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Phonological Process Analysis in Preschool Children

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Agenda

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- Background & Normative data for two-, three-, & four-year-olds
- Phonological process analysis options: Single words or Connected speech?
- Interpreting the samples
- Treatment approach considerations
- Conclusions / Q & A

Three subtypes of Speech Sound Disorder (SSD), according to Speech Disorders Classification System

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(1) Genetic, Otitis Media with Effusion (OME) and/or Psychosocial

(2) Dysarthria, Apraxia (CAS) and/or Not otherwise specified

(3) Residual error subgroups (/s/ and /r/) / Articulation

- Children with Speech Sound Disorders (SSD) are a heterogeneous population, deserving the creation of subgroups.
- Other classification schemes:
  - Speech sound error symptoms
  - (Dis-)abilities presumed to cause the SSD
  - Language learning environment

Kirk & Vigeland (2014)

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THE SIX PSYCHOMETRIC SPEECH SOUND DISORDER / PHONO TESTS INCLUDED IN THIS REVIEW DID NOT SHOW MOST OF THE "…PROPERTIES REQUIRED OF WELL-DESIGNED NORM-REFERENCED TESTS.

OF PARTICULAR CONCERN WAS LACK OF ADEQUATE SAMPLE SIZE, POOR EVIDENCE OF CONSTRUCT VALIDITY, AND LACK OF INFORMATION ABOUT DIAGNOSTIC ACCURACY (P.365)."

Solutions to this norm-referenced phonology test problem?

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CREATE OR AWAIT BETTER TESTS

OR

CREATE & USE CRITERION-REFERENCED TESTS!

Normative data for two-, three-, & four-year-olds…

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…FOR PHONOLOGICAL PROCESSES

Normative data / "Norm guidelines"

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2 yo: 50% intelligible to strangers; phonological processes suppressed:

- Final consonant deletion
- Nasal and glide cluster reduction
- Velar and labial assimilation
- Stopping of /θ/ & /f/
- Prevocalic voicing

3 yo: 75% intelligible to strangers; phonological processes suppressed:

- Weak syllable deletion
- /s/ and liquid cluster reduction
- Velar fronting
- Stopping of /s/, /v/, & /z/
- Final devoicing

Normative data / "Norm guidelines"

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- **Four-year olds** are most near-adult-like (~90-100% intelligible) in their phonological production skills and abilities:
  - These phonological processes persist or are suppressed:
    - Palatal fronting
    - Stopping of /ð/
    - Gliding of liquids and Vocalization
- Processes that have no available norms (e.g., alveolarization)
- Processes that are atypical of development at any age (e.g., interdentalization)

Background information:

1. "Phonological processes" are patterns of sound error(s) or changes from the intended to the actual sound, observed across multiple sounds and words.
2. Phonological processes can either be completely "consistent," applying to 100% of opportunities, or "inconsistent," applying less often.
3. An assumption often used is that when a child applies a phonological process with relatively low consistency, say 20% of all opportunities, he is close to complete "suppression" of the process, thus contributing to the development of more intelligible speech.
4. Children with normally developing phonology exhibit many different phonological processes while learning to talk.
5. Children with a phonological disorder exhibit one or more consistent age-inappropriate or atypical phonological process.
6. Various linguists and phoneticians have categorized phonological processes in various ways (Edwards & Shriberg, 1983; Grunwell, 1983; Yaruss, 1994). This is a compilation of available descriptions of twenty-six phonological processes, organized into six types of phonological processes:

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Typical Two-year-old Phonological Process Explanations:

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Phonological processes affecting the canonical shape of the word:

Final Consonant Deletion (FCD):

a) A consonant in the final position of a word (or the first half of a compound word) is deleted.

b) Typically occurs up to age 3; Grunwell's norms allow it to fade out up to 3;3; Examples:

"dog" /dɔg/→ [dɔ]

"mouth" /maʊθ/→ [maʊ]

"nose" /noʊz/→ [noʊː]

Typical Two-year-old Phonological Process Explanations:

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Ensure child doesn't have a URI (cold), etc

Nasal Cluster Reduction (NCR):

a) A cluster of nasal plus non-/s/ obstruent (e.g., /ŋk, mp/) is reduced by one element, typically the nasal.

b) Also can occur across syllable boundaries, such as "grandma" /grænmɑ/→ [græmɑ].

c) Typically occurs up to age 3; Examples:

"jump rope" /ʤʌmprop/→ [ʤʌprop]

"shampoo" /ʃæmpu/→ [ʃæpu]

"princess" /prɪnsɛs/→ [prɪsɛs]

Typical Two-year-old Phonological Process Explanations:

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Glide Cluster Reduction (GCR):

a) A cluster of stop plus glide (e.g., /w, j/) is reduced by one element, typically the glide.

b) Also can occur across syllable boundaries, such as "Edward" /ɛdwɚd/→ [ɛdɚd].

c) Typically occurs up to age 3; Examples:

"vacuum" /vækjum/→ [vækum]

"thank you" /θæŋkju/→ [θæŋku]

"queen" /kwin/→ [kin]

"sandwich" /sændwɪtʃ/→ [sæmɪtʃ] (with NCR, LA)

Typical Two-year-old Phonological Process Explanations:

Assimilation processes:

Velar Assimilation (VA):

a) A consonant becomes a velar /k, g, ŋ/ because of the influence of a nearby velar.
b) Typically occurs up to age 2½; Grunwell's norms ("consonant harmony") allow it to fade out up to 3;0; Examples:

"green" /grin/→ [griŋ]

"chicken" /tʃɪkən/→ [kɪkən]

"snake" /sneɪk/→ [ŋeɪk]

"thank you" /θæŋkju/→ [kæŋkju]

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Typical Two-year-old Phonological Process Explanations:

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Labial Assimilation (LA):

a) A consonant becomes labial /p, b, w, m, f, v/ because of the influence of a nearby labial.
b) Common in severe phonological disorders, but no age information is available. Grunwell's norms ("consonant harmony") allow it to fade out up to 3;0; Examples:

"swing" /swɪŋ/→ [fwɪŋ]

"bathtub" /bæθtʌb/→ [bæftʌb]

"library" /laɪbrɛrɪ/→ [baɪbrɛrɪ]

Typical Two-year-old Phonological Process Explanations:

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Voicing processes:

Prevocalic Voicing (PV):

a) A voiceless obstruent (e.g., /p, t, k, f, s, ʃ, tʃ/) before a vowel, liquid, or glide is replaced by a voiced obstruent (e.g., /b, d, g, v, z, ʒ, dʒ/).
b) Often co-occurs with cluster reductions, esp. in word-initial position
c) Typically occurs up to age 2;8 or 3;0; Grunwell norms ("context-sensitive voicing") suggest it fades out by 3;1; Examples:

"stamp" /stæmp/→ [dæmp] (with sCR)

"plate" /pleɪt/→ [beɪt] (with LCR)

"cage" /keɪdʒ/→ [geɪdʒ]

Typical Two-year-old Phonological Process Explanations:

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Manner of articulation processes:

Stopping (ST):

a) A fricative (e.g., /f, s, θ, ð/) or affricate /tʃ, dʒ/ is replaced by an oral stop (e.g., /p, t, d/).
b) Occurs up to age 2 ½ or 3 for most sounds; may persist somewhat beyond age 4½. Grunwell (1983) breaks this down into each fricative and affricate:
   i) Stopping of /θ/ should be suppressed by ~ 2;6, but then /θ/→ /f/ up to age 5;0 or beyond;
   ii) Stopping of /f/ should be suppressed by ~ 3;0

Typical *Three-year-old* Phonological Process Explanations

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Typical *Three-year-old* Phonological Process Explanations:

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Syllable structure processes

- **Weak syllable deletion (WSD):**
  a) A syllable (typically unstressed) in a polysyllabic word is deleted. Includes "syllable coalescence" in which parts of two adjacent syllables are combined.
  b) Typically occurs up to age 3½ to 4; Examples:

"banana" /bənænə/→ [nænə] or [bænə]

"television" /tɛləvɪʒən/→ [tɛvɪʒən]

"guitar" /gɪtɑr/→ [tɑr]

Three-year-old Phonological Process Explanations:

/s/-Cluster Reduction (sCR):

a) A sequence or "cluster" of 2 or 3 consonants involving /s/ (e.g., /sp, sl, str, skw/) is reduced by one element.

b) Also includes cases of segment coalescence, such as "spoon" /spun/→ [fun], where the /f/ may reflect the fricative quality of /s/ and the labial quality of /p/.

c) Typically occurs up to age 3; Grunwell's norms allow it to fade out up to 3;7

d) Atypical sCR is when the unmarked or non-/s/ element(s) is deleted as in "spoon" /spun/→ [sun]

e) Typical examples:

"spider" /spaɪdɚ/→ [paɪdɚ]

"string" /strɪŋ/→ [trɪŋ]

"sleep" /slip/→ [lip]

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Three-year-old Phonological Process Explanations:

Liquid Cluster Reduction (LCR):

a) A cluster of obstruent plus non-syllabic liquid (e.g., /fr, kl/) or non-syllabic liquid plus obstruent (e.g., /lv/) is reduced by one element.

b) Also includes cases of segment coalescence, such as "clown" /klaʊn/→ [faʊn].

c) Typically occurs up to age 3; Grunwell's norms allow it to fade out up to 3;9

d) Atypical LCR is when the unmarked or non-/r/ element(s) is deleted as in "drink" /drɪŋk/→ [rɪŋk]

e) Typical examples:

"flower" /flaʊwɚ/→ [faʊwɚ]

"elves" /ɛlvz/→ [ɛvz]

"dragon" /drægən/→ [dægən]

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Three-year-old Phonological Process Explanations:

- **Velar Fronting (VF):**
  a) A velar segment (e.g., /k, g, ŋ/) is replaced by an alveolar (e.g., /t, d, n/).
  b) Typically occurs up to 3; Grunwell norms suggest it fades out by 3;3; it is a common process in severe phonological disorders; Examples:

"catch" /kɛtʃ/→ [tɛtʃ]

"dog" /dɔg/→ [dɔd]

"swing" /swɪŋ/→ [swɪn]

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Three-year-old Phonological Process Explanations:

- Stopping of /s/ should be suppressed by ~ 3;1
- Stopping of /v/ should be suppressed by ~ 3;6
- Stopping of /z/ should be suppressed by ~ 3;7

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Typical Three-year-old Phonological Process Explanations:

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Final Devoicing (FD):

a) A voiced obstruent (e.g., /b, d, g/) in final position is replaced by a voiceless obstruent (e.g., /p, t, k/).

b) Occurs in some 4-year-olds, but Grunwell norms ("context-sensitive voicing") suggest it fades out as early as 3;1; Examples:

"cheese" /tʃiz/→ [tʃis]

"crib" /krɪb/→ [krɪp]

"bathtub" /bæθtʌb/→ [bæθtʌp]

Typical *Four-year-old* Phonological Process Explanations

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Typical *Four-year-old* Phonological Process Explanations:

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Place of articulation processes:

- **Depalatization (DP) (Also called Palatal Fronting):**
  a) A palatal obstruent (e.g., /ʃ, ʒ, tʃ, dʒ/) is replaced by or "fronted to" an alveolar (e.g., /s, z, ts, dz/).
  b) Often co-occurs with deaffrication and stopping
  c) Occurs in some 4-year-olds; Examples:

"cage" /keɪdʒ/→ [keɪdz] or [keɪz] (with DA)

"shovel" /ʃʌvəl/→ [sʌvəl]

"shovel" /ʃʌvəl/→ [tʌvəl] (with ST)

Typical *Four-year-old* Phonological Process Explanations:

- Fronting of /ʃ/ to [s] should be suppressed by ~ 4;4
- Fronting of /tʃ, dʒ/ to [ts, dz] should be suppressed by ~ 4;7
- Stopping of /ð/ should be suppressed by the age of 5;6

- **Gliding of Liquids (GL):**
  a) A liquid /l, r/ is replaced by a glide /w, j/ in prevocalic contexts.
  b) Occurs up to age 4;0 for /l/ and up to 5;6 for /r/. ; Examples:

"rabbit" /ræbɪt/→ [wæbɪt]

"clock" /klɑk/→ [kwɑk]

"flag" /flæg/→ [fwæg]

"three" /θri/→ [θwi]

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Typical *Four-year-old* Phonological Process Explanations:

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Vocalization (VOC):

a) A liquid /l, r/ or syllabic liquid /ɚ, əl/ in syllable- or word-final position is replaced by a vowel (typically /ʊ, u, ə/).

b) Also includes pre-consonantal liquids, such as /l/ in "twelve" /twɛlv/

c) Occurs up to age 6;0 for /l/ and up to 7;0 for /r/. ; Examples:

"twelve" /twɛlv/→ [twɛʊv]

"car" /kɑr/→ [kɑʊ]

"feather" /fɛðɚ/→ [fɛðə]

"dishwasher" /dɪʃwɔʃɚ/→ [dɪʃwɔʃo]

No Available Age-related Evidence for these Phonological Processes:

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Palatization (PAL):

d) Alveolar fricatives or stops (e.g., /s, z, t, d/) are replaced by palatal fricatives /ʃ, ʒ,/ or affricates /tʃ, dʒ/.

e) No age information is available for this process; Examples:

"nose"/noʊz/→ [noʊʒ]

"scissors" /sɪzɚz/→ [ʃɪʒɚʒ] (3 times)

No Available Age-related Evidence for these Phonological Processes:

33

Alveolarization (ALV):

a) An interdental or labiodental fricative (e.g., /θ, ð, f, v/) is replaced by an alveolar obstruent (e.g., /s, z, t, d/).

b) No age information is available for this process; Examples:

"three" /θri/→ [sri]

"breathe" /brið/→ [briz]

"this" /ðɪs/→ [zɪs]

No Available Age-related Evidence for these Phonological Processes:

34

Labialization (LAB):

a) An interdental fricative /θ, ð/ is replaced by a labial obstruent (typically /f, v/, but also /p, b/ if the Stopping process (ST) also applies).

b) No age information is available for this process; Examples:

"teeth" /tiθ/→ [tif]

"breathe" /brið/→ [briv]

"this" /ðɪs/→ [bɪs]

"bathtub" /bæθtʌb/→ [bæftʌb]

No Available Age-related Evidence for these Phonological Processes:

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Gliding of Fricatives (GL):

a) A fricative or affricate (e.g., /f, s, z, ʃ, tʃ/) in prevocalic position is replaced by a glide /j, w/.

b) No age information is available for this process; Examples:

"feather" /fɛðəɹ/→ [wɛðəɹ]

"zipper" /zɪpəɹ/→ [jɪpəɹ]

"cheese" /tʃiz/→ [jiz]

No Available Age-related Evidence for these Phonological Processes:

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Affrication (AFF):

a) A fricative (e.g., /f, v, s, z, ʃ, ʒ/) is replaced by an affricate (any stop plus homorganic fricative, including /ts, dz, pf/ as well as /tʃ, dʒ/).

b) No age information is available for this process; Examples:

"shrimp" /ʃrɪmp/→ [tʃrɪmp]

"zipper" /zɪpəɹ/→ [dzɪpəɹ]

"fire truck" /faɪr trʌk/→ [pfaɪr trʌk]

No Available Age-related Evidence for these Phonological Processes:

37

Deaffrication (DA):

a) An affricate /tʃ, ʤ/ is replaced by a fricative.

b) No age information is available for this process; Examples:

"chicken" /tʃɪkən/→ [ʃɪkən]

"catch" /kɛtʃ/→ [kɛʃ]

"cage" /keɪʤ/→ [keɪʒ]

Atypical Phonological Processes (i.e., no norms):

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Atypical consonant processes:

Interdentalization (INT):

a) Sibilants (alveolar/palatal [af]fricatives) /s, z, ʃ, ʒ, tʃ, ʤ/ are dentalized or replaced by interdentals /θ, ð/.

b) Typical ages are not available for this process; it often requires remediation to address and therefore is considered problematic for normal phonological development.

c) Examples:

"this" /ðɪs/→ [ðɪθ]

"cheese" /tʃiz/→ [θið] (2 times)

"glasses" /glæsəz/→ [glæθɪð] (2 times)

Atypical Phonological Processes (i.e., no norms):

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- **Initial Consonant Deletion (ICD):**
  a) Word-initial consonants are deleted.
  b) This process is not typically observed in children's normal phonological development.
  c) Examples:

"car" /kɑr/→ [ɑr]

"frog" /frɔg/→ [ɔg]

"nose" /noʊz/→ [oʊz]

Atypical Phonological Processes (i.e., no norms):

40

- **Lateralization (LAT):**
  a) A sibilant /s, z, ʃ, ʒ, tʃ, dʒ/ is replaced by a lateral fricative [ɬ] or lateral emission.
  b) This process is not typically observed in children's normal phonological development.
  c) Examples:

"sleep" /slip/→ [ɬ ip]

Atypical Phonological Processes (i.e., no norms):

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Velarization (VEL):

a) Alveolar or interdental obstruents (e.g., /t, s, θ/ are replaced by velars.
b) This process is not typically observed in children's normal phonological development.
c) Examples:

"this" /ðɪs/→ [gɪs]

"train" /treɪn/→ [geɪn] (plus LCR)

"zebra" /zibrə/→ [gibrə]

Atypical Phonological Processes (i.e., no norms):

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Glottal Replacement (GR):

a) Obstruents (stops, fricatives, affricates) are replaced by the glottal stop /ʔ/.
b) This process is not typically observed in children's normal phonological development.
c) Examples:

"cheese" /tʃiz/→ [tʃiʔə]

"basket" /bæskət/→ [bæʔɪʔə] (2 times)

"this" /ðɪs/→ [ðɪʔə]

Phonological Process Analysis Options

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Single words?

- Drawbacks: Motivating to the child? Word avoidances?
- Opportunity to check stimulability: Imitation types (direct, delayed)
- Opportunity to check facilitation:
  - As a singleton v. cluster
  - Target sound occurs 1x in a word
  - Target sound in a stressed syllable
  - Target sound in a high frequency word or in a shorter, simpler word

Connected speech?

- Drawback: May lack context & frustrate the child with a phono-dis
- Baseline intelligibility can be determined via X = 1 unintelligible syllable (SALT)
- More recognizable problems and generalizable solutions
- Suprasegmentals can be assessed:
  - Intonation / rate
  - Syllable stress
  - Juncture

Speech Sample Analysis

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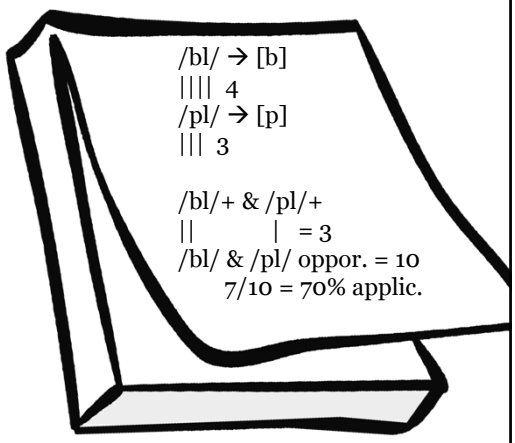
- **Connected speech sample:** Which of the 26 phonological processes are occurring on at least one opportunity?
- **Single-word sample:** What is the stimulability / facilitating context?
- **Either or both samples:** What is the percent opportunity to apply?
  - e.g., topic is about the "blue plane" /blu/ & /plen/
  - Let's watch Ely. What notes would you make?



Ely: 4;4 S+DP; Dyslexia in familial Hx

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- Ely's video

Interpreting the Samples

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INTERPRETATIONS ARE BASED ON EITHER OR BOTH SINGLE WORD AND CONNECTED SPEECH SAMPLES

Measures: Percent Consonants Correct (PCC)

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- Frequently reported; What about Percent Vowels Correct (PVC)?
- Can be determined on any sample: Single-word (highest PCC likely), elicited imitated sentences (somewhat lowerPCC) & spontaneous (likely lowest PCC)
- Many problems with its use:
  - Influenced by speech sample type and size;
  - Ignores vowels;
  - Tedious measure to use clinically;
  - Age-appropriate, delayed, atypical errors are weighted equally → false positives and atypical SSD children are prioritized equally to children with phonological delays

The old way (Stampe, 1973; Edwards, 1986) & the way of most standardized tests: Phonological process analysis

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- "Phonological processes" are error patterns reflecting:
  - Developmental phonological constraints (e.g., cluster reduction)
  - Atypical constraints (e.g., initial consonant deletion)
- Standardized assessments might identify:
  - The number of times error patterns are used in a picture naming task by more than 10 % of children in six-month age bands (Norms)
  - Delay (use of error patterns typical of a younger age group), and
  - Disorder (use of error patterns not apparent at any age in the norms)

Adjunct to Phonological process Analysis: Use of Acoustic Analysis

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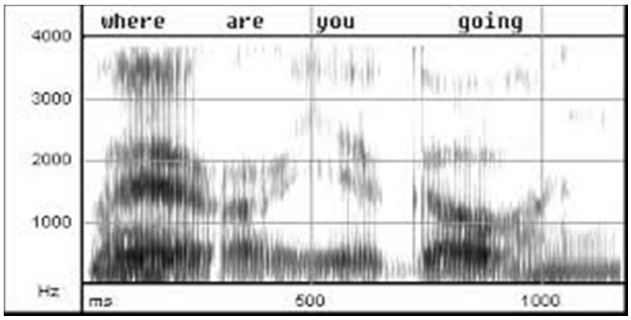
- Free acoustic analysis tools are readily available: e.g., Praat.org; **audacity**.sourceforge.net ;etc
- Acoustic measures are more valid than perceptual measures of children with SSD (Navasivayam et al. , 2013)



Adjunct to PCC:

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Proportion of whole-word proximity (PWM; Newbold, Stackhouse & Wells, 2013)

- Numerator = All phonemes (consonants and vowels) in a child's production of a word (correct plus incorrect), added to the number of accurately produced consonants.
- Denominator = Number of phonemes plus consonants in the adult production of that word

Interpreting the Samples

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Single-word

- Percent application of any of the 26 phonological processes that could be occurring
- Stimulability? Facilitation? /ri/
- Backing down to stimulating target sounds?
- Are target sounds in the inventory?

Connected Speech

- Intelligibility with and without context?
- Suprasegmental assessment?
- Comparison to single-word production
- SALT analysis: e.g., Ely
- Coping with frustration over not being understood?

Treatment Considerations: What to target?

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- Highest percent application phonological processes
- Most delayed phonological processes
- The atypical phonological processes
- Phonological processes affecting high frequency words (child's name)
- Interacting phonological processes
- Phonological processes with greatest negative impact on intelligibility
- The processes, which, if suppressed efficiently (e.g., low %application), would start a "domino effect" for the other phonological process suppression

Phonological Working Memory (PWM)

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- PWM supports phonological representations (Gathercole, 2006)
- Children can imitate non-words containing frequently-used consonants and consonant combinations easier (PWM advantage) than they can imitate non-words containing infrequently-used consonant sequences.
- "Speech difficulty likely impairs PWM, not that PWM underlies speech errors" (Dodd, 2014)
- Thus when we efficiently assess and treat phonological disorders in preschoolers, we are perhaps improving PWM as a side-effect.

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Norms?

Single words?

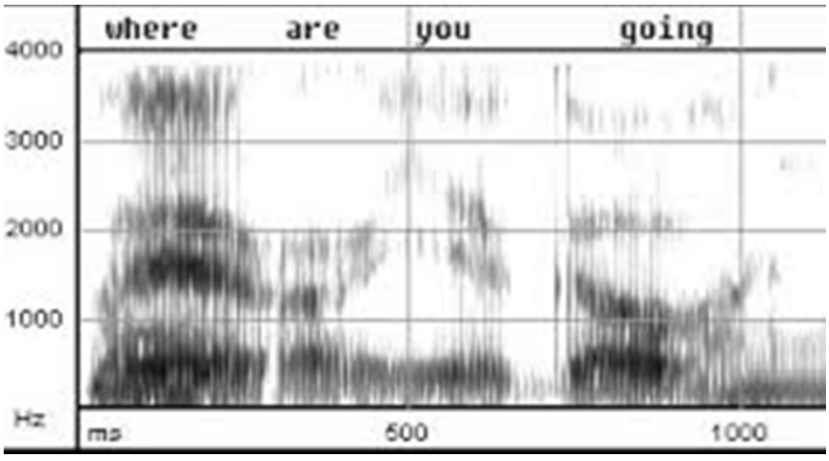
Connected speech?

Interpretation?

Tx options?

Ely?

Other cases?



Conclusions & Questions ?