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Updates in Phonological Process Analysis in Preschoolers

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Updates in Phonological Process Analysis in Preschoolers

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Learner Outcomes

As a result of this course, participants will be able to:

- Explain why assessing phonological processing is important.
- List and describe the phonological processes that are suppressed in two-, three- and four-year-olds with normal phonology.
- Describe how to plan an informal assessment of preschoolers' phonological processes in both single word and connected speech samples.

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Timed Agenda: 60 min

- Background: 20 min
- Normative guidelines per age: 2-, 3-, 4-yo's: 30 min
- Sampling plan: Phonological process analysis options; Single words or Connected speech: 5 min
- Conclusions / Q & A: 5 min

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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: ➡ 27 phon. processes, when categorized by ages and by no ages (0 norms)

More background

Why is assessing
phonology
important?

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Background: Phonological Working Memory (PWM)

- Children can repeat-back/imitate non-words (NWR) that contain frequently-used consonants and consonant combinations more easily than they can do NWR of infrequently-used consonant sequences (i.e., PWM advantage).
- PWM supports phonological representations (Gathercole, 2006).
- Speech difficulty likely impairs PWM (Dodd, 2014).
- Thus, when we efficiently assess and treat phonological disorders in preschoolers, we are likely improving PWM as a side-effect (i.e., a “vicious” or a positive cycle).

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Background: Phonological Working Memory (PWM)

- Marini et al. (2017) found that former Late Talkers still, at age 3;4 (40 mos), have a mild lexical delay. Their results imply that the task of Non-Word Repetition is an early indicator of future lexical deficits.
- Perhaps some children, like those in the DNA-KE family with a FOXP gene mutation, have an impaired speech-based representation in the phonological loop, with an intact “visuospatial sketchpad,” so that sub-vocal rehearsal is impaired (Schultze et al., 2018).

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Normative data for two- to four-year-olds:

- Accuracy and frequency of consonant clusters increases with age (Faes & Gillis, 2017).
- Speech sound disorders occur in 16% of three-year-olds, so almost as high as 1 / 5 three-yr's (Voss-Hoynes, 2017).
- Heritability of SSD with monozygotic twins: Concordance rates of 0.95, but genetics is still speculative (e.g., FOXP, Voss-Hoynes, 2017).

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Three subtypes of Speech Sound Disorder (SSD) in Speech Disorders Classification System (SDCS, Lewis et al., 2006)

- Genetic, Otitis Media with Effusion (OME) and/or Psychosocial origins
- Dysarthria, Apraxia (CAS) and/or Not otherwise specified
- Articulation; Residual error subgroups (e.g., /s/ and /r/)

Children with SSD are a heterogeneous population, so there are subgroups. Other classification schemes:

- Speech sound error symptoms (e.g., typical v. atypical)
- (Dis-)abilities presumed to cause the SSD
- Language learning environment

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Background for Analysis and Assessment:

- High word inconsistency has been associated with poor performance on receptive vocabulary measures.
- Is this because of:
 - Unstable lexical representations? (Macrae, 2013)
 - Errors in selecting and sequencing phonemes? (Dodd & McIntosh, 2010)
 - Or, alternatively, perhaps high word inconsistency occurs regardless of vocabulary skills, because inconsistency occurs in typical speech development (Sosa, 2015; McRae & Sosa, 2015)

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Background for Analysis and Assessment:

- Approximately 6-10% percent of all school-agers do not naturally acquire the “late eight” phonemes, which are:
 - /θ/, /ð/, /r/, /l/, /s/, /z/, /f/, /tʃ/
- One in four adults living in a major US city, are learning English, and they may lack these “late eight” sounds, as well
- These late eight sounds are “marked,” or not universal in the languages of the world, but may be prevalent in English (e.g., Bleile, 2017).

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Normative guidelines

List and describe the phonological processes that most two-, three-, & four-year-olds with normal phonology have suppressed

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Normative data / “Norm guidelines”

Two-year olds are 50% intelligible to strangers; these phonological processes are suppressed by year’s end:

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

Three-year olds are 75% intelligible to strangers; these phonological processes are suppressed by year’s end:

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

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Normative data / “Norm guidelines”

Four-year olds are near-adult-like in their phonological production skills and abilities:

- These phonological processes persist, but not past 5yo:
 - Palatal fronting
 - Stopping of /ð/
 - Gliding of liquids and Vocalization
- Some processes have no available norms (e.g., alveolarization)
- Some processes are considered atypical of development at any age (e.g., interdentalization)

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Typical two-year-old phonological process explanations, there are 7:

The first three phonological processes affect the canonical shape or syllable structure of the word -- FCD, NCR, GCR:

- ① **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” /dɒg/ → [dɒ]	“mouth” /maʊθ/ → [maʊ]
	“nose” /noʊz/ → [noʊ:]

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Typical two-year-old phonological process explanations:

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

- ② **Nasal Cluster Reduction (NCR):**
- A cluster of nasal plus non-/s/ obstruent (e.g., /ŋk, mp/) is reduced by one element, typically the nasal.
 - Also can occur across syllable boundaries, such as “grandma” /grænma/ → [græmə].
 - Typically occurs up to age 3; Examples:
 “jump rope” /dʒʌmpɹop/ → [dʒʌpɹop] “princess” /prɪnsɛs/ → [prɪsɛs]
 “shampoo” /ʃæmpu/ → [ʃæpu]

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Typical two-year-old phonological process explanations:

- ③ **Glide Cluster Reduction (GCR):**
- A cluster of stop plus glide (e.g., /w, j/) is reduced by one element, typically the glide.
 - Also can occur across syllable boundaries, such as “Edward” /ɛdwɔrd/ → [ɛdɔrd].
 - Typically occurs up to age 3; Examples:
 “vacuum” /vækjʊm/ → [vækʊm]
 “thank you” /θæŋkjʊ/ → [θæŋkʊ]
 “queen” /kwɪn/ → [kɪn]
 “sandwich” /sændwɪtʃ/ → [sæmɪtʃ] (with NCR, LA)

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Typical two-year-old phonological process explanations:

Assimilation processes:

④ **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/ → [grɪŋ]

"chicken" /tʃɪkən/ → [kɪkən]

"snake" /sneɪk/ → [neɪk]

"thank you" /θæŋkju/ → [kæŋkju]

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Typical two-year-old phonological process explanations:

⑤ **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" /laɪbrəri/ → [bɑɪbrəri]

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Typical two-year-old phonological process explanations:

Manner of articulation processes:

⑥ 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

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Typical two-year-old phonological process explanations:

Voicing processes:

⑦ 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]

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Typical *Three-year-old* phonological process explanations

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Typical *Three-year-old* phonological process explanations, there are 6 of these:

Syllable structure processes

- ① **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” /bəˌnænə/ → [nænə] or [bænə]
 - “television” /teləˌvɪʒən/ → [tɛvɪʒən]
 - “guitar” /ɡɪˌtɑr/ → [tɑr]

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Typical *Three-year-old* phonological process explanations:

② /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” /spaidə/→ [paidə]
 - “string” /striŋ/→ [triŋ]
 - “sleep” /slip/→ [lip]

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Three-year-old phonological process explanations:

③ 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.
- 1 b) Also includes cases of segment coalescence, such as “clown” /klaun/→ [faun].
- 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” /flaʊwə/→ [faʊwə]
 - “elves” /ɛlvz/→ [ɛvz]
 - “dragon” /drægən/→ [dægən]

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Three-year-old phonological processes: *Place of articulation*

④ **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;3; Grunwell norms suggest it fades out by 3;3; it is a common process in severe phonological disorders; Examples:

“catch” /kætʃ/ → [tætʃ]

“dog” /dɒg/ → [dɒd]

“swing” /swɪŋ/ → [swɪn]

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Three-year-old phonological processes: *Manner of articulation*

- ⑤a) Stopping of /s/ should be suppressed by ~ 3;1
- ⑤b) Stopping of /v/ should be suppressed by ~ 3;6
- ⑤c) Stopping of /z/ should be suppressed by ~ 3;7

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Three-year-old phonological processes: *Voicing* type

⑥ **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" /tʃi:z/ → [tʃis]

"crib" /krɪb/ → [krɪp]

"bathtub" /bæθtʌb/ → [bæθtʌp]

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Typical *Four-year-old* phonological processes

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Typical *Four-year-old* phonological processes (4 of them):

Place of articulation processes:

① **Depalatalization (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)

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Typical *Four-year-old* phonological process explanations:

①a) Fronting of /ʃ/ to [s] should be suppressed by ~ 4;4

①b) Fronting of /tʃ, dʒ/ to [ts, dz] should be suppressed by ~ 4;7

② Stopping of /ð/ should be suppressed by the age of 5;6

③ **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” /klɒk/ → [kwɒk]

“flag” /flæɡ/ → [fwæɡ]

“three” /θri/ → [θwi]

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Typical *Four-year-old* phonological process explanations:

④ Vocalization (VOC):

- a) A liquid /l, r/ or syllabic liquid /ɾ, 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” /twelv/
- c) Occurs up to age 6;0 for /l/ and up to 7;0 for /r/. ; Examples:

“twelve” /twelv/ → [twɛʊv]

“car” /kɑr/ → [kɑʊ]

“feather” /fɛðɹ/ → [fɛðə]

“dishwasher” /dɪʃwɔʃɹ/ → [dɪʃwɔʃo]

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No available age-related evidence for these five phonological processes, so if persisting at age 4, concern is warranted:

① 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]

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No available age-related evidence for these five phonological processes:

② **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]

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No available age-related evidence for these five phonological processes:

③ **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” /fɛðə/ → [wɛðə]

“zipper” /zɪpə/ → [jɪpə]

“cheese” /tʃiːz/ → [jiːz]

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No available age-related evidence for these five phonological processes:

④ **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” /zɪpə/ → [dzɪpə]

“fire truck” /faɪr trʌk/ → [pfaɪr trʌk]

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No available age-related evidence for these five phonological processes:

⑤ **Deaffrication (DA):**

- a) An affricate /tʃ, dʒ/ is replaced by a fricative.
- b) No age information is available for this process; Examples:

“chicken” /tʃɪkən/ → [ʃɪkən]

“catch” /kɛtʃ/ → [kɛʃ]

“cage” /keɪdʒ/ → [keɪʒ]

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Five phonological processes atypical at any age:

Atypical consonant processes:

① Interdentalization (INT):

- a) Sibilants (alveolar/palatal [affricatives] /s, z, ʃ, ʒ, tʃ, dʒ/ 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” /tʃiːz/ → [θiːð] (2 times)
 - “glasses” /glæsəz/ → [glæθɪð] (2 times)

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Five phonological processes atypical at any age:

② 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” /kɑːr/ → [ɑːr]
 - “frog” /frɒɡ/ → [ɒɡ]
 - “nose” /noʊz/ → [oʊz]

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Five phonological processes atypical at any age:

3 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" /slɪp/ → [ɬ ip]

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Five phonological processes atypical at any age:

4 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" /zɪbrə/ → [gɪbrə]

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Five phonological processes atypical at any age:

5) 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" /tʃi:z/ → [tʃiʔə]

"basket" /bæskət/ → [bæʔɪʔə] (2 times)

"this" /ðɪs/ → [ðɪʔə]

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"Sampling plan"

Interpretations are based on either or both the single-word & connected speech samples

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Phonological process analysis options

Single words?

- Opportunity to check stimulability and Imitation types
- Opportunity to check facilitation:
 - As a singleton v. cluster
 - Target sound 1x in a monosyllabic or bisyllabic word: Initial, Medial - Syll-releasing or arresting, Final
 - Target sound in a high frequency word

Connected speech?

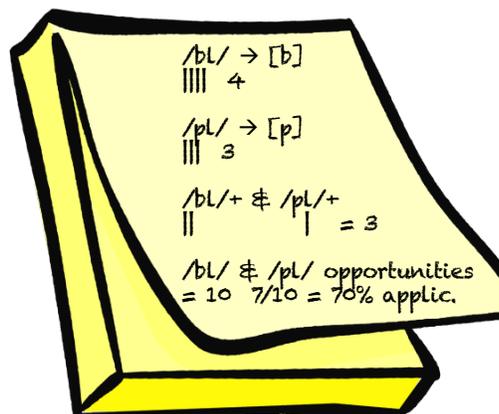
- Baseline intelligibility can be determined, X = 1 unintelligible syllable (e.g., *SALT*)
- More recognizable problems and generalizable solutions
- Suprasegmentals can be assessed:
 - Intonation / rate
 - Syllable stress
 - Juncture

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Speech Sample Analysis:

- **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 sample:** What is the percent opportunity to apply?
 - e.g., topic is about the "blue plane" /blu/ & /plen/



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An option: Percent Consonants Correct (PCC)

- Frequently reported
- 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 all weighted equally → false positives and atypical SSD children are prioritized equally to children with phonological delays

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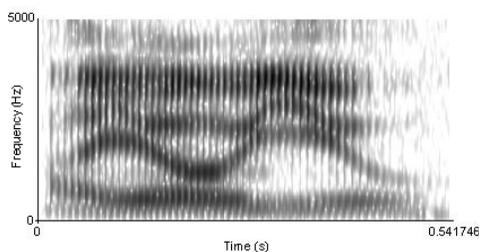
The old way (Stampe, 1973; Edwards, 1986) the way of most standardized tests: Phonological process analysis:

- “Phonological processes” are error patterns reflecting:
 - Developmental or atypical phonological constraints (e.g., cluster reduction vs. initial consonant deletion)
- Phonological processes are inventory-based (phoneme +/-)
- Standardized assessments might identify:
 - # 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);
 - Disorder (use of error patterns not apparent at any age in the norms).

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Adjunct to Phonological process Analysis: Use of acoustic analysis

- Free acoustic analysis tools are readily available, such as www.praat.org
- Acoustic measures are more valid than perceptual measures of children with SSD (e.g., Navasivayam et al. , 2013)



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Conclusions

- One function that phonological process analysis serves is that of **screening, which is a critical task.**
- Severity and subgroup diagnosis is best determined by thorough case history, OPE, standardized tests (e.g., KLPAs with GFTA; HAPP-3) and/or stimulability.
- A child with a mild phonological or speech sound disorder of any subgroup need only show one age-inappropriate phonological process (n=7 phon. processes persist @ 2yo, 6 persist @ 3yo, 4 persist @ 4yo = 17) or atypical phonological process (n=10).

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Questions?

...And hopefully
some answers

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