trials (10 repetitions of all 8 real word targets)
Treatment begins with imitation and then moves to spontaneous mode of responding

1st approximation = any production with tongue tip down (i.e., non-alveolar) and no /t/. Initially, the child would produce a non-alveolar sound but then would retain the /t/ substitute, e.g., for 'cat' the child might produce/t@t/. The child was taught to say a non-alveolar sound – space – the rest of the word, e.g., not alveolar – space -- /@t/ for 'cat.' On the last two trials of session 1, the child was using a variety of non-alveolar substitutes for ~60% of the targets.

2nd approximation = any production with velar placement, space, rest of word. Here, the child tended to produce a voiceless velar fricative for target /k/ words, e.g., /K @t/. On the last two trials of session 2, the child was using this type of substitute for ~70% of the targets.

3rd approximation = /k/, space, rest of word (/k @t/ for 'cat'). On the last two trials of session 3, the child was using /k/ for ~50% of the targets.

4th approximation = /k/, small space, rest of word. On the last two trials of the session 4, the child was using this production for ~60% of the targets.

5th approximation = voiceless velar fricative + rest of word (no space allowed). On the last two trials of session 5, the child was using this approximation for ~60% of the treated words.

6th approximation = adult-like production. Child met criterion to move from imitation to spontaneous production (75% accuracy for treated words x 2 sessions) at the end of session 7.

When therapy moved to the spontaneous phase, the child reverted to including his /t/ substitute in his productions, e.g., /kt@t/ for 'cat.' The technique of successive approximations was again used.

7th approximation = /k/, space, rest of word. On the last two trials of session 8, the child was using this approximation for ~50% of the treated words.

8th approximation = 4th approximation from imitation. On the last two trials of session 9, the child was using this approximation for ~50% of the treated words.

9th approximation = 5th approximation form imitation. On the last two trials of session 10, the child was using this approximation for ~60% of the treated words.

10th approximation = adult-like production. Child met criterion (90% accuracy across 3 sessions) in session 16.

Important Points to Note

Approximations were NEVER trained to a high level of use (e.g., 90-100% use) or to consistent use (i.e., use in majority of productions across several sessions). This is to avoid establishing retention of an incorrect or distorted production.

Note that the child progressed quickly from each approximation to the next. Again, this is essential to avoid establishing retention of an incorrect or distorted production. Most children with functional phonological delays will show this type of rapid advancement. If a child does NOT progress fairly rapidly from one approximation to the next, you may need to select a different sound for treatment. Children with cognitive delays, apraxia of speech, hearing impairment, or oral motor incoordination may have difficulty advancing quickly through the approximations.

Motivation is essential to rapid progress! Therefore, it is essential to find activities that motivate the child and to "up the ante" so that children do not plateau.

Thank You for Attending!

Questions?

Join our closed facebook group for discussion and questions post-conference!
SLP Conference: Complexity in Phonological Treatment