Phonological Complexity Principles: Promoting Efficient Change in Overall Intelligibility

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Disclosures

- **Relevant Financial Relationships:** Jennifer Taps Richard owns and directs SLPath. She is an author/speaker and receives compensation for her presentations as well as for the sale of materials.
- **Relevant Non-Financial Relationships:** No relevant non-financial relationship exists.

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Session 2: Monitoring and Target Selection

Step 3: Progress Monitoring
↓
Goal Writing
↓
Target Selection Practice
↓
Case Study Results

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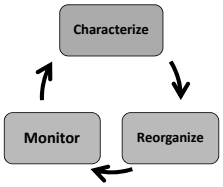
Step 3:
Monitoring: Is intervention working?
Planning for generalization and writing measurable goals



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Making Predictions

- Your predictions are that **global (system-wide) change** will occur following intervention on your selected target

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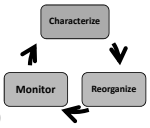
Step 3:
Monitoring



- intervention data (Elbert & Gierut, 1986)
  - Examine change in the treated sound(s) in the treated words during the intervention
  - Is intervention helping the child learn the selected sound(s)?
- Generalization data
  - Examine change in untreated sounds or words
  - Is intervention promoting global, system-wide sound change?

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Monitoring
Olswang & Bain, 1994

- Also consider child's
  - Attention
  - Motivation
  - Participation in each session
  - Increased independence with targets
    - Needing fewer prompts and supports along the way

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In other words…

- After each intervention phase (3-4 months), start back at the beginning:
  - determine phonetic, phonemic, and cluster inventories
  - determine whether clusters or singletons are appropriate target

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Another Method:
Percentage Consonants Correct (PCC)
Shriberg & Kwiatkowski, 1982

- Calculate PCC for word level or imitated sentences
  - Often representative of conversation level (Masterson & Apel, 2006; Johnson, Weston & Bain, 2004)
- Calculate PCC for conversation if needed

- Give credit for sounds produced correctly
- Do not give credit for substitutions, distortions, omissions or additions

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PCC Calculation

- e.g., [slɪ] for "sick" 0/2 consonants correct (/s/ not correct due to addition and /k/ incorrect due to deletion)
- [tɪk] for "sick" 1/2 consonants correct (substitution)
- [s̪ɪk] for "sick" 1/2 consonants correct (/s/ not correct due to distortion)

- [sɪk] for "sick" 2/2 consonants correct

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Best Practice: Monitoring

- Administer probes every 3-4 months
  - Great for progress reports and IEP meetings
- Keep words on probes untreated
- After each probe administration, consider targets from the pool of 0% accuracy
- Calculate PCC to demonstrate change over time

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Prognosis Factors for Goals

- Number of stimulable OUT sounds
- Robustness of inventories
  - Clusters
  - Singletons
- Other disabilities
  - e.g., concomitant language disorder, autism
- Social/emotional factors
- Motivation

Supplementary Handout: pp. 9-15

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Tips for Writing Goals

- **Goal:** Treated clusters or complex singletons, etc.
- **Baseline:**
  - Pre-intervention inventory
    - Singletons
    - Clusters
  - Untreated singletons and clusters to monitor
  - Include statement: All unknown sounds and clusters will be monitored throughout intervention in addition to the above intervention targets.

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Tips for Writing Goals

- **Overall goal:**
  - Thom will independently produce /sl-/ and /thr-/ while telling stories with 80% accuracy.
- **Baseline:**
  - Prior to intervention, Thom's phonetic inventory included these sounds: /p b t d k g f s z ts ʤ ŋ m n w j h/. He has not acquired these sounds: /v θ ð ʃ ʒ tʃ dʒ l r/.
  - Thom produced one consonant cluster (two or three consonants together, such as /sl-/) two times: /bw-/. He has not yet acquired other clusters.
  - All unknown sounds and clusters will be monitored throughout intervention in addition to the above targets.

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Tips for Writing Goals

- **Overall goal:**
  - Thom will independently produce eight new singletons and/or consonant clusters in at least two single words as measured by an independent probe administered three times per year.
- **Baseline:**
  - See next slide

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Baseline Data for Sample Goals

- Prior to intervention, Thom's phonetic inventory included these sounds: /p b t d k g f s z ts ʤ ŋ m n w j h/. He has not yet acquired these sounds: /v θ ð ʃ ʒ tʃ dʒ l r/.
- Thom produced one consonant cluster two times: /bw-/. He has not yet acquired other clusters.
- All unknown sounds and clusters will be monitored throughout intervention in addition to the above targets.
- Treatment will begin with/sl-/ and /thr-/ in words, sentences, and stories. New targets will be selected as needed.

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Tips for Writing Goals

- **Overall goal:**
  - Thom will increase his overall accuracy to 80% in single words as measured by percentage consonants correct (PCC) on independent probes administered three times per year.
- **Baseline:**
  - Prior to intervention, Thom's PCC was 49% for singleton sounds (e.g., he said "wick" for "lick," which is 1/2 consonants correct).
  - Prior to intervention, Thom's PCC was 35% for consonant cluster targets (e.g., he said "wuck" for "truck," which is 1/3 consonants correct).

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Target Selection Practice

Target Selection Document

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Target Selection: Questions to Consider

- **What three-element clusters may we target?**
  - Does child's phonemic inventory include /p t k w l r/?
  - Are there three-element clusters for which he/she has the second AND third consonants? Which ones?
  - What changes do you predict if you target sCC (based on language universals)?
- **What SD = 3 cluster (/fl-/, /fr-/, /sl-/, /ʃr-/, /θr-/) includes two NONSTIMULABLE OUT sounds (ideally)?**
  - What changes do you predict if you target the SD = 3 cluster (based on language universals)?

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Target Selection for Thom

Three-Element Clusters: None

↓

Two-Element Clusters: /bw-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /f //s/ /z/

↓

Stops: /p//b//t/ /d//k//g/

Also in system: /w j h m n ŋ/

Phonemic inventory: /p b t d k g s z ʦ ʤ w j h m n ŋ/

Nonstimulable OUT sounds: /θ ð ʒ ʧ l r/

Does Thom have **three-element (sCC) clusters** in his system? **NO**

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Target Selection for Thom

Three-Element Clusters: None

↓

Two-Element Clusters: /bw-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /f //s/ /z/

↓

Stops: /p//b//t/ /d//k//g/

Also in system: /w j h m n ŋ/

Phonemic inventory: /p b t d k g s z ʦ ʤ w j h m n ŋ/

Nonstimulable OUT sounds: /θ ð ʒ ʧ l r/

Does Thom's phonemic inventory include /p t k w l r/?

/p t k w/

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Target Selection for Thom

Three-Element Clusters: None

↓

Two-Element Clusters: /bw-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /f //s/ /z/

↓

Stops: /p//b//t/ /d//k//g/

Also in system: /w j h m n ŋ/

Phonemic inventory: /p b t d k g s z ʦ ʤ w j h m n ŋ/

Nonstimulable OUT sounds: /θ ð ʒ ʧ l r/

Does Thom's phonemic inventory include both **C2** and **C3** (from **sCC** clusters)?

/p t k w/ → YES: /skw-/

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Target Selection for Thom

Three-Element Clusters: None

↓

Two-Element Clusters: /bw-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /f //s/ /z/

↓

Stops: /p//b//t/ /d//k//g/

Also in system: /w j h m n ŋ/

Phonemic inventory: /p b t d k g s z ʦ ʤ w j h m n ŋ/

Nonstimulable OUT sounds: /θ ð ʒ ʧ l r/

What do we predict that Thom will learn (treated and untreated)?

Treated: /skw-/
Untreated: both kinds of two-element clusters, affricates, fricatives, singletons
Increased overall intelligibility

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Target Selection for Thom

Three-Element Clusters: None

↓

Two-Element Clusters: /bw-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /f //s/ /z/

↓

Stops: /p//b//t/ /d//k//g/

Also in system: /w j h m n ŋ/

Phonemic inventory: /p b t d k g s z ʦ ʤ w j h m n ŋ/

Nonstimulable OUT sounds: /θ ð ʒ ʧ l r/

Which **two-element cluster(s)** (SD =3) may we target that include **two nonstimulable** sounds?

/θr-/: SD = 3 and both **/θ/** and **/r/** nonstim.

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Target Selection for Thom

Three-Element Clusters: None

↓

Two-Element Clusters: /bw-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /f //s/ /z/

↓

Stops: /p//b//t/ /d//k//g/

Also in system: /w j h m n ŋ/

Phonemic inventory: /p b t d k g s z ʦ ʤ w j h m n ŋ/

Nonstimulable OUT sounds: /θ ð ʒ ʧ l r/

What do we predict that Thom will learn (treated and untreated)?

Treated: /θr-/
Untreated: clusters with larger SD, affricates, fricatives, singletons
Increased overall intelligibility

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Target Selection for Billie (Age 3;6)

Three-Element Clusters: None

↓

Two-Element Clusters : /bj-/ /tw-//pj-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /s//z/

↓

Stops: /p//b/ /t/ /d/

Also in system: /w j h m n/

Phonemic inventory: /p b t d s z ʦ m n w h/

Nonstimulable OUT sounds: /f v ð ʧ l r/

Does Billie have **three-element (sCC) clusters** in her system?

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Target Selection for Billie (Age 3;6)

Three-Element Clusters: None

↓

Two-Element Clusters : /bj-/ /tw-//pj-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /s//z/

↓

Stops: /p//b/ /t/ /d/

Also in system: /w j h m n/

Phonemic inventory: /p b t d s z ʦ m n w h/

Nonstimulable OUT sounds: /f v ð ʧ l r/

Does Billie's phonemic inventory include /p t k w l r/?

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Target Selection for Billie (Age 3;6)

Three-Element Clusters: None

↓

Two-Element Clusters : /bj-/ /tw-//pj-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /s//z/

↓

Stops: /p//b/ /t/ /d/

Also in system: /w j h m n/

Phonemic inventory: /p b t d s z ʦ m n w h/

Nonstimulable OUT sounds: /f v ð ʧ l r/

Does Billie's phonemic inventory include **C2** and **C3** (from **sCC** clusters)?

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Target Selection for Billie (Age 3;6)

Three-Element Clusters: None

↓

Two-Element Clusters : /bj-/ /tw-//pj-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /s//z/

↓

Stops: /p//b/ /t/ /d/

Also in system: /w j h m n/

Phonemic inventory: /p b t d s z ʦ m n w h/

Nonstimulable OUT sounds: /f v ð ʧ l r/

Which **two-element cluster(s)** (SD =3) may we target that include **two nonstimulable** sounds?

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Target Selection for Billie (Age 3;6)

Three-Element Clusters: None

↓

Two-Element Clusters : /bj-/ /tw-//pj-/

↓

Affricates: /ʦ/ /ʤ/

↓

Fricatives: /s//z/

↓

Stops: /p//b/ /t/ /d/

Also in system: /w j h m n/

Phonemic inventory: /p b t d s z ʦ m n w h/

Nonstimulable OUT sounds: /f v ð ʧ l r/

What do we predict that Billie will learn (treated and untreated)?

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Target Selection for Damon (Age 4;4)

Three-Element Clusters: None

↓

Two-Element Clusters: **/**br- fw-/
/tr- kr- bw- dw- gw-/
/tw- kw- pj- pw-/

Affricates: /ʧ/ /ʤ/

↓

Fricatives: /β/ /f/ /v/ /ð/ /s//z/ /ʃ/ /ʒ/

↓

Stops: /p//b/ /t/ /d/ /k/ /g/ /ʔ/

Also in system: /l r w j h m n/

Phonemic inventory: /p b t d k g f s ʃ ʧ l r m n w j h/

Nonstimulable OUT sound: /ŋ/

Does Damon have **three-element (sCC) clusters** in his system?

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Target Selection for Damon (Age 4;4)

Three-Element Clusters: None

↓

Two-Element Clusters: **/**br- fw-/
/tr- kr- bw- dw- gw-/
/tw- kw- pj- pw-/

Affricates: /ʧ/ /ʤ/

↓

Fricatives: /β/ /f/ /v/ /ð/ /s//z/ /ʃ/ /ʒ/

↓

Stops: /p//b/ /t/ /d/ /k/ /g/ /ʔ/

Also in system: /l r w j h m n/

Phonemic inventory: /p b t d k g f s ʃ ʧ l r m n w j h/

Nonstimulable OUT sound: /ŋ/

Does Damon's phonemic inventory include /p t k w l r/?

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Target Selection for Damon (Age 4;4)

Three-Element Clusters: None

↓

Two-Element Clusters: **/**br- fw-/
/tr- kr- bw- dw- gw-/
/tw- kw- pj- pw-/

Affricates: /ʧ/ /ʤ/

↓

Fricatives: /β/ /f/ /v/ /ð/ /s//z/ /ʃ/ /ʒ/

↓

Stops: /p//b/ /t/ /d/ /k/ /g/ /ʔ/

Also in system: /l r w j h m n/

Phonemic inventory: /p b t d k g f s ʃ ʧ l r m n w j h/

Nonstimulable OUT sound: /ŋ/

Does Damon's phonemic inventory include **C2** and **C3**?

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Target Selection for Damon (Age 4;4)

Three-Element Clusters: None

↓

Two-Element Clusters: **/**br- fw-/
/tr- kr- bw- dw- gw-/
/tw- kw- pj- pw-/

Affricates: /ʧ/ /ʤ/

↓

Fricatives: /β/ /f/ /v/ /ð/ /s//z/ /ʃ/ /ʒ/

↓

Stops: /p//b/ /t/ /d/ /k/ /g/ /ʔ/

Also in system: /l r w j h m n/

Phonemic inventory: /p b t d k g f s ʃ ʧ l r m n w j h/

Nonstimulable OUT sound: /ŋ/

What do we predict that Damon will learn (treated and untreated)?

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Target Selection for Damon (Age 4;4)

Three-Element Clusters: None

↓

Two-Element Clusters: **/**br- fw-/
/tr- kr- bw- dw- gw-/
/tw- kw- pj- pw-/

Affricates: /ʧ/ /ʤ/

↓

Fricatives: /β/ /f/ /v/ /ð/ /s//z/ /ʃ/ /ʒ/

↓

Stops: /p//b/ /t/ /d/ /k/ /g/ /ʔ/

Also in system: /l r w j h m n/

Phonemic inventory: /p b t d k g f s ʃ ʧ l r m n w j h/

Nonstimulable OUT sound: /ŋ/

Which **two-element cluster(s)** (SD =3) may we target (with one OUT sound)?

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Target Selection for Damon (Age 4;4)

Three-Element Clusters: None

↓

Two-Element Clusters: **/**br- fw-/
/tr- kr- bw- dw- gw-/
/tw- kw- pj- pw-/

Affricates: /ʧ/ /ʤ/

↓

Fricatives: /β/ /f/ /v/ /ð/ /s//z/ /ʃ/ /ʒ/

↓

Stops: /p//b/ /t/ /d/ /k/ /g/ /ʔ/

Also in system: /l r w j h m n/

Phonemic inventory: /p b t d k g f s ʃ ʧ l r m n w j h/

Nonstimulable OUT sound: /ŋ/

What do we predict that Damon will learn (treated and untreated)?

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Data Analysis: Damon (Age 4;4)

/skw-/, /spl-/

Targets	6/25/10 & 7/9/10	12/9/10 & 1/26/11	5/4/11
peach	pi	pitʃə	pitʃ
bread	bwɛ	brɛ	brɛd
cereal	ʃɪjɪdoʊ	ʃɪrdɪoʊ	sɪrɪoʊl
chip	ʧɪ	ʧɪp	ʧɪp
star	da	ta	star

What changed for each target?
Why? (Which language universal applied?)

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Complexity Approach

- "The more complex the input *beyond* a child's existing knowledge, the greater the phonological learning" (Baker & Williams, 2010)
- In fact, "it has been shown that simpler input actually makes language learning more difficult because the child is provided with only partial information about linguistic structure." (Gierut, 2007)

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Additional Factors That Guide Target Selection

- Phonological knowledge (Brière, 1966; Gierut, 1990, 1991, 1992, 2005; Gierut et al, 1987; Gierut & Neumann, 1992; Hammerly, 1982; Hardy, 1993; Johnston, 1988; Williams, 1991)
  - target least known (OUT) sounds
- Stimulability (Powell et al, 1991; Dinnsen & Elbert, 1984; Elbert & McReynolds, 1978; Miccio et al, 1999; Powell, 1993; Sommers et al, 1967)
  - target NONSTIMULABLE sounds
- Developmental norms (Dyer et al, 1987; Gierut et al, 1996; Powell, 1991; Powell et al, 1998)
  - target LATER ACQUIRED sounds

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What happened to Jack?

Let's find out!

Supplementary Handout: pp. 18-19

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Jack 5;2

Three-Element Clusters — **None**

Also in system: /w l r j h m n ŋ/

↓

Two-Element Clusters — **/mj-/ (SD = 2)**
/vj-/ (SD = 3)
/sj-/ /fw-/ (SD = 4)
/bj-/ (SD = 5)
/tj-/ /pw-/ /pj-/

↓

Affricates — **/ʧ/ /ʤ/**

• 50% intelligibility in conversation

↓

Fricatives — **/f/ /v//s//z//ʃ/**

↓

Stops — **/p//b//t//d/ /k//g/**

104

Jack 5;7

Three-Element Clusters — **/spl-/ /str-/**

Also in system: /w l r j h m n ŋ/

↓

Two-Element Clusters — **/sm-/ /sn-//mj-/ (SD = 2)**
/sl-/ /fl-/ /vj-/ (SD = 3)
/bl-/ /gl-/ /dr-/ /sj-/ /fw-/ (SD = 4)
/pl-/ /kl-/ /bj-/ (SD = 5)
/tj-/ /pw-/ /pj-/ /tw-/ (SD = 6)
/st-/ (SD = - 2)

↓

Affricates — **/ʧ/ /ʤ/**

• 70% intelligibility in conversation

↓

Fricatives — **/f/ /v//s//z//ʃ/**

All added singletons and clusters in blue

↓

Stops — **/p//b//t//d/ /k//g/**

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Jack 5;10

Three-Element Clusters /spl-/ /str-/ /spw-/ /stw-/

↓

Two-Element Clusters /sm-/ /sn-/ (SD = 2)
/ɹ-/ /sl-/ /fl-/ /mj-/ (SD = 3)
/sw-/ /bl-/ /gl-//fw-/ (SD = 4)
/bj-/ /kl-//pl-/ (SD = 5)
/kw-/ /tw-/ /pj-/ (SD = 6)
/st-/ /sp-/ (SD = -2)

↓

Affricates /ʧ / /ʤ/

↓

Fricatives /f / /v/ /θ/ /s//z//ʃ/ /ʒ/

↓

Stops /p//b//t//d/ /k/ /g/

Also in system: / l r w j h m n ŋ/

• 90% intelligibility in conversation

All added singletons and clusters in blue

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Targets	10/18/16	3/6/17	6/8/17
snake	seɪŋk	sneɪk	sneɪk
slug	sjug	slʌg	slʌg
spider	paɪdə	splaɪdə	spaɪdə
dragon	dægɪn	drægɪn	dwˠægɪn
school	tu	stul	stul
flag	fæd	flæg	flæg
★ crayons	ʧænz	klænz	kwænz
glue	du	glu	glu
glasses	dæsɪz	glæsɪz	glæsɪz
black	bjæt	blæk	blæk
square	tɛoʊ	stwɛr	swɚ
splashing	pjæsɪn	splæʃɪŋ	splæʃɪŋ
★ snowflake	noʊfeɪt	snoʊfeɪk	snoʊfleɪk
vanilla	dʌnɪlə	lɪnɪlə	dɪnɪlə
sandwiches	sæwɪʧɪz	sænwɪʧɪz	sænwɪʧɪz
cereal	ʂɪwoʊ	sɪɹɪoʊ	sɪɹɪoʊ
run	wʌn	wʌn	wˠʌn
★ game	ʤeɪm	deɪm	geɪm
valentine	bælʌtaɪn	væwɪnteɪm	bælɪntaɪm
badge	bægs	bæʤ	bæʤ

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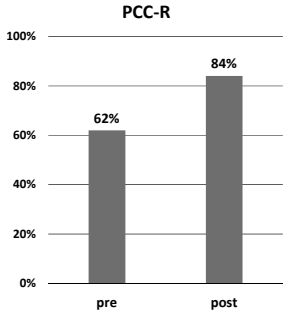
Jack: Global measures



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Ella

- Age 3;11
- No previous intervention
- Excellent language skills and preacademic skills
- Attending preschool five days per week
- Supportive family
- Reticent personality
- Easily frustrated

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Clusters	11/5/12	3/11/13	6/19/13
snake	neɪk	neɪk	sneɪk
slug	tʌg	slʌg	slʌg
spider	paɪdoʊ	paɪdoʊ	spaɪdə
dragon	bwægɪn	dwægɪn	dwægɪn
flag	pwæg	flæg	fwæg
crayons	pwænz	kwænz	kwænz
glue	du	glu	glu
glasses	dæsɪz	glæsɪz	glæsɪz
★ square	pwɛoʊ	twɛoʊ	skwɛoʊ
shredded	pwɛdɪʃ	ʃɛwɪd	ʃrɛdɪd
★ grapes	bweɪps	gweɪps	greɪps
spoon	pun	pun	spun
swing	pwɪŋ	pwɪŋ	swɪŋ
splashing	pwæʃɪŋ	pwæʃɪŋ	spwæʃɪŋ
swimming	pwɪmɪŋ	pwɪmɪŋ	swɪmɪŋ
★ slide	taɪd	tlaɪd	slaɪd
scream	pwim	pwim	skwim
thrilling	pwɪwɪŋ	fwɪlɪŋ	θwɪwɪŋ
sprint	pwɪnt	pwɪnt	spwɪnt
queen	pwin	kwin	kwin

change
adult-like

Treatment targets: /fl-/, /θr-/, /skw-/

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Ella Age 3;11

Three-Element Clusters: **None**

↓

Two-Element Clusters : /bw-/ /pw-/

↓

Affricates: /ʧ / /ʤ/

↓

Fricatives : /s//z/ /ʃ/ /ʒ/

↓

Stops: /p//b/ /t/ /d/ /k/ /g/

Also in system: /w j h m n ŋ/

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Ella Age 4;3

Three-Element Clusters	**None (1 occurrence of /stw-/ and /spw-/)**
↓	
Two-Element Clusters	**/sl-/ /fl-/ (SD = 3)** **/gl-/ /fw-/ (SD = 4)** **/tr-/ /kl-/ /bw-/ (SD = 5)** **/kw-/ /tw-/ /pw-/ (SD = 6)**
↓	
Affricates	**/ʧ //ʤ/** **Also in system: /w l r j h m n ŋ/**
↓	
Fricatives	**/f //v//ð/ /s//z//ʃ//ʒ/**
↓	
Stops	**/p//b//t//d//k//g/**

10 weeks of intervention on /fl-/ and /skw-/ – 18 hours
All added sounds/clusters in blue

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Ella Age 4;6

Three-Element Clusters	**/skw-/ /spw-/ /stw-/**
↓	
Two-Element Clusters	**/sm-/ /sn-/ (SD = 2)** **/sl-/ /fl-/ /ʃr-/ /θr-/ (SD = 3)** **/gl-/ /dr-/ /gr-/ /sw-/ (SD = 4)** **/tr-/ /kl-/ (SD = 5)** **/kw-/ /tw-/ (SD = 6)** **/sp-/ /sk-/ /st-/ (SD = -2)**
↓	
Affricates	**/ʧ / /ʤ/** **Also in system: /w l r j h m n ŋ/**
↓	
Fricatives	**/f / /v/ /θ/ /ð/ /s/ /z/ /ʃ/ /ʒ/**
↓	
Stops	**/p/ /b/ /t/ /d/ /k/ /g/**

20 weeks of intervention on /fl-/ /θr-/ and /skw-/ – 34 hours
All added sounds/clusters in blue

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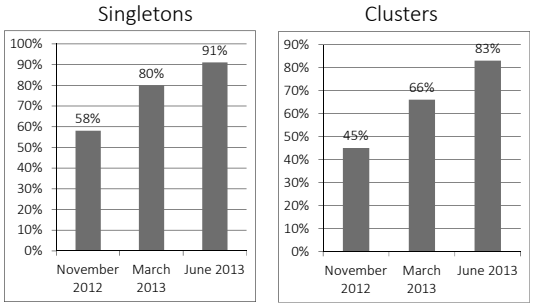
Ella: PCC



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Debrief with Neighbors

- What would you like to know more about?
- How full is your brain?

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