

**CAS:
Definition, Characteristics, and
Incidence**

Youtube video of "brush"

“A diagnosis in search of a population”

- Controversial, but increasingly recognized
 - Some reports that the incidence is increasing?
- *A rose by any other name...*
 - Developmental Apraxia of Speech, DAS
 - Childhood Apraxia of Speech, CAS
 - Developmental Verbal Dyspraxia, DVD
- Historically:
 - Developmental motor aphasia (Orton, 1937)
 - Developmental articulatory dyspraxia (Ingram, 1964)
 - DAS (Rosenbek & Wertz, 1972)
 - Phonological programming deficit syndrome (Rapin & Allen, 1981)

Childhood Apraxia of Speech

- Apraxia is traditionally defined by difficulty producing purposeful movements of speech
 - problem in motor control of speech production, assumed to be a neurologically based problem
- Use of the term “apraxia” with this population is part of the controversy
 - MUST be differentiated from adult version or *acquired* apraxia
 - Report of language impairment and auditory processing deficits for these individuals.

No single accepted definition of CAS (Hall, Jordan, & Robin, 2007)

- Marquardt, Sussman & Davis (2002)
 - *DAS is a neurologically based disorder in the ability to carry out coordinative movements of the speech production apparatus for articulation in the absence of impaired neuromuscular function.*
- Velleman & Strand (1994)
 - *Children with DVD demonstrate deficits in transitions and sequencing for speech, oral-motor, and manual tasks. These difficulties manifest themselves in speech as errors in production of suprasegmentals, vowels, and voicing. Parallel deficits have been reported in grapheme-phoneme tasks, speech perception, and syntax.*

Out of the mouths of babes – or NOT



- *I'm thinking the right sounds but my mouth does something else.*
- *My brain just isn't cooperating with my mouth today!*

ASHA CAS definition (2007)

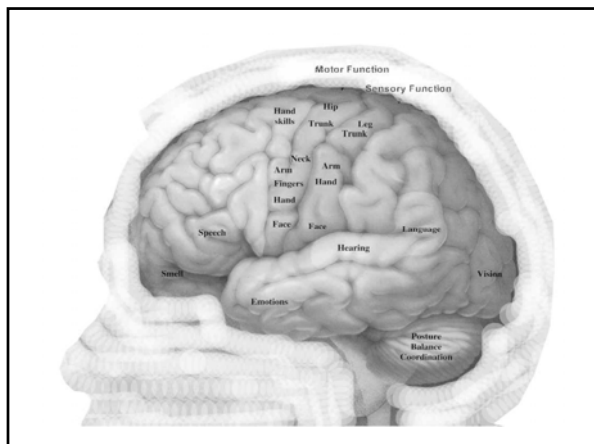
- *...A neurological childhood (pediatric) speech sound disorder, in which the precision and consistency of movements underlying speech are impaired in the absence of neuromuscular deficits (e.g., abnormal reflexes, abnormal tone). CAS may occur as a result of a known neurological impairment, in association 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 spatio-temporal parameters of movement sequences results in errors in speech sound production and prosody.*

Motolinguistic Perspective Crary (1993)

- Definition:
 - *Developmental Apraxias of Speech are a group of phonological disorders resulting from disruption of central sensorimotor processes that interfere with learning for speech.*
 - *Paralysis or weakness might be present but is not sufficient to account for the nature and severity of the observed speech disorder.*

Crary (cont'd)

- Key is "sensorimotor disruption"
 - CAS is a motor performance deficit
 - Motor and speech-language functions overlap in the left-hemisphere "language areas"
 - See brain regions
 - Also, "sensory" piece - evidence that children with CAS show significant auditory-sequencing weaknesses



CAS Speech Characteristics

Note: These characteristics are not unique to CAS

- Limited phonemic repertoire
 - Frequent omission errors
 - Inconsistent articulation errors
 - High incidence of vowel errors
 - Altered prosody
 - More errors with increased length and complexity
 - Poor imitation skills
 - *Failure to remediate despite intensive treatment*
- Repeat: These characteristics are not unique to CAS

CAS Nonspeech Characteristics

Again, no single characteristic defines CAS

- Oral apraxia
- Reduced diadochokinetic rates
- Receptive - expressive language gap with receptive better to WNL
- Gestures substituted for oral communication
- Decreased performance on other sensory tests - including auditory tests

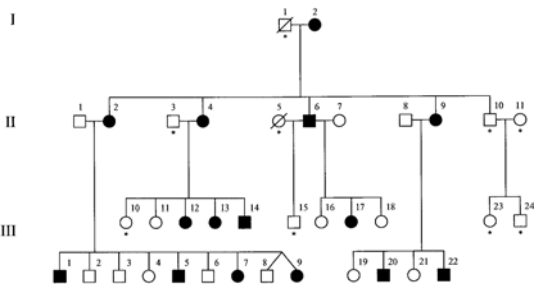
How rare is CAS?

- Incidence (rate of new cases at specified time)
 - 1971, Howarth in Australia reported 2 of 350 in a clinic had CAS, or .57%
 - 1972, Morley in U.K. reported 12 of 944 children in Newcastle-upon-Tyne had CAS, or 1.3%
- Prevalence (proportion of population who experience the disorder at a certain time)
 - 1997, Shriberg et al. reported that 3%-5% of children seen at the UW, Madison clinic for speech disorders had CAS
 - Flemmer (2005) found 0.052% CAS for all children in Iowa state school system and 1.47% of the clinical caseload was suspected CAS

The KE Family – Case Study in CAS

- British family
 - Half of the members exhibit significant language impairment, dominant inheritance pattern
- Basis for report of “grammar gene” (Gopnik & Crago, 1991)
- In addition to the language impairment:
 - Affected family members exhibit significant articulation impairment with oral apraxia.
- Example of a “phenotype” that could lead to identification of “genotype”
- Researchers have isolated a region of chromosome 7 (i.e., 7q31) based on this family and unrelated individuals with a similar profile, labeled gene SPCH1

KE Family Pedigree



- Blackened dots/squares are the affected males/females

Family Pedigrees for Children with CAS

- 22 Children with CAS (strict criteria)
- Compared to 93 children – 51 Speech Only, 42 S/LI
 - Moderate to severe speech sound disorder with at least 3 phonological processes
 - Normal on the *Oral Speech Motor Control Protocol*
- 19 of 22 children with CAS (86%) had at least one family member “affected” by speech and/or language impairment (continuum of disorders – mild speech to severe S/LI)
 - Compared to the children with S/LI who had family affection rates of about 53%
- Likely CAS is polygenic disorder, individuals inherit more genes that place them at-risk for S/LI
 - Intrepreted findings of S/LI in families of people with CAS as additional evidence that CAS is not a pure motor speech impairment

CAS: Assessment Procedures and Differential Diagnosis

CAS Assessment Battery

- Case history – include feeding and family histories
- Articulation assessment:
 - Single monosyllabic words
 - Multisyllabic words
 - Catts procedure for complex phonological production
 - Hodson APR subtest for MSW
 - Phrases/sentences
 - Conversational speech
 - Vowels and diphthongs
- Oral motor assessment including strength, coordination, sequencing, and diadochokinesis
 - *Oral and Speech Motor Control Protocol*
- Prosody rating
- Language assessment

MSW Assessment – 2 tools:

Complex Phonological Production Task

Alligators	vegetables	domino
Stethoscope	octopus	gorilla
Helicopter	dinosaur	volcanoes
Submarine	asparagus	valentine

Word Repetition Task

Peculiar	aluminum	probably
Colorado	cinnamon	calendar
Orchestra	symphony	syllable
Animal	specific	enemy

Phrase Repetition Task:

Fly free in the Air Force
 A box of mixed biscuits
 Six slim sailors
 Have some fried flounder.
 Shiny seashell necklace

Hodson Assessment of Phonological Patterns - 3 (HAPP3) MSW Screening Subtest

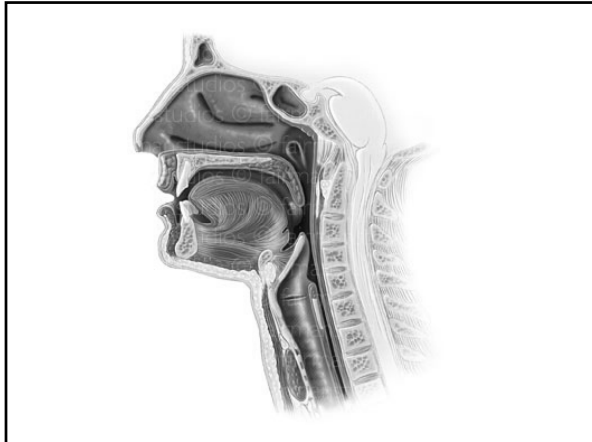
Aluminum foil
 Fire extinguisher
 Hippopotamus
 Jewelry box
 Measuring spoons
 Refrigerator
 Movie projector
 Spaghetti
 Sleeping Beauty
 Telephone message
 Stethoscope
 Thermometer

Assessment of Oral Motor Function

- Assess presence of weakness or dysarthria and/or oral praxis
- Some available tools:
 - *Oral and Speech Motor Control Protocol* (Robbins & Klee, 1987)
 - *Kaufman Speech Praxis Test for Children* (Kaufman, 1995)
 - *Diagnostic Evaluation of Articulation and Phonology* (Dodd et al., 2006)

Assessing Minor and Major Structural Variations

- Lips and Tongue
 - Examine structure, movement volitional and nonvolitional
 - There is not a precise or established amount of strength or coordination needed to produce accurate articulations
 - Difficult to interpret when no known paralysis
 - No direct relationship between nonspeech movements and speech impairment
 - Speakers can often overcome even major deviations
 - Compensatory gestures that are perceptually adequate
- Velopharyngeal functioning
 - Cannot view unassisted, use your ear to hear



Assessing Prosody

- *Profiling Elements of Prosodic Systems – Children (PEPS-C; Peppe & Wells, 2002)*
 - Described by Velleman in Proceedings of the 2002 CAS Research Symposium
 - Chunking function input / output
 - Chocolate, cake, and coffee vs. chocolate cake and coffee
 - Interaction function input / output
 - Intonation to indicate confusion vs. understanding

Lewis et al. (2004) CAS Criteria

- 42 children (ages 3 – 10 years) with sCAS were referred
- 22 (16 boys and 6 girls) met strict CAS criteria:
 - Severely restricted consonant repertoire
 - score below the 5th %ile on GFTA and at least 3 phonological patterns considered moderate to severe on KLP
 - Vowel errors
 - Reduced diadochokinetic rates on the *Oral Speech Motor Control Protocol* (Robbins & Klee, 1987)
 - Sequencing errors in multisyllabic words or “pataka”
 - Unusual error types
 - nondevelopmental processes, metathesis, prolongations, and addition errors

Shriberg – SD-AOS Markers

- Excessive/equal stress
- Inappropriate timing (syllable segregation)
- Inconsistent errors on the same word type
- Pre-articulatory oral gestures (aka groping)
- Post-articulatory repetitions and revisions
- Metathesis/sequencing errors

Identifying CAS in young children

- Early signs of CAS in very young children include:
 - *Does not coo or babble as an infant*
 - *First words are late, and they may be missing sounds*
 - *Only a few different consonant and vowel sounds*
 - *Problems combining sounds; may show long pauses between sounds*
 - *Simplifies words by replacing difficult sounds with easier ones or by deleting difficult sounds (although all children do this, the child with apraxia of speech does so more often)*
 - *May have problems eating*
- Are these symptoms unique identifiers of CAS?

Early Signs Overlap with Language Impairment (Highman et al., 2008)

- Differences in report of “did not make many sounds as an infant” not significant for CAS And LI
 - TD = 100% yes, LI = 75% yes, but CAS = 45% yes
- ***Reduplicated babbling showed a significant difference between CAS and LI***
 - TD = 100%, LI = 100%, but CAS = 60%
- Variegated babbling
 - TD = 65%, LI = 35%, CAS = 0%
- Babble as much as other children
 - TD = 95% same or more, LI = 25% same, CAS = 10% same
- Average age for First words
 - TD = 9 mos., LI = 13 mos., and CAS = 14 mos.
- ***Average age for 2-word combos significantly different***
 - TD = 15 mos., LI = 27 mos., and CAS = 33 mos.

CAS: Motor speech only?

- Children with CAS exhibited rec/exp deficits at preschool age and school-age testing
- Children with CAS performed more poorly than S/LI school-age children in follow-up study :
 - Syllable sequencing deficits
 - Persistent and unusual speech errors in conversation
 - Receptive and expressive language deficits (although rec better than exp)
 - Spelling deficits
 - IQ performance scale weaknesses
- CAS is not an isolated motor speech disorder
- Changing nature of CAS across development

The Labeling Dilemma

- Advantages and Disadvantages of Labels
- What difference does it make when the child is labeled with...
 - A speech sound disorder?
 - A phonological disorder?
 - Childhood apraxia of speech?
- When do we need a label? When the label...
 - Provides new info regarding causal info
 - Caution: Might miss other factors when you believe you know the causal factor
 - Uniquely identifies treatment needs/choices
 - Assists clinician, child, parent in understanding the disorder
 - Reported average 9 years of treatment for children with CAS
- POEMS – Patient Oriented Evidence that Matters (as discussed by Dollaghan, 2002)

CAS: Treatment Procedures

Traditional Treatment Techniques

(Crary, 1993)

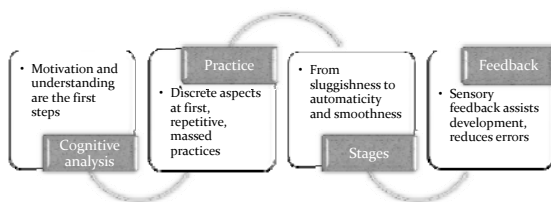
- Motor-oriented
- “Bottom-up” philosophy
 - Rosenbek et al.
 - Emphasize motor sequences, limit number of stimuli, use a task continuum based on phonetic principles, use intensive systematic drill, use visual modality, systematically incorporate rhythm, intonation, stress and motor movements
 - Yoss & Darley
 - Begin with oral motor movements in the mirror, imitate vowels, imitate visible consonants, use CV (diphthong) pairs to accentuate articulatory movements, move on to CVC, build up to carrier phrases, self-monitoring emphasized with slower rate of speech, tailor to individual child

Treatment Principles for CAS

(Marquardt & Sussman, 1991)

- Use developmental sequence of sounds for instruction, because of maturation factor
- Use multimodal inputs (auditory, visual, tactile-kinesthetic) to teach articulatory patterns
- Use facilitating contexts
- Teach self-monitoring early
- Use a hierarchical sequence starting with simpler contexts moving toward more complex productions, emphasizing movement sequences
- Consider child’s responsiveness to treatment

Motor Learning Principles

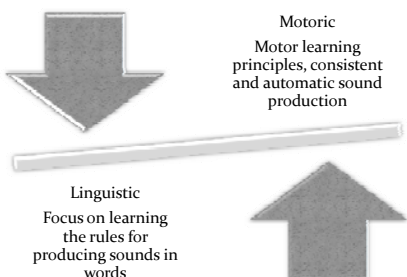


Note that fatigue can be a factor in practice for children with CAS

Oral Motor SPEECH Treatment

- Contrasted with NONspeech oral motor practices
- NSOMEs (nonspeech oral motor exercises) have a role in disorders like dysarthria, feeding/swallowing
 - If using NSOMEs then need to have clear evidence of weakness or ROM deficits
 - No evidence for their use as a primary intervention technique with speech sound disorders of unknown origin or CAS
- Recent summary by Marshalla in SHAA journal
 - Note that many of the oral motor movements are SPEECH movements
 - Movement ideas are not matched to disorder areas

Motoric versus Linguistic Approaches



Other CAS Treatment Considerations

- CAS will warrant increased treatment frequency, intensity
- Team Approach to Assessment/Treatment:
 - SLP, OT, family, pediatrician, psychologist
- Develop Core Vocabulary to create functional intelligibility
 - Select highly functional words that can be produced with good approximations (“appo” for “apple”)
 - Family assists in vocabulary selection
 - Core vocabulary book to support practice and communication
- Teach young children signs to reduce frustration
 - Other AAC options

Tactile Cueing Approaches

- Touch Cue Method by Bashir et al.
 - Addresses phonemic sequencing and patterning deficits of CAS
 - Touch cues (tactile cues developed for 8 consonants) are presented with visual “watch me” and auditory cues “listen to me”
 - Treatment progresses from CV, to alternating CVCV, to CVC and cue fading begins
 - Final steps include MSW, total fading of tactile cues
- PROMPT – Prompts for Restructuring Oral Muscular Phonetic Targets by Chumpelik
 - Start from a target position or sequence, then tactile methods to reshape articulatory movements,
 - Unique complex prompts for each English phoneme
 - Tactile cues applied to face, chin, jaw opening, neck
 - Flexible program, designed to fit individual, but requiring extensive knowledge of the system by the clinician

High quality research supporting effective CAS treatment

- None. Zip. Zilch. Zero.
- Cochrane review 2009 by Morgan and Vogel re: Intervention for childhood apraxia of speech
- Although identified 31 papers that appeared to address treatment of CAS, not a single study met the criteria for well-designed study
 - No conclusions for treatment effectiveness could be summarized.

Resources

- Apraxia-KIDS
 - This is an informative web site and starting point for patient/family support.
 - Hope Speaks project
- CAS Info sheet by Caroline Bowen
 - This speech-language pathologist has a business with a detailed web site. This is a patient info sheet.
- Letters to the Parents of Children with CAS by P. Hall
 - Letters I – IV in 2000 issue of LSHSS
