Childhood Apraxia of Speech
Building Confidence in Clinical Skills

Part 1 - Assessment

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Disclosures

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What we will cover this morning

CAS Assessment

Understand speech development

Understand CAS as a Breakdown in Speech Motor Control

Assessment: Comprehensive History and Direct Assessment

Analyze Results Make Differential Diagnosis

Hands-On Practice in Assessment

Understand speech development
Phonology - General Stages of Early Speech Sound Development

(Bleile, 2006, Oller, 2000, Serkhane et al, 2007)
Phonology Development
Summary: Early Years

- Phonology
  - Increasing number of speech sounds (Shriberg, 1993, Lof, 2004)
    - Early 8 – /m, b, y, n, w, d, p, h/ by age 3
  - Variety of differentiated vowel sounds
  - Increasing number and diversity of place, manner and voicing features
    - Bilabial, Alveolar, Palatal, Glottal
    - Oral Stop, Nasal, Glide
    - Voiced and Unvoiced

Phonology Later Development
3-4 Years

- Increasing number of speech sounds (Shriberg, 1993, Lof, 2004)
  - Mid 8 – t, k, g, ng, f, v, ch, j (3-4 years); Early 8 – m, b, y, n, w, d, p, h
  - Increasing number and diversity of place, manner and voicing features
    - Labiodental, Postalveolar, Velar, Bilabial, Alveolar, Palatal, Glottal
    - Fricative, Affricate, Oral Stop, Nasal, Glide
    - Voiced and Unvoiced
  - Intelligibility Index (Coplan & Gleason, 1988)
    - 4 years – 100% intelligible in conversation
Phonology Later Development
5.5 - 8 Years

- Increasing number of speech sounds (Shriberg, 1993, Lof, 2004)
  - Late 8 – sh, th (both), s, z, l, r, zh; Mid 8 – t, k, g, ng, f, v, ch, j; Early 8 – m, b, y, n, w, d, p, h

- Increasing number and diversity of place, manner and voicing features
  - Interdental, Labiodental, Postalveolar, Velar, Bilabial, Alveolar, Palatal, Glottal
  - Liquid, Fricative, Affricate, Oral Stop, Nasal, Glide
  - Voiced and Unvoiced
Speech Motor Control

Model of Speech Production

Cognition
- Ideas

Language
- Word Retrieval
- Phonological Mapping
- Syntactic Framing

Motor Speech
- Planning
- Programming
- Execution

(Caruso & Strand, 1999)

What is involved in a motor task?
- A movement can have a beginning and an end – it starts and stops
- A movement can be short or long
- A movements can be simple or complex
Speech Motor Control
Speech is a Complex Motor Task

- What is involved in a speech motor task?
  - How many muscles and body parts are involved in speaking?
  - How fast do they move when we speak?
  - How precise must our speech be – pie vs bye?

[Thelen, 1991; Caruso & Strand, 1999; Borden, 1984]

Speech Motor Control
Speech is a Complex Motor Task

- In speech, what are the units of movement?
  - Sounds?
  - Syllables?
  - Words?
  - Phrases?
  - Utterances?
  - Other? ______________
Speech Motor Control
Speech is a Complex Motor Task

- Utterance: unit of vocal expression preceded & followed by silence. Can be made up of
  - Words
  - Phrases
  - Clauses
  - Sentences

- Utterances as Movement Envelopes
  [-----------------------------]
Speech Motor Control
Speech is a Complex Motor Task

- Movement Envelope Parameters
  - Length [---] vs. [---------------------]
    - Number of syllables
    - Number of movements
      - Glides more difficult?
      - Diphthongs more difficult?

Speech Motor Control
Length [---] vs. [---------------------]

Hippopotamus
He can eat a mouse

Understand Speech Development
Speech Motor Control
Length [---] vs. [------------------]

He can eat a mouse
Sylvester can devour a rodent

Speech Motor Control
Complexity [^--^--] vs. [^--^^--^^^^]

- Movement Envelope Parameters
  - Complexity [^--^--] vs. [^--^^--^^^^]
  - Phonotactic structure

Understanding Speech Development
Speech Motor Control Complexity [^--^--] vs. [^--^^-^^^

- Complexity [^--^--] vs. [^--^^-^^^
- hierarchy of phonotactic complexity (Velleman, 2002)
  - Simple open syllable (CV) – “bye”
  - Reduplicated open syllables (CVCV same syllable repeated) - “bye-bye”
  - Harmonized (C or V) non-reduplicated disyllabic open syllable forms: CVCV – “baby”
  - Non-harmonized non-reduplicated disyllabic open syllable forms - “today”
  - Harmonized closed syllables - “mom”
  - Non-harmonized closed syllables - “dog”
  - CVCVC words (reduplicated, harmonized, or neither) – “movies”
  - Words with initial, medial, and/or final clusters “strong”, “monster”, “complex”

Speech Motor Control Complexity [^--^--] vs. [^--^^-^^^

- Complexity [^--^--] vs. [^--^^-^^^
- Index of Phonetic Complexity (IPC) (Jakielski, 2014): >points = >complexity
  - 1 point each for:
    - Dorsal place (/k, g, j/)
    - Fricative, affricate, liquid manner (/t, v, s, z, h, θ, ϸ, j, z, s, j, ts, tr/)
    - Rhotic vowel (vowel plus /r/)
    - Syllable shapes ending with consonant (VC, CVC, etc.)
    - 3+ syllable lengths
    - Time consecutive singleton consonants that vary by place (coat)
    - Consonant clusters (step)
    - Heterorganic clusters – consonants vary by place in cluster (play)
Speech Motor Control
Complexity [^--^--] vs. [^--^--^--^--]

Hippopotamus

Phantasmagoric

Understand Speech Development

Speech Motor Control
Length and Complexity Practice

- Thatch – 6 letters, 1 word
  - How many movements?
    - __
  - How complex?
    - __ (IPC?)
- Sprigs – 6 letters, 1 word
  - How many movements?
    - __
  - How complex?
    - __ (IPC?)

Understand Speech Development
Speech Motor Control
Length and Complexity Practice

- Sue ran away (3 words)
  - How many movements?
    - ___
  - How complex? (IPC?)
    - ___
- Samantha cooperates nicely (3 words)
  - How many movements?
    - ___
  - How complex? (IPC?)
    - ___

Speech Motor Control
NOW describe this…

“Home”

- Length?
  - ___ movements
- Complexity? IPC?
  - ___
Speech Motor Control

NOW describe this…

“Daniel’s home is in Atlanta Georgia”

- Length?
  - ___ movements
  - /d-a-n-y-e-t-z-h-o-m-i-z-i-n-a-t-l-a-n-t-a-dg-o-e-r-dg-uh/

- Complexity? IPC?
  - ___
  - CVCCVCCCVCCVCVCCVCVCCVCVCCVCVCCVC

Speech Motor Control Development

- Motor Control - Speech becomes increasingly adult-like over developmental time (Maassen, et al, 2007)
  - Early Development
    - Dominance of mandible in early articulation movements
    - Singleton Mono- and Disyllabic Syllable Structures
      - V, CV, VC, CVC, VCV, CVVC, VCVC
  - Later Development
    - Emerging Independent movements over time
    - Consonant clusters acquired after singletons (Levelt et al, 1999)
      - CV – CVC – V – VC followed by
        - Either CVCC – VCC – CCV – CCVC
        - OR CCV – CCVC – CVCC – VCC

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Speech Development Summary

- **Phonology**
  - Increasing sound inventory
  - Increasing intelligibility
  - Increasing number and diversity of place, manner and voicing features

- **Speech Motor Control**
  - Increasing independent movements
  - Increasing utterance length
  - Increasing complexity of syllable shapes with consonant clusters later

Understand CAS as a Breakdown in Speech Motor Control

Definition/Causes/Prevalence Markers
Childhood Apraxia of Speech Definition

- Understand CAS as a Breakdown in Speech Motor Control

- Cognition
  - Ideas

- Language
  - Word Retrieval
  - Phonological Mapping
  - Syntactic Framing

- Motor Speech
  - Planning - Apraxia
  - Programming – Apraxia and Stuttering
  - Execution - Dysarthria

Childhood Apraxia of Speech Definition

“Childhood apraxia of speech (CAS) is a neurological childhood (pediatric) speech sound disorder in which the precision and consistency of movements underlying speech are impaired in the absence of neuromuscular deficits (e.g. abnormal reflexes, abnormal tone). CAS may occur as a result of known neurological impairment, in association with complex neurobehavioral disorders of known or unknown origin, or as an idiopathic neurogenic speech sound disorder. The core impairment in planning and/or programming spatiotemporal parameters of movement sequences results in errors in speech sound production and prosody” (ASHA 2007b)

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Childhood Apraxia of Speech

Prevalence (ASHA, 2015c)

Children in general population

Speech Disorders

2-25%

CAS

0.1%

Understand CAS as a Breakdown in Speech Motor Control

Definition/Causes/Prevalence Markers
Markers for CAS
Later Speech Development

**Markers for CAS Later Speech Development**

- Specific Red flags to look for in Later Speech Development - Markers for CAS (3-5 years) (ASHA, 2007a)
  - Inconsistent errors on consonants and vowels in repeated productions of syllables or words
  - Vowel errors
  - Lengthened and disrupted coarticulatory transitions between sounds and syllables
  - Inappropriate prosody, especially in the realization of lexical or phrasal stress

- Other specific markers seen in children with CAS (ASHA, 2007a)
  - Increased errors in longer or more complex syllable and word shapes, esp. omissions, and in word-initial positions
  - Unusual errors that defy process analysis
  - Persistent or frequent regression
  - Groping during speech attempts
  - Differences in performance of automatic (overlearned) vs. volitional (spontaneous or elicited) activities, with volitional more affected

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Markers for CAS
Associated Features

(ASHA, 2007a)

<table>
<thead>
<tr>
<th>Language &amp; Literacy</th>
<th>Speech Perception</th>
<th>Metalinguistic</th>
<th>Non-speech motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant language deficits</td>
<td>Deficits in auditory perception</td>
<td>Increased self awareness of their own speech limitations</td>
<td>General awkwardness or clumsiness</td>
</tr>
<tr>
<td>Receptive language often significantly better than expressive language</td>
<td>Deficits in auditory discrimination</td>
<td>Oral apraxia – groping and impaired oral volitional movements</td>
<td></td>
</tr>
<tr>
<td>Rhyming deficits (producing rhymes)</td>
<td>Deficits in auditory memory</td>
<td>Mildly low muscle tone</td>
<td></td>
</tr>
<tr>
<td>Deficits in word attack, word identification and spelling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At risk for phonological awareness deficits</td>
<td>Abnormal orosensory perception</td>
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</tbody>
</table>

Understand CAS as a Breakdown in Speech Motor Control

Associated Features

- At risk for literacy impairments
  - Children with SSD achieve “lower levels of reading” than normally developing peers – even when their language skills are age appropriate and regardless of the severity of their speech disorder (Rvachew, 2007)
    - Important to assess speech perception and phonological awareness skills in pre-school years
  - Some evidence that there is a “core” phonological deficit in SSDs (Anthony, et al, 2011) that parallels the core phonological deficit asserted in RD (Stanovich, 1988)
  - Children with CAS are particularly susceptible to PA and RD (McNeill, Gillon and Dodd, 2009)

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Assessment

Roles and Responsibilities

History

Direct Assessment

Roles and Responsibilities

- Who diagnoses CAS anyway?
  - Neurologist
  - Pediatrician
  - Developmental Pediatrician
  - Speech Language Pathologist

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Roles and Responsibilities

- Goal of the Assessment
  - Determine underlying cause (differential diagnosis) for speech/language difficulties
  - Determine severity of delay/disorder
  - Make recommendations for appropriate therapy plan

Red Flags in History

+ Red Flags in Sp/Language Skills

= CAS Profile

Red Flags in History + Red Flags in Sp/Language Skills = CAS Profile
History

- Comprehensive
  - Family History
  - Birth History
  - Medical History
  - Fine and Gross Motor Development
  - Speech and Language Development
  - Educational/Pre-literacy/Therapy
Family History

- Red flags to look for in family history (parents, grandparents, aunts, uncles, cousins)
  - History of speech delays/disorders
  - History of developmental delays
  - History of genetic syndromes
  - History of neurodevelopmental disorders

Birth History

- Red flags to look for in Birth History
  - Instrument, breech, caesarian delivery
  - Decreased physical status at birth (decreased apgars <7)
  - Premature birth
  - Decreased size/weight at birth
  - Hospitalization immediately following birth
Medical History

- Red flags to look for in Medical History
  - Neurodevelopmental disorders (Shriberg, 2011)
    - Autism
    - Chromosome Translocations
    - Down syndrome (Trisomy 21)
    - Rolando Epilepsy
    - Fragile X syndrome (FMR1)
    - Joubert syndrome (CEP290; AHI1)
    - Galactosemia
    - Rett syndrome (MeCP2)
    - Russell-Silver syndrome (FOXP2)
    - Velocardiofacial syndrome (22q11.2 deletion)

- Other red flags, cont.
  - Neurological event (e.g., stroke, TBI)
  - Neurological condition (seizures)
  - Medications/responses to medications
  - Feeding/swallowing difficulties
  - Hearing disorders, multiple ear infections/otological care/surgeries; failed newborn screening
  - Illness/high fevers with change in speech status

Fine/Gross Motor Developmental History

- Red flags to look for in Developmental History (ASHA, 2007a)
  - Fine motor delays/difficulties – feeding, dressing, toileting, difficulty manipulating items with the hands/coordinating hand/finger movements
  - Gross motor delays/difficulties – crawling, walking, riding a bike, jumping rope
Language/Functional Comm History

- Red flags to look for in Language/Communication Development (ASHA, 2007a)
  - Receptive Language > Expressive Language
  - Supplementing verbal communication with gesture, sign, AAC systems/devices

Early Speech Development History

- Red flags to look for in Early Speech Development (Davis & Velleman, 2000; Highman, Leitao, Hennessey, & Piek, 2012; Maassen, 2002)
  - Decreased or lack of babbling – “Quiet baby”
  - Delayed onset of first words – later than 12 months
  - Limited consonant and vowel inventory (preferred Vs and Cs possible); gaps in types of sounds, few voiceless sounds
  - Vowel errors
  - Simple syllable shapes (eg, V and CV)
  - Increased difficulty with more complex articulatory gestures
  - Limited intonation
  - Words appear and then disappear
  - Difficulty attaining and maintaining articulatory postures
  - Groping/lack of flexibility when imitating speech
  - Possible groping and/or difficulty with feeding
Educational/Preliteracy/Therapy History

- Red flags for Educational/Preliteracy/Therapy History
  - Phonological Processing deficits
  - Previously in Speech Therapy
    - Documented speech disorder/delay
  - Not progressing in speech therapy
    - NO speech-specific work

Evidence shows motor planning is task specific

- Consensus opinion - the evidence is against the use of Oral Motor Exercises for improving speech in children with CAS.
  - Some evidence that oral motor control for non-speech movement separate from oral motor control for speech movements (McCauley, et al 2009)
  - “Conservative conclusion is that evidence [for the use of OME’s in treating speech sound disorders] is equivocal” (Kent, 2015)
Red Flags in History
+ Red Flags in Sp/Language Skills
= CAS Profile
Direct Assessment Skills

- Language Skills
  - Receptive
  - Expressive
  - Functional Communication/Pragmatics (including AAC)
- Oral Motor and Speech Skills
  - Oral Motor
    - Structure and function
    - Oral, non-verbal motor skill
  - Speech Skills
    - Intelligibility
    - Articulation – sound analysis and phonetic inventory
    - Phonology – phonological pattern errors
    - Motor Speech Skill – markers for motor planning and programming difficulty (CAS)
    - Syllable structure analysis
    - Voice/fluency

Direct Assessment Standardized Tests for CAS?

- None that are reliable or valid (McCausley & Strand, 2008)
- Do we need them? What should we do without them?
Direct Assessment Tasks - Language Assessment

- Receptive Vocabulary
- Receptive Language
- Expressive Language
- Functional Communication/Pragmatic

- Use standardized assessment for rec/exp lang – PPVT, REEL, CELF, OWLS, PLS, etc.
- Determine if Receptive > Expressive
- Observe functional communication and pragmatics during speech sample activity and throughout session
- If specific pragmatic concerns may use standardized test for pragmatics

Direct Assessment Tasks - Oral Motor Exam

- Structural-Functional Examination
  - Structures – size, symmetry, abnormalities, dental occlusion
  - Function – ROM, Strength, Speed, ability to vary muscular tension of jaw, kips, tongue

- Observe structure and function of oral structures
- Note deviations
**Direct Assessment**
**Tasks - Oral Non-Verbal Apraxia**

- Oral, non-verbal apraxia assessment
- Informal - Ask the child to perform single, non-verbal oral movements on command (e.g., blow, pucker lips, puff out cheeks, cough) and judge if the child can imitate the oral movements immediately and without effort, hesitation, groping, etc.

**Direct Assessment**
**Tasks - Speech/Language Sample**

- Phonetic inventory
- Syllable structure analysis
- Intelligibility analysis – word level and utterance level
- Mean Length of Utterance
- Functional Communication/AAC
- Pragmatics
- Voice/fluency/prosody
- Video tape 10 minutes of play with parents (or therapist)
- Transcribe and analyze
**Direct Assessment Tasks - Articulation Assessment**

- Standardized Artic Assessment
  - Phonetic Inventory
  - Standard Score
  - Informal analysis of phonological pattern errors
- Use word level articulation assessment such as Goldman Fristoe, or DEAP

**Direct Assessment Tasks - Phonological Assessment**

- Standardized Phonological Assessment
  - Phonological Pattern Errors
- Use word-level phonological assessment such as the HAPPP-3
Direct Assessment Tasks – Pre-literacy Assessment

- Standardized pre-literacy/literacy assessments
  - Phonological Awareness
  - Decoding

- Select an assessment depending on the age of the child
  - CTOPP
  - TOWRE

Direct Assessment Tasks - Motor Speech Exam

- Imitation Tasks
  - Increasingly longer words*
    - Young child – 1-, 2-, and 3-syllable
    - Older child – 3+ syllable
  - Developmentally appropriate sounds
  - Variety of consonants and vowels
  - DDK
    - 3-6 Year Norms (Robbins & Klee, 1987)
    - 6-13 Year Norms (Fletcher, 1972)

- Imitation Tasks (any age)
  - Have the child repeat increasingly longer words/utterances (length and complexity determined by age and language abilities)
  - Have child repeat each one 2X
  - Listen for key signs of CAS
  - DDK (3+ years old)
    - Measure Rate and judge with norms
    - Listen for articulatory accuracy
    - Listen for sound sequencing

* Use something you already have or design your own – DEMSS hopefully to come soon
Differential Diagnosis
Mayo Clinic System

- Gold Standard: CAS Classification using a Pediatric Adaptation of the Mayo Clinic System \(^a\) (Shriberg & Strand, 2014)
  - Vowel distortions
  - Difficulty achieving initial articulatory configurations or transitional movement gestures
  - Equal stress; lexical or phrasal stress errors
  - Distorted substitutions
  - Syllable or word segregation
  - Groping
  - Intrusive schwa
  - Voicing errors
  - Slow speech rate and/or slow DDK rates
  - Increased difficulty with multi-syllabic words
- \(> 4\) signs over \(> 3\) speech tasks = CAS
Differential Diagnosis
Madison Speech Assessment

- Articulation Task
- Challenging Word Tasks (2)
- Challenging Phrase Task
- Consonants Task
- Conversational Sample
- DDK Task
- Phonation Task
- Syllable Repetition Tasks (2)
- Stress Tasks (2)
- Vowel Tasks (3) (Shriberg & Strand, 2014)

Differential Diagnosis
Recent Studies

- Pause Marker Method to ID CAS (Shriberg & Strand, 2014)
- The Type I "Pause Marker" provides a "single sign marker that likely can be used cross-linguistically to discriminate CAS from speech delay, and to scale the severity of CAS"
- Type I = atypical pause - abrupt, change, grope, other
- NOT Type II = more typical addition, repetition/revision. long, breath
Differential Diagnosis
Recent Studies

- Two assessments
  - Polysyllabic word picture-naming task (Gozzard et al. 2004)
  - OME (Robbins and Klee, 1987)
- Four-measure combination had 91% predictive accuracy
  - Syllable segregation – polysyllabic naming task
  - Percentage of lexical stress matches – polysyllabic naming task
  - PPC – polysyllabic naming task
  - Accuracy on repetition of /pstk/ 

30-Minute Assessment (Murray, et. al. 2015)

Other assessments?

- Syllable Repetition Task (Shriberg et al., 2012)
  - Repeat non-words with simple sounds: 2-4 syllables in length [dama, nadamaba]
- Maximal Performance Tasks (Thoonen et al., 1996, 1999; Rvachew, Hodge & Ohberg, 2005)
  - Maximal sound prolongations (vowels and fricatives)
- Diadochokinetic tasks (DDKs)
  - AMR [pa-pa-pa…; ta-ta-ta…; ka-ka-ka…]
  - SMR [pa-ta-ka-pa-ta-ka…]
Differential Diagnosis
Take-Away from Recent Studies...

 Prosody

- Prosody is a critical feature for diagnosis of CAS: syllable segregation and stress errors

Apraxia
- Inconsistent errors
- No swallowing issues
- No weakness

Phonological
- Predictable pattern of errors
- No swallowing issues
- No weakness

Dysarthria
- Generally consistent errors
- Swallowing often affected
- Weakness of musculature

More detailed comparison chart found at:
Differential Diagnosis

Determine Confidence in Diagnosis
Determine Severity/Prognosis

Confidence in Diagnosis Robbie 2;7

Analyze Results

CAS Markers
Family History Red Flags
Early Speech Dev Red Flags
Rec Lang > Exp Lang

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Differential Diagnosis

Determine Confidence in Diagnosis
Determine Severity/Prognosis

Analyze Results

Determine Severity

- Speech Sound Production Severity Rating Scale (Tennessee Department of Education, 2009)
  - Sound production
  - Motor speech skill
  - Intelligibility
- Mild 4-7
- Moderate 8-11
- Severe to Profound 12-18
Prognosis

- Children with CAS can go on to develop normal-sounding speech
- Determine a prognosis during assessment based on
  - Concomitant disabilities
  - Ability to improve speech accuracy when given assistance
  - Age at assessment
  - Severity of disorder

Mock Assessment Diagnosis Student #1

- _________ signs over _________ tasks
Mock Assessment
Diagnosis Student #2

- ________ signs over ________ tasks

Real-time Video Assessment

- Diagnosis?
- Confidence?
Advocating for Children with CAS

Advocate for Children with CAS

Understand Speech Development
Understand CAS as a Breakdown in Speech Motor Control
Assessment: Comprehensive History and Direct Assessment
Analyze Results Make Differential Diagnosis

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Advocate for Children with CAS
ASHA Practice Portal – CAS (ASHA, 2015a)
http://www.asha.org/Practice-Portal/Clinical-Topics/Childhood-Apraxia-of-
Speech/Childhood-Apraxia-of-Speech-Content-Development/

- What are the signs and symptoms of CAS
- What are the causes of CAS
- Who should diagnose CAS
- How do I assess for CAS
- How do I diagnose CAS
- What is the incidence and prevalence of CAS
- What are my roles and responsibilities as a Speech Language Pathologist working with a child with CAS
- What are some good resources for CAS

Advocate for Children with CAS
On-line Resources for CAS

- Childhood Apraxia of Speech Association of America (CASANA)
  - www.apraxia-kids.org
  - Annual conference – San Antonio July 9-11, 2015
  - Facebook
  - Twitter
  - Email listserve
  - Sponsors Walks to Support CAS
  - More…

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What we will cover this afternoon
CAS Treatment

- Have Confidence in the Diagnosis
- Use Assessment Results to Plan Treatment
- Initiate Measurable Therapy
- Monitor in the School Years
- Hands-on Practice Treatment

Questions/Discussion
References


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