FRAMEWORK FOR ASSESSING SPEECH SOUND SYSTEM DISORDERS

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Agenda

• Part I: A Model for Conceptualizing Speech-Language Processing Related to Articulation and Phonology (45 minutes)
• Part II: Sound System Characteristics: Development and Disorders (45 minutes)
• Break (15 minutes)
• Part III: Assessment Framework for Speech-Sound System Disorders (60 minutes)
• Questions (15 minutes)

Part I:
A Model for Conceptualizing Speech-Language Processing Related to Articulation and Phonology

The Speech-Language Processing Model

• Nation and Aram 1977
• Conceptual view of the relationships between anatomy, physiology, and behavior
• Considers input of language (environment) as foundational to processing and the ultimate output of language
• All domains of language
• Procedure for collecting and analyzing factors that may underlie hearing, speech, and language problems
• Leads to formation of hypotheses about the nature and characteristics of communication disorders
The Speech-Language Processing Model

Auditory Reception Segment

- **Sensation** - Acuity
- **Perception** - Figure-Ground; Speech from Noise; Temporal Info; Differences in Phonemes and Syllables
- **Comprehension** - Matching incoming info to known info via coding; Attaching meaning to words, morphemes, connected speech
- **Repetition** - Encoding and reproducing info from STM
- **Language Representation** - Storing and retrieving info; operating on info; Creating ideas (CENTRAL LANGUAGE SEGMENT)

Phonological Processing

- Swank (1994) Specific Phonological Coding Impairment
  - Phonological coding - code abstract representations of the sound attributes of spoken or written words in phonemes; implicit knowledge of rules for ordering phonemes for processing or producing speech-sound strings
  - Phonological encoding - impose a phonetic identity of rapid human speech sounds; analyzing the speech sound perceptually, deriving the phonological structure of words, storing the phonological representations of words in semantic memory
  - Phonological awareness and metaphoronomy - gain access to and perform mental operations on phonological information; awareness of syllables and intrasyllabic units (onset and rimes) and awareness of phonemic units
Phonological Processing

- Phonological coding for lexical access - retrieve speech sounds associated with a concept from long term memory (for word finding and naming)
- Phonological coding in working memory - maintain phonological information in working memory until a task is completed (e.g., repeating oral or written stimuli)
- Expressive phonological coding - produce speech-sound sequences and multisyllabic words and complex phrases (nature and order of phonemes)

SPCI assumes a basic deficiency in the ability to generate, maintain, and operate on phonological representations in working memory.

The Speech-Language Processing Model

- Speech Production Segment

  - Repetition
  - Language Representation (CENTRAL LANGUAGE SEGMENT)
    - Formulation - Selection of phonology, syntax, semantics, and pragmatics: all codes for speaking
    - Sequencing - Selecting phonotactic and syllabic code for words and making transitions between syllables and words
  - Motor Control - Muscle movement timing and control for producing sounds, syllables, words, and connected discourse

Part II
Sound System Characteristics
Development and Disorders

Sound System - Development

Prelinguistic Foundations
- Babbling
- Jargon

Phonetically consistent forms

First Words - Access to Patterns
Whole word templates (Velleman & Vihman, 2002) and reorganization
- Implicit learning - incidental or unintentional through exposure
- Explicit learning - intentional goal to replicate a word/phrase
- Mirror motor neurons - neural system matching action observation and execution (imitation)
- Vocal motor schemes - memory traces through practice

Importance of the syllable - patterns of sound combinations (phonotactics)
Sound System - Development

- Consider sound development in tandem with lexical development!
- Toddlers produce words to engage in social interaction, thus words convey meanings.
- As toddlers develop phonological representations (words), they store them and retrieve them in social contexts.
- Adults provide models and reinforce interactions.
- Trends are evident in sound system development. Let's take a look!

Toddlers between 15 and 24 months accrue initial phonemes in their inventories. (Stoel-Gammon, 1985)
- At 15 and 18 months /b, d, h, m, n, w/
- At 21 and 24 months /b, t, d, m, n, h, w, k, g, f, s/
- Final phonemes between 18 and 24 months:
  - At 15 months - none
  - At 18 months /t/
  - At 21 months /t, n/
  - At 24 months /p, t, k, n, r, s/

- Blue highlights indicate phone occurred in 90% of inventories.
- Labial, alveolar, velars (Place)
- Stop, nasal, fricative, liquid (Manner)
- /r/ in final position but rare in initial position

Transitional segments (Dyson, 1988)
- 24 to 30 months: /ts, tf, f, fw, bw, r/ initial
- 24 to 30 months: /ts, g, v, z, η, r, ps, ηk, ntʃ/ final
- 33 to 39 months: /f, sh, r, kw, bw, tr, sp, st, sn, sl/ initial
- 33 to 39 months: /ts, d, g, tf, f, η, r, ps, ts, nts, ntʃ, ηk, ns, ntʃ/ final

Word Shapes - % of children using

<table>
<thead>
<tr>
<th></th>
<th>Younger Group</th>
<th>Older Group</th>
</tr>
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<tbody>
<tr>
<td>V</td>
<td>4.8 to 5.1</td>
<td>4.5 to 5.7</td>
</tr>
<tr>
<td>VC</td>
<td>7.2 to 7.7</td>
<td>8.5 to 9.1</td>
</tr>
<tr>
<td>CV</td>
<td>17.6 to 21.6*</td>
<td>16.6 to 20.1*</td>
</tr>
<tr>
<td>CVC</td>
<td>38.3 to 40.2*</td>
<td>34 to 40*</td>
</tr>
<tr>
<td>2 syllable</td>
<td>12.7 to 14.2**</td>
<td>12 to 14.5**</td>
</tr>
<tr>
<td>3 syllable</td>
<td>&lt; 1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Phonological Processes - mean % children using (18-29 months) (Preisser et al)

Omissions
- Clusters - 73
- Postvocalic obstruent - 21
- Syllable reduction - 19
- Prevocalic obstruent - 8

Class Deviations
- Liquids - 77
- Stridency deletion - 40
- Velar - 28
- Nasal/glide - 27
Sound System - Development

• Implicational laws: If a child’s grammar has the phonological property X, then it will also have the property Y, but not vice versa. X is the marked and governing property and Y is the unmarked property. The relationship between X and Y is termed markedness. The complex always implies the simpler. Marked sounds are the best choice for treatment -- the unmarked sounds will develop as they are implicationally related.

• Marked consonants imply unmarked consonants (Examples)
  • Consonants imply vowels
  • Voiced obstruents imply voiceless obstruents
  • Fricatives imply stops
  • Affricates imply fricatives
  • Liquids imply nasals
  • Clusters imply singletons
  • Liquid clusters imply liquid contrast
  • Sounds consistently in error (nonstimulable) imply stimulable sounds

Phonological Disorders

11 Characteristics (Crystal, 1981; Lowe, 1994)

A restricted range and frequency of segments, with consequently fewer potential contrasts and many homophones

• Range of segments - few sounds in the inventory
• Frequency of segments - sounds are not used often
• Contrasts - limited choices of sounds; a few sounds used for many sounds
• Homophones - words sound alike because of the use of only a few sounds

A restricted range and frequency of segmental combinations

• Range of segmental combinations - limited number of sounds being used together in syllable structures
• Frequency of segmental combinations - sound combinations are not used often

A restricted range of features, especially affecting place of articulation

• Range of features - place, manner and voicing characteristics of sounds; limited sound class
• An extremely limited range of fricatives; /f, v, ð, ð, s, z/

Phonological Disorders

An extremely limited range of nonnasal sonorants /w, j, l, r/

The likelihood of voiced (fortis)/voiceless (lenis) or aspiration/unaspiration confusion

Syllable structure tends towards a canonical CVCV form, open syllables being the norm (apart from the use of final nasals)

• Deletion of final consonants; deletion of coda; open syllable

Consonant clusters are generally absent

• Consonant cluster reduction; consonant cluster simplification; partial or total

Phonological Disorders

Use of the glottal stop as a substitute form

• Glottal stop substituted for velar stops /k,g/, fricatives, or affricates

The vowel system is relatively well-developed, apart from the tendency to centralize

• Centralization - A vowel is replaced by a vowel with a more central tongue position [bot] - [bʌt]

A relatively wide range of sounds from outside the normal articulatory possibilities of the language

Idiosyncratic processes
Phonological Disorders

Other Characteristics (Stoel-Gammon & Dunn, 1985)

- Static system; plateau; progress slow
- Variability in use of processes
  - sometimes the target sound is correct and other times a process is used;
  - two different processes affect the same sound (fronting of /k/ and deletion of /k/)
- Persistence and frequency of phonological processes
- Co-occurrence of early processes with correct production of later sounds (chronological mismatch)

Phonological Disorders

Idiosyncratic rules or processes that reduce intelligibility

Restricted use of contrasts
  - Phoneme collapse (also known as systematic sound preference) results in homonymy

Problems with imitating progressively longer words (Flipsen, 2008)

To sum it up: Poor phonological knowledge!

Break (15 minutes)

- AHHHHH!
Differential Diagnosis - Phonological Disorders

Purposes of Assessment
To determine:
  - if a disorder exists
  - the nature of the disorder*
  - the severity of the disorder*
  - a plan for intervention - targets*
  - progress during intervention
  - research

Phonological Assessment

Assessment Protocol - Rule out factors
Rule out motor issues with oral exam including AMR and SMR.
  - Alternating motion rates: /pʌ,pʌ,pa/, /tʌ,ta,ta/, /kʌ,ka,ka/
  - Sequential motion rates: /pʌ,tʌ,kʌ/, /pʌ,tʌ,ka/, /pʌ,ta,ka/
Rule out hearing problems with hearing screening and hearing evaluation as needed.
Rule out overall language disorder with screening and diagnostic test as appropriate.

Phonological Assessment

Assessment Protocol - Seek detail through procedures and analysis
1. A thorough single word articulation/phonological test including singleton consonants, clusters, and vowels
2. Consistency of word production - give the test again
3. Stimulability of error phonemes
4. Connected speech sample

Phonological Assessment - Analysis of the Data
What information is obtainable from single word tests?
- Phonetic inventory
- Phonemic inventory
- Phoneme collapse
- Phonological knowledge
- Consistency
- Description of types of errors
- Phonological processes
- Syllable shapes
- Percentage of Consonant Correct
- Stimulability
Phonological Assessment - Analysis of the Data

Phonetic Inventory
For a child in the moderate to severe range of intelligibility, a list of the phonemes produced (regardless of context) is warranted. It will provide the array of vowels, consonants and clusters that the child can say.
Create a list for the initial position of words.
Create a list for the final position of words.

Phonemic (Segmental) Inventory
Create a list of phonemes the child uses functionally (correctly in context) in the initial position of words.
Create a list of phonemes the child does not use correctly in initial position and note the error: p/f, t/k.
Create a list of phonemes the child uses functionally in the final position.
Create a list of phonemes the child does not use correctly in final position and note the error.

These lists are descriptive data - useful for making clinical decisions. For example, increase the phonetic inventory to include different classes of sounds.

Phonological Assessment - Analysis of the Data

Phoneme collapse occurs when the child uses one sound to represent many sounds. There is a lack of contrast and this results in homonymy.

Example:
/t/ is used for /t/, /k/, /s/, /sh/, /ch/ - 5 sounds collapsed to 1
top, cop, sop, shop, chop (all are produced [tap])

Omissions: final consonant deletion (row-rope; bye-bike)
Cluster reduction (tree-tea)

Phonological Assessment - Analysis of the Data

- Phonological Knowledge - Error patterns tell us what a child knows about the sound system. 6 levels of knowledge:
  - Level 1 - Full knowledge (no errors in the sound in words)
  - Level 2 - Target phonemes/morphemes produced; sounds appear in all positions, but errors occur on some words
  - Level 3 - Sound errors occur on some fossilized morphemes
  - Level 4 - Sound errors occur in certain word positions (positional constraints)
  - Level 5 - Errors occur on fossilized morphemes and in certain word positions
  - Level 6 - Errors consistent on sounds or morphemes; never correct

Phonological Assessment - Analysis of the Data

- Consistency - Stability in the use of sounds in words
  - Children with phonological and articulation disorders do not typically have inconsistency errors.
  - Useful to observe this aspect as one feature of CAS (to help rule it in our out). Children with CAS may alter production of phonemes or syllables
  - Connected speech sample is another observation, especially on words the child produces more than once.
Phonological Assessment – Analysis of the Data

Types of Errors - Descriptions of errors can be done using several strategies.
- Categorize errors: Omissions, Substitutions, Distortions
- Describe by sound class: -/t, t/k (stops), D/s (fricative)
- Describe by sound change: -/t, t/k, D/s
- Describe by sound position (positional contraints): -/t (F), t/k (IMF), D/s (IMF)
- Describe by features: substitution of velars, omission of stops, distortion of sibilants
- Describe by feature change: place - alveolar to velar; manner - fricative to stop; voicing - voiced to voiceless

Phonological Assessment – Analysis of the Data

Phonological Processes are simplification strategies that alter words through sound substitution, deletion (syllable structure), assimilation, vowel, and idiosyncratic processes.
- Recall that the pattern is evident through word analysis and that 20-40% of instances of a process is considered a guidepost and often the class of sounds is involved, not just individual phonemes.
- Severity indicators: omissions (ICD, syllables, FCD, clusters), vowels (centralized), absence of fricatives, glides and liquids.

Phonological Assessment – Analysis of the Data

Syllable Shapes
- When children omit phonemes, syllable shape is restricted. Limited syllable shape is characteristic of CAS, PD, and AD. But info is useful in intervention planning.
- CV - open syllable; onset - no coda
- VC - no onset, coda
- CVC - onset and rime
- CVCC
- CCVC
- CCCVCCC

Phonological Assessment – Analysis of the Data

Percentage of Consonants Correct (Shriberg & Kwiatkowski, 1982)
- Intelligibility is important indicator of severity, not necessarily the nature of the disorder.
- Record each consonant in each word as correct or not (tally). You can keep track of each consonant and the releasing or arresting position for descriptive purposes:
  - Initial   |   Final   |   Total
  -/b/ 111001100 | 0001000   | 6/17
  -/m/ 1111111   | 11110101  | 12/14
  -/t/ 111111111 | 001101    | 12/15
  -/k/ 00000     | 0000      | 0/9
  -/s/ 0001000   | 110010011 | 6/16
  - Total 36/71 = 51% (Mod-Severe)
Phonological Assessment - Analysis of the Data

• Stimulability – use of cues (ZPD) to reproduce a phoneme and use it in syllables, words, and sentences.
• Children with PD often have good stimulability. Why? Because it taps the phonetic production of words (imitation), not the phonemic structure (use). It can help distinguish b/w CAS or AD as compared to PD.
• What does stimulability involve?
  • Speech adaptability – the amount of cues needed along a continuum
    • Imitation of motor skill (structural and functional integrity)
    • Underlying representation of the phoneme (phonological level)
  • Skills involving accuracy, consistency, and phonological knowledge
  • Important in generalization and predicting progress, and now plays major role in target selection

Target Selection - Phonological Disorders

Phonetic Inventory:
Increase the number of sounds the child is able to say
  • Expand consonants
  • Expand consonants across all sound classes
  • Expand consonant clusters, especially /s/ and /l/ blends
  • Expand vowels if necessary

Phonemic Inventory:
Increase the use of consonants in words
Focus on function of phonemes to close syllables, expand syllable types and eliminate positional constraints

Phonological Assessment - Analysis of the Data

• What information is available from a connected speech sample?
  • Validity!
    • PCC is more authentic
    • Occurrences of phonemes (phonemic inventory)
    • Note inconsistency of phonemes in same words and different words
    • Phonological processes may increase
    • Phoneme collapse may increase
    • Syllable structure may show more patterns of simplification (not many examples of complex syllable structure on single word tests)
    • Stimulability in a wider array/context

Target Selection - Phonological Disorders

Phoneme Collapse:
Determine which contrasts will eliminate homonymy. Select targets from different sound classes.

Phonological Knowledge:
Teach sounds that are absent/error from the phonetic and phonemic inventory based on the levels of knowledge.
  • Lack of knowledge/Sounds never occur in phonetic and phonemic inventories - Level 6
  • Positional constraints - Levels 4 & 5
  • Morphological constraints/Fossilized forms - Level 3
  • Production errors on some words - Level 2
Target Selection-Phonological Disorders

Phonological Processes:
Use assessment data to select patterns of errors for targets.
Those affecting intelligibility
At least 20-40% of opportunities
Processes beyond age range expectations

Sound Error Descriptions:
Use descriptions to understand the types of changes being made on the sounds.

Complexity and Implicational Rules:
Class of sounds in error (affricates, fricatives, liquids..)
Marked sounds in error
Select most difficult sounds
Select sound classes the imply other classes
Add syllable shapes!

Stimulability and Consistency:
Select non-stimulable sounds and include stimulability in intervention plan.
Inconsistency may relate to motor planning issues, so take this into consideration.

Ultimate Goal

Intelligibility:
Use the PCC as an index of change.
Use connected speech samples and analysis procedures to monitor progress.
Strive for qualitative changes too!

Assessment should be dynamic and analysis should drive clinical decisions and progress monitoring.

Questions
References


Flipsen, P. Jr. (2008). Understanding childhood apraxia of speech (CAS) for SLPs. SLPinfo.org


