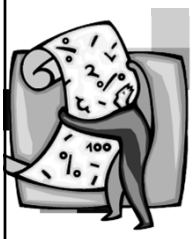

Tests and Measurements for Childhood Apraxia of Speech: Making Sense of it All

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Disclosures

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  - *Disclosure:* Dr. Meredith is a member of the Professional Advisory Board of the Childhood Apraxia of Speech Association of North America. She receives no compensation as a member of CASANA's Professional Advisory Board, but will receive compensation for this presentation. There are no other relevant financial or non-financial relationships to disclose.

How do we define CAS?

- ***Childhood apraxia of speech*** 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, 2007, p. 3-4)

Core Characteristics of CAS (ASHA, 2007)

1. *Inconsistent errors* on consonants and vowels in repeated productions of syllables or words.
2. *Lengthened and disrupted coarticulatory transitions* between sounds and syllables.
3. *Inappropriate prosody*, especially in the realization of lexical or phrasal stress.

What should the assessment for a child with CAS accomplish?

- CAS may be (and often is) exhibited along with any number of other deficits and strengths for any particular child.
- The goal of the SLP is to determine the nature of the motor planning deficit in relation to any other deficits, such as intelligence, linguistic, and motor execution, so that he or she can may make reasonable decisions as to the **relative contribution of the disorder to the child's overall communicative performance**. (Strand, 1996)

Basic conceptualization of the processes involved in speech production

Ideation	Communicative Intent	**Cognitive** ↓
Symbolization	Word Retrieval Phonologic Mapping Syntactical Framing Stress assignment	**Linguistic** ↓
Motor Planning & Motor Programming	Specify Movement Parameters * range of motion * strength * speed * direction * degree of muscle contraction	**Motor** ↓
Acoustic Output	Move Muscles Involved * respiration * phonation * resonance * articulation	**Motor**

The assessment should look at the whole child☺

- *Neuromuscular condition*
- *Developmental History*
- *Structural-Functional (Oral-Peripheral) Examination*
- *Examination of Physiological Parameters*
- *Motor Speech Examination*
- *Articulation Testing and Phonologic Analysis of Speech Errors*
- *Receptive and Expressive Language*
- *Phonologic awareness and literacy skills*
- *Hearing Evaluation*
- *Cognitive/Intelligence*

Neuromuscular Condition

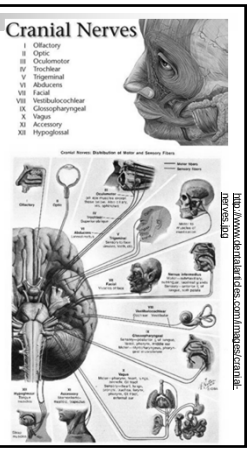
- Vocabulary you may come across in this part of the report:
  - Descriptors of *tone*
    - Hypotonic (floppy) or hypertonic (rigid)
  - *Reflexes*-are there reflexes that shouldn't be there any more or are there reflexes that should be there but aren't?
  - *Strength*-is there weakness?
  - *Symmetry*-do both sides look the same?
    - Atrophy-muscle shrinkage
    - Hypertrophy- muscle or tissue looks bigger than expected
  - *Gait*-how does the child walk?
    - Is it broad based, as if having difficulty with balance?
    - Is the movement clumsy?
    - Does one side look weaker than the other?

Structural-Functional Examination

- This helps the therapist see if there is a *dysarthric* component to your child's communication impairment.
  - *Dysarthria*: group of speech disorders caused by disturbances in the strength or coordination of the muscles of the speech mechanism as a result of damage to the brain or nerves.
  - Observations about the muscles needed for speech and nerves that innervate them should be stated.

Cranial nerves for speech

- *CN V-Trigeminal nerve*
  - Provides motor for the jaw and sensory for the face and teeth
- *CN VII-Facial nerve*
  - Provides motor to the face and sensory to the anterior 2/3rds of the tongue
- *CN IX-Glossopharyngeal & CN X-Vagus*
  - Provides motor to the larynx and pharynx
  - Important for swallowing and voice
- *CN XII-hypoglossal nerve*
  - Provides motor for the tongue



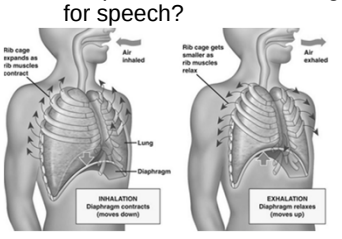
http://www.drugabuse.gov/publications/drugfacts/cocaine

Structural-Functional Examination

- Therapist is looking for the following during movement and at rest:
  - Symmetry
  - Adventitious movement (extra involuntary movement, such as a tremor or a tic)
  - Strength and tone (state of muscle at rest)
  - Range of motion
  - Coordination
  - Ability to vary tension

Examination of Physiological Parameters

- What do we use for speech?
  - *Respiration*: Is there enough breath support for speech?



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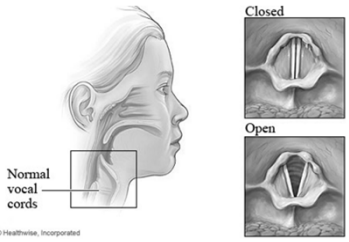
5 cm2 for 5 seconds rule

http://www.inquiryinaction.org/img/content/chapter5/5.10/blowing_soap_bubbles.jpg

What we use for speech

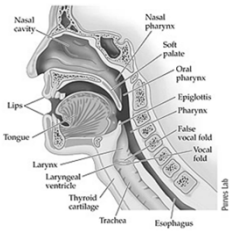
- *Phonation*: Are the vocal folds able to vibrate in a regular manner?



http://choirly.com/wp-content/uploads/2012/03/vocal-folds.jpg

What we use for speech

- *Articulation*-Is articulatory movement sufficient for speech?
- *Resonance*-
  - Can the soft palate go up to close off the nasal cavity for all sounds except for m, n, and ng.
  - Does the child sound like speech is coming out their nose too much (hypernasal) or not enough (hyponasal)?



http://www.dukemagazine.duke.edu/issues/050608/images/050608-lg-figure1purves.jpg

Summarizing motor execution

- The evaluation should indicate that structure, function, and physiology were assessed.
- Summary statement may state that:
  - All structures for speech are *within normal limits* (WNL) or *within functional limits* (WFL)
  - OR it may note weakness, decreased speed, decreased range of motion, or decreased coordination of specific structures needed for speech.
  - It may also note the physiological support needed for speech is WNL, WFL, or impaired.

Motor Speech Evaluation

- Helps to determine motor planning for speech
- Examine ability to sequence sounds in various contexts.
  - CV; VC; CVC (using various vowels)
  - monosyllabic word repetition with same consonants (mom)
  - Monosyllabic with different consonants (e.g., mop)
  - Bisyllabic word repetition (mama, mommy, patty)
  - multisyllabic word repetition
  - Repetition of words of increasing length (e.g., zip, zipper, zippering)
  - phrase repetition of increasing length
- Comparison of automatic speech (e.g., counting, days of the week) to novel utterances.

* C=consonant V=vowel

Motor Speech Evaluation

- The ability to produce particular sound sequences while varying the temporal relationship between stimulus and response

1. *Immediate Repetition-the* child repeats it right after the examiner (if incorrect, try spontaneous)
2. *Simultaneous*-the child and examiner says the utterance together (if incorrect, add other cues)

Non-verbal oral apraxia

- Test for ability to volitionally sequence non-speech oral movement
  - Pucker
  - Pucker-smile
  - Pucker-smile-blow
- Need to be able to differentiate dysarthria from non-verbal oral apraxia
- *Not necessary to treat the oral apraxia, but it will need to be taken into consideration when treating the verbal apraxia.*

Other measures to assist with motor speech assessment

- Spontaneous speech sample
  - The SLP will be able to make observations about:
    - Expressive language skills (if they can understand the child well enough)
    - Articulation skills
    - Prosody – the melody of speech including pitch, loudness, phrasing
    - Resonance- is it hypernasal or hyponasal?
    - Breath support- how many syllables can the child say in one breath group?
    - Fluency- does the child have repetitions?
    - Any noticeable groping?

Consistency of errors

- Does the child make consistent errors or do they vary?
  - E.g., says telephone as t-e-fo once and then le-te-po the next time
  - The SLP may have the child repeat a set of words multiple times to determine consistency of errors.
  - Children with CAS have inconsistent productions.
  - Dodd, author of *Diagnostic Evaluation of Articulation and Phonology (DEAP)*, classifies speech productions that are 40%inconsistent or more as being inconsistent.

Diadochokinesis Tasks (DDK)

- Sequential motion rate (SMR) of individual syllables: pa, ta, ka
- Alternating motion rate (AMR) Repetition of alternating syllables, such as, pataka (or patticake or buttercup)
- The SLP may note:
  - Rate of speech – compared to normative data
    - Maybe stated in terms of how many were produced in a given amount of time or how many syllables were produced per second.
  - Voicing errors-e.g., does pa turn into ba?
  - Ability to sequence the syllables

What are we looking for in regards to CAS?

- Inconsistency of errors
- Disordered prosody
- Presence of vowel errors
- The child has more errors as the word, syllable length, and phrases becomes longer
- Difficulty sequencing sounds and syllables (multisyllabic words and the alternating movement rates (AMR) are especially difficult)
- When the child does break down they improve when given a simultaneous model

Apraxia Exams on the Market that Include a Motor Speech Exam

- *Verbal Motor Production Assessment for Children (VMPAC)* (Hayden & Square, 1999)-
  - Assesses for any motor impairment (dysarthria and apraxia)
  - provides normative data for comparison
- *Screening test for Developmental apraxia of Speech-2* (Blakely, 2000)
- *The Apraxia Profile/Checklist* (Hickman, 1997)
- *The Kaufman Speech Praxis Test for Children* (1995)
- *Dynamic Evaluation of Motor Speech Skill DEMSS)* (Strand, et al., in progress)

Assessment of Articulation Skills

- Articulation Skills
  - There are **many** standardized tests available.
  - Typically assess all sounds in all word positions at the single word level.
  - The following are examples of articulation exams that go beyond the one word level.
    - *Goldman Fristoe Test of Articulation-2 (GFTA-2)*
    - *Diagnostic Evaluation of Articulation and Phonology (DEAP)*

  **Most articulation tests do not assess vowels, so the therapist may need to supplement his or her testing materials.*

International Phonetic Alphabet (IPA) (strange symbols for sounds)

Consonants

p	b	t	d	tʃ	dʒ	k	g
pit	bit	tea	day	church	jog	cat	get
f	v	θ	ð	s	z	ʃ	ʒ
few	vet	think	the	seven	zoo	shoe	beige
m	n	ŋ	h	l	r	w	j
men	new	bring	hi	let	red	west	yellow

www.icalweb.com

http://www.icalweb.com/wiki/images/5/51/Ipa.gif

Vowel Phoneme	Key Word
/i/	*key*
/ɪ/	*win*
/e/	*rebate*
/ɛ/	*red*
/æ/	*had*
/u/	*moon*
/ʊ/	*wood*
/o/	*okay*
/ɔ/	*law*
/ɑ/	*cod*
/ə/	*about*
/ʌ/	*bud*
/ɚ/	*butter*
/ɝ/	*bird*

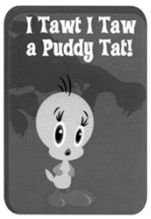
Unknown reference

Assessment of Phonological Processes or Patterns

- Phonological processes analysis
  - Looks for *patterns* in the child's speech errors (see next slide)
  - Examples of tests include:
    - *Hodson Assessment of Phonological Patterns*
    - *Kahn-Lewis Phonological Analysis-2* to be used with the *GFTA-2*
    - *Diagnostic Evaluation of Articulation and Phonology (DEAP)*
- These results can help differentiate between a phonological delay, apraxia, or a combination of both.

Terms for phonological processes (patterns)

Phonological process	example
Deletion of Final Consonants:	'do' for 'dog'
Syllable Reduction:	'pupu' for 'purple'
Stopping:	'*d*ip' for 'zip'
Cluster Simplification:	'*t*ee' for '*tr*ee'
Liquid Simplification:	'*w*un' for '*r*un'
Velar Fronting:	'*t*ate' for '*c*ake'
Palatal Fronting:	'sip' for '*sh*ip'
Deaffrication:	'*sh*oe' for '*ch*ew'
Initial Voicing:	'*d*o' for '*t*wo'
Final Devoicing:	'fuss' for 'fuzz'



http://imagecache2.allposters.com/images/pic/ATA/25470BP~I-Tawt-I-Taw-A-Puddy-Tat-Posters.jpg

Language Assessments

- Receptive Language Skills (auditory comprehension)
  - *Semantics* (word meaning/vocabulary)
  - *Morphology* (this includes sentence structure and the understanding of plurals, prepositions, verb tense, etc.)
  - Sentences of increasing length and complexity
  - Following directions
  - Reading for school-age children

Language Assessments

- Expressive Language Skills
  - Vocabulary
  - Morphology (word forms)
  - Syntax (sentence structure)
  - Writing for school-age children

Summary of language skills

- Children with CAS tend to have a receptive-expressive language gap.
  - In other words, they understand much more than they are able to express.
  - Test scores should show this, in addition to parent report.
- Deficits may also be seen in reading and writing in school-age children.

Phonological and Phonemic Awareness Skills

- You can typically begin to assess these skills around age 4, but more so at age 5 with standardized tests.
- Examples of phonemic and phonologic awareness skills:
  - Rhyming
  - Segmentation (divide sentences into constituent words; divide words into syllables; and divide words into phonemes
  - Isolation (identify the initial, final, and medial sounds in words)
  - Deletion (what's 'coat' without the 'c'?)
  - Substitution (what's 'coat' if you take away 'c' and put in 'm')
  - Blending (what does c-a-t say?)
  - Graphemes (what sound does this letter make?)
  - Decoding (what word do these letters make?)

Intelligence/Cognitive Testing

- There are several tests of non-verbal intelligence that can be used with children with speech and language disorders.
  - *Primary Test of Nonverbal Intelligence (PTONI)* (ages 3-9:11)
  - *Test of Nonverbal Intelligence, Fourth Edition (TONI-4)* (ages 6-89)
  - *Comprehensive Test of Nonverbal Intelligence, Second Edition (CTONI-2)* (ages 6-89)
- *Bayley Scales of Infant Development-3rd edition*- used with infants and toddlers to get a sense of cognitive and other skills. (1 to 42 months)

Formal Standardized Assessment Measures

- *Formal standardized norm-referenced* assessments are often found for the Articulation, Language, and Intelligence Tests.
- Normative data has been obtained so that standard scores can be given, which compares the performance of your child to their age-matched peers.

Reliability and Validity

- If your child has been given a standardized test, you may inquire about the reliability and validity of the measure.
  - *Reliability*- the repeatability of the measurement
  - *Validity*- Does the test really test what it says it is testing?

Standard Error of Measurement

- The *standard error of measurement (SEm)* estimates how repeated measures of a person on the same instrument tend to be distributed around his or her "true" score.
- The true score is always an unknown because no measure can be constructed that provides a perfect reflection of the true score.

Direct quote from http://www.fldoe.org/ese/pdf/y1996-7.pdf

What do all those scores mean???

Peabody Picture Vocabulary III-A

Raw Score:	83
Standard Score:	100
Percentile Rank:	50
Age Equivalent Range:	5-11 to 6-06
Score description	average

http://learningdisabilities.about.com/od/assessmentandtesting/qt/testscores.htm

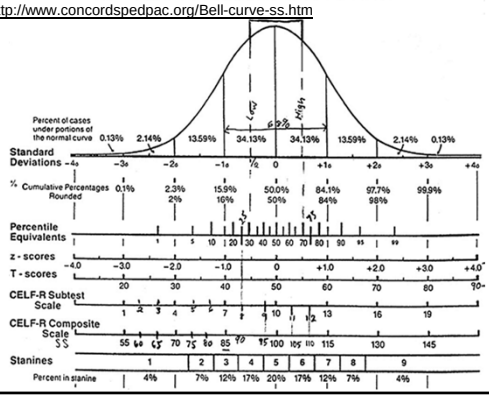
- **Percentiles:** These scores show how a student's performance compares to others tested during test development.
  - A student who scores at the 50th percentile performed at least as well as 50 percent of students his age in the development of the test.
- **Z-Scores:** These scores range from +4 to -4 and have an average of zero.
  - Positive scores are above average. Negative scores are below average.

http://learningdisabilities.about.com/od/assessmentandtesting/qt/testscores.htm

- **T-Scores:** have an average of 50 and a standard deviation of 10.
  - Scores above 50 are above average.
  - Scores below 50 are below average.
    - The table on the next page shows the approximate standard scores, percentile scores, and z-scores, scores that correspond to t-scores.
- **Stanine Scores:** Stanine is a contraction of the term "standard nine." These scores range from one to nine and have an average of about 4.5.

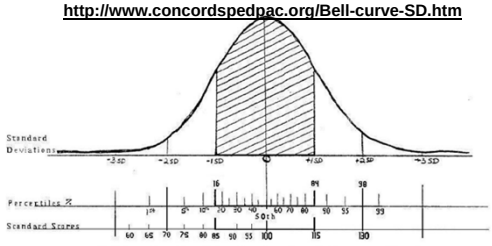
THE NORMAL CURVE, PERCENTILES, AND SELECTED STANDARD SCORES

http://www.concordspedpac.org/Bell-curve-ss.htm



The Normal Bell curve
Percentiles, Standard Scores and Standard Deviations

http://www.concordspedpac.org/Bell-curve-SD.htm



Guidlines for Describing the Severity of Language Disorders

Relationship of Range to Mean	Description
Between -1 and -1 1/2 SD* below the mean	Mild to moderate language disorder
Between -1 1/2 and -2 SD* below the mean	Moderate language disorder
Below -2 SD* of the mean	Severe language disorder

* SD refers to standard deviation

The Problem with Age Equivalent
(Lawrence, 1992)

- *Age-equivalent score*- the average raw score derived from the normative sample at a specific age.
  - You'll often see age scores reported in years and months.
  - Do they really test a large enough group of children at each of these ages in every socio-economic, personal, racial, and geographical background????
    - NO! These scores are merely extrapolated from the scores they have of children at year or ½ year intervals.
    - In addition, typical children range greatly.
  - Granted, these scores can help parents understand where the child falls, but they need to be taken with a grain of salt, to say the least.

What does it all mean?

- At the end of the report there should be a nice summary that puts it all in parent friendly terms.
- Rarely is a child ever just apraxic or dysarthric, so there is usually more than just that diagnosis.

What's the relative contribution?

- 1st, What are all of the factors contributing to the child's communication disorder?
  - Phonologic?
  - Apraxic?
  - Dysarthric?
  - Intelligence?
  - Expressive and/or receptive language?
  - Articulation delay?
  - Hearing Impairment?

Is there a case for CAS?

- What's your evidence?
- What symptoms does this child present that allow the SLP to differentiate from other disorders?
  - Consistency of errors?
  - Presence of vowel errors?
  - Disordered prosody?
  - Increased errors on increasing length of utterance?
  - Groping?
  - Difficulty sequencing sounds and syllables?

Is there a case for CAS?

- What characteristics rule out other possibilities? For example:
  - Structures have adequate range of motion, speed, strength, and coordination for speech
  - Child has receptive language skills that are WNL or they're at least higher than expressive language skills
  - Errors don't just fit a consistent pattern as they would for a child with a phonologic delay.

What if there is more than just CAS?

- Which symptoms suggest a dysarthric component vs. apraxic or phonologic vs. apraxic.
- What level of phonologic awareness skills (if they're old enough to assess this.)
- Are there any other symptoms that may suggest difficulties with word finding, memory, auditory processing, etc.

VERY IMPORTANT

- A child is rarely ever JUST APRAXIC!
- Don't let the diagnosis of apraxia be the only diagnosis when there's more going on!
- Don't assume that because the child has apraxia their other symptoms are part of the CAS diagnosis, (e.g., poor phonological awareness, poor reading and writing skills, challenging behaviors, etc.)
- The SLP should be very clear about ALL of the factors contributing to the child's communication disorder.

Take Age into Consideration

- If a 2;6 year-old child is nonverbal, does it mean they're apraxic?
  - Young children may not be able to present enough evidence for the dx.
  - Allow time for dynamic assessment and treatment before making a dx.

Example of an evaluative summary

- In summary, Annie presents with average receptive language skills and severely delayed expressive language skills. She also presents with a motor planning difficulty for sequencing the movements necessary for speech (childhood apraxia of speech). Children with severe speech and expressive language delays are at risk for having difficulty with phonological awareness skills, which often leads to difficulty with reading and writing. Annie is demonstrating concerns in these areas, as well.

Example of an evaluative summary

- Although not formally assessed, Annie also seems to have problems with word retrieval. This is not uncommon in children with childhood apraxia of speech. Annie is a bright girl and is a hard worker. Although tasks were challenging, she persevered throughout many long testing sessions.

Recommendations

- Recommendations will reflect all areas needing intervention
- In the case of motor planning, the motor speech assessment will lead to the specific recommendations for the motor planning component
  - E.g., Where did the child break down, but have success with simultaneous cuing and tactile prompts?

Example of recommendations written on a report

- **Recommendations**: Annie should continue to receive speech therapy services 4 times a week. I am glad to see she is receiving services from both the school and the Scottish Rite Center, as it is often difficult for one setting to provide all 4 sessions/week. Speech therapy should address the following:

Example of recommendations written on a report

- motor planning for speech
  - Start with 10 functional target phrases to work on intensively (Get input from A and her family as to what these sentences should include.)
  - Choose sentences that include various CVCs, CCVCs and some bisyllabic words (be clear that her initial consonants can not turn into 'h')
  - Use correct syntax in the sentences (initially the 'little words' may need more emphasis so that she includes them, but then move to normal prosody as soon as possible.)
  - Gradually increase the complexity of the syllable shapes, word length, and sentence length as she becomes more successful.

Example of recommendations written on a report

- Address phonological awareness skills with a systematic, explicit and multimodal approach. Examples of appropriate programs include:
  - A multi-modality approach such as the Lindamood Phoneme Sequencing program would be helpful (www.LindamoodBell.com)
  - Road to the Code
  - Phonic Faces (http://www.elementory.com/)

Example of recommendations written on a report

- Increase expressive language skills. (Since it can be difficult to work on speech and language skills at the same time, allot some therapy time to just focusing on syntax and not worrying too much about the articulatory accuracy.
  - Inclusion of articles
  - Inclusion of correct verb forms
  - Inclusion of bound morphemes
- A's word retrieval skills should also be assessed. In addition, the school psychologist or reading specialist should assess A for dyslexia. If auditory processing is of a concern when she returns to school, an audiologist should assess this area, as well.

Caregiver Input

- No evaluative report is complete without the caregivers' input!
- Caregivers typically know their child best.
- Make sure the report includes the child's strengths.
- Every child has strengths!

Lastly

- The SLP needs to be open to questions about their report if something doesn't seem right or you don't understand something.

Remember that tests do have their limitations. (Susan Anthony's website http://www.susancanthony.com/Workshops/testing_trans.html)

- One of the main problem Americans have with tests is we put too much emphasis on them. They are valuable. They are not useless. **But they are not the most important thing in the world!**
- Someone once wrote, *"Not everything precious can be measured, and not everything measurable is worth teaching."*

Remember that tests do have their limitations. (Susan Anthony's website http://www.susancanthony.com/Workshops/testing_trans.html)

- Here are some things standardized tests can't measure:
  - knack for business
  - artistic or musical ability
  - the ability to work with people
  - curiosity and creativity
  - the ability to listen
  - diligence, perseverance
  - common sense, initiative
  - motivation, study habits
  - self-control
  - clear thinking
  - character and virtue

References and Resources

- Anthony, S. C. (n.d.) Understanding Standardized Tests Transcript http://www.susancanthony.com/Workshops/testing_trans.html
- ASHA-Hearing Screening and Assessment http://www.asha.org/public/hearing/Audiogram/
- Lawrence, C. (1992). Assessing the Use of Age-Equivalent Scores in Clinical Management *Language, Speech, and Hearing Services in Schools* Vol.23 6-8 January 1992.
- Logsdon, A. Understanding Test Scores - Understand Your Child's Test Scores http://learningdisabilities.about.com/od/assessmentandtesting/qt/testscores.htm
- Norms and the Meaning of Test Scores. http://web.sau.edu/WaterStreetMaryA/NEW%20intro%20to%20tests%20&%20measures%20Website_files/norms_and_the_meaning_of_test__s.htm
- Ontario Association for Families of Children with Communication Disorders http://www.oafccd.com/factshee/fact61.htm
- Rubba, J. (2003). *Phonological Awareness Skills and Spelling Skills* http://cla.calpoly.edu/~jrubba/phon/phonaware.html
- Strand, E. A., McCauley, R., Weigand, S. D., Stoeckel, R., & Baas, B. (2013). A motor speech assessment for children with severe speech disorders: reliability and validity evidence. *Journal of Speech Language and Hearing Research*, (56) 505-520.
- Wright, P. W. D. & Wright, P. Tests and Measurements for the Parent, Teacher, Advocate, and Attorney http://www.wrightslaw.com/advoc/articles/tests_measurements.html
- Zenisky, A., Keller, L., & Sireci. S. (2004). A basic primer for understanding standardized tests and using test scores, *System for Adult Basic Education Support, vol. 16*. http://www.sabes.org/resources/publications/adventures/vol16/16zenisky.htm