FOR CLINICIANS:
An Articulation-Phonology Update

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Presented by

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Incidence and Prevalence

- Among the most prevalent communication disability in preschoolers and school age children
- Affects approximately 10% of this population
- For 80% of these children, the disorder is sufficiently severe to require treatment.

Incidence and Prevalence

Prevalence of speech delay in 6-year old children and comorbidity with language impairment

Shriberg, Tomblin, & McSweeny (1999)

- The prevalence of speech delay in 6-year-old children was 3.8%
- Speech delay was approximately 1.5 times more prevalent in boys (4.5%) than girls (3.1%)
- Cross-tabulations by sex, residential strata, and racial/cultural backgrounds yielded prevalence rates for speech delay ranging from 0% to approximately 9%

Incidence and Prevalence

Prevalence of speech delay in 6-year old children and co morbidity with language impairment

Shriberg, Tomblin, & McSweeny (1999)

- Co morbidity of speech delay and language impairment was 1.3%, 0.51% with Specific Language Impairment (SLI)
- Approximately 11–15% of children with persisting speech delay had SLI
- Approximately 5–8% of children with persisting SLI had speech delay

Incidence and Prevalence

Prevalence of speech delay in 6-year old children and co morbidity with language impairment

Shriberg, Tomblin, & McSweeny (1999)

- More than half of the children diagnosed with speech sound problems will have later academic difficulties in language, reading, and spelling.
- Many other studies agree with this

School SLPs Work with Speech-Sound Disorders

	Percentage of Students	
	K - 3	4 - 6
Speech-sound production	58.2	48.7
Intelligibility	16.9	3.6
Spoken Language Production	47.5	48.2
Spoken Language Comp.	38.4	41.9
Fluency	3.4	8.8
Pragmatics	1.7	1.6
Voice	0.6	0.5

Whitmire, K., Karr, S., & Mullen, R. (2000). Action: School services. *Language, Speech, & Hearing Services in Schools, 31*, 402-406.

Effects on Daily Life

- Long term consequences
- Difficulty processing linguistic information
- Fewer years of formal education
- Hold jobs as unskilled laborers
- Difficulties in reading/writing
- May have children with speech sound problems

Societal Attitudes

Children with minor /w/ for /r/ substitution are considered to be:

Less talkative	Dysfluent
Unpleasant to listen to	Soft
Boring	Nervous
More tense	Afraid
Isolated	Uncomfortable
Less confident	Dull

(Silverman & Paulus, 1989)

Societal Attitudes

Social acceptance of an actor with a mild speech-sound impairment was less positive than the same actor demonstrating a physical disability.

(Anderson & Antonak, 1992)

Societal Attitudes

People with speech impairment were found to be less extroverted and socialized with fewer people than people with typical speech productions.

(Felsenfel et al., 1992)

Genetic Bases of Speech Sound Disorders

Lewis, B., Shriberg, L., et al. (2006). The genetic bases of speech sound disorders: Evidence from spoken and written language. *Journal of Speech, Language and Hearing Research, 49,* 1294-1312.

- Speech sound disorders are complex disorders.
- The search for genetic influences is challenging.
- Here are some things to think about:

Genetic Bases of Speech Sound Disorders

1. It is likely that SSDs have more than a single etiology

- Multiple genes will probably contribute to population risk for SSD.

Genetic Bases of Speech Sound Disorders

2. Similar phenotypes may have different underlying etiologies

Phenotypes are:

The observable physical characteristics that are an expression of a specific trait based on genetic and environmental influences.

Genetic Bases of Speech Sound Disorders

2. Similar phenotypes may have different underlying etiologies

- Similar SSDs may not be the result of the same combination of genetic or environmental factors.
- 4 possible causalities: genes, neurobiology, cognition, behavior.
- E.g., children with same behavioral impairment may present with different cognitive impairment.
- A single marker may not be sufficient to identify homogeneous groups.

Genetic Bases of Speech Sound Disorders

3. Similar genotypes may give rise to different phenotypes

Genotypes are:

The genetic makeup, as distinguished from the physical appearance, of an organism or a group of organisms.

Genetic Bases of Speech Sound Disorders

3. Similar genotypes may give rise to different phenotypes

- The same genetic mutation may have different effects in different individuals because of interactions with other genes and/or the environment.

Genetic Bases of Speech Sound Disorders

4. There is not a direct pathway from genes to phenotypes

- Genetic, cellular, anatomical, and environmental conditions interact to produce an SSD.
- A given condition may be controlled by more than one gene.
- Genes may influence SSD indirectly, e.g., by working on a cognitive structure.

More on Terms (the confusion continues….)

ARTICULATION PROBLEM

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PHONETIC DISABILTY

More on Terms (the confusion continues….)

Phonetic Disability

- **Individual sounds are articulated incorrectly**
- **The phonological rule system is intact**
- **Inaccurate production of the correct phoneme**
- **Concerned with the specific production errors of a particular sound**

More on Terms (the confusion continues….)

Phonemic Disability

Sounds may be well articulated, but inappropriate for the context

Concerned with the underlying system that accounts for the specific output problem

Represents the systematic patterns of sound changes

Topic 1

DEVELOPMENTAL NORMS

What we are really asking is…

- Do we know when speech sounds are learned?
- Can we use norms to determine if a child is eligible for therapy?
- Can we use norms to choose targets for therapy?

Assumptions about Developmental Norms

- Universal order
- Developmental prerequisites
- Methodological issues involved in gathering norms

Frequently Used Speech-Sound Norms

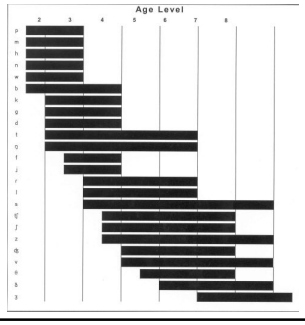
THE CLASSICS

- Sander (1972)
- Prather, Hedrick, & Kern (1975)
- Templin (1957)

MORE RECENT NORMS

- Smit et al. (1990)
- Goldman-Fristoe Test of Articulation (2000)

Sander (1972) "Norms"



Norms for Treatment Eligibility

Problem 1

Which set of norms can you believe?

Problem 2

Holding children with disorders to a **HIGHER** standard.

Norms for Target Selection

Issue 1: Universal Order

Is there a universal order? Data from other languages. Children with disorders follow "normal?"

Issue 2: Developmental Prerequisites

Is mastery of earlier developing sounds necessary before production of later developing sounds?

Issue 3: Early vs. Late

Some researches advocate for training later sound and not early sounds.

Topic 2

PHONOLOGICAL PROCESSES

Phonological Processes: Historical Origins

- Stampe's Natural Phonology Theory
- Assumptions
  - Full Perception Hypothesis
  - Underlying representation assumption
  - Suppression instead of development
- Explanation vs. Description

Reasons NOT to Use Phonological Processes

- Philosophical reasons
- Clinical reasons
- Terminology reasons
  (processes vs. processing)

Things to Look for to Help Identify Patterns

Handout on things to look for to help identify non-obvious patterns

Klein, E. S. (1986)

Topic 3

Childhood Apraxia of Speech (CAS)

Some Practical Questions about CAS

- Do you treat children with the diagnosis of CAS?
- Do you diagnosis a child with having CAS?
- What criteria do you use?
- How does your treatment differ for Apraxia therapy compared with other speech-sound Tx?
- Does CAS really exist?

Defining CAS

Ad Hoc Committee on Childhood Apraxia of Speech (2007)

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.

Defining CAS

A subtype of severe speech sound system disorder in children

- Due to unidentified neurological differences with possible genetic bases.
- With abnormalities arising at the linguistic or early motor processing levels of production.
- Frequently characterized by vowel errors, prosodic disturbances, and/or inconsistency as well as increased risk for persisting problems in language and literacy.

Diagnosing CAS

Exclusionary Criteria

- No peripheral organic disorder (e.g., clefts)
- No sensory deficits (e.g., vision or hearing)
- No peripheral muscle weakness or dysfunction (i.e., dysarthria, cerebral palsy)
- IQ must be typical
- Receptive language must be typical

Diagnosing CAS

Speech: Phonologic/Phonetic

1. Limited consonant and vowel phonetic inventory
2. Frequent omissions
3. High incidence of vowel errors
4. Inconsistent errors
5. Altered suprasegmentals
6. Increased errors with output length
7. Difficulty in imitation (groping or refusal)
8. Predominant use of simple syllable shapes

Diagnosing CAS

Nonspeech Characteristics

1. Impaired volitional oral movements
2. Reduced expressive compared to receptive language skills
3. Reduced diadochokinetic rates

Diagnosing CAS

Distinction between characteristics associated with a disorder and those that are distinctive-how unique to this group are they?

Diagnosing CAS

Sensitivity

Proportion of people WITH the disorder/condition who test POSITIVE on the marker/test.

Correct identification of people with the disorder

Diagnosing CAS

Specificity

Proportion of people WITHOUT the disorder/condition who test NEGATIVE on the marker/test.

Correct identification of people without the disorder

Diagnosing CAS

Characteristics showing the greatest promise as diagnostic makers

Good sensitivity and specificity

1. VOWEL ERRORS:
2. INCONSISTENT ERRORS:
3. ABNORMAL PROSODIC PATTERNS: Excessive, equal or misplaced stress; effortful production

Diagnosing CAS

Criteria used by 75 SLPs to establish a Dx

Forrest, K. (2003)

1. Inconsistent productions
2. General oral-motor difficulties
3. Groping
4. Unable to imitate sounds
5. Increased errors with increased utterance length
6. Poor sequencing of sounds

Diagnosing CAS

Characteristics of CAS

See Velleman & Strand (1994)

- Common Characteristics of CAS
  - Segments within syllables and words
  - Suprasegmental patterns
  - Language characteristics
- Common Early History Characteristics

Diagnosing CAS

Differential Diagnostic Characteristics

Older Children and Infants/Toddlers

See Davis & Velleman (2000)

- General Characteristics
- Phonetic/Phonological Characteristics
- Potential Co-Occurring Characteristics

Diagnosing CAS

CAS

vs.

Dysarthria

vs.

Phonological Disorder

See handout

Differential Diagnosis of CAS

Vowel Accuracy

- In-depth analysis requires attention to regional, social dialectal variation in vowels.
- Measures in which information about vowels is encouraged: HAPP-3; ALPHA-R
- Complete list of American English monophthongs and diphthongs for SAE, see Walton & Pollock, 1993
- Information on vowel development in typically developing children, see Pollock & Berni, 2003

Differential Diagnosis of CAS

Consistency of Errors

- Obtain 2 spontaneous (picture naming) and 2 imitated tokens of selected words (particularly multisyllabic words) on a standard articulation test, consecutively.
  - Children without CAS will usually improve across trials and with a model.
  - Children with CAS are more likely to show degraded performance across trials.

Differential Diagnosis of CAS

Prosody

- Best observed in connected speech samples
- Formal measures are available, but time consuming
- Profiling Elements of Prosodic Systems, Children, American Version (Peppe & Wells, forthcoming)

Differential Diagnosis of CAS

Prosody Functions—Use in Context

- **Chunking:** Using intonation and pauses to differentiate individual nouns from noun phrases.
- **Affect: Use of intonation to indicate like or dislike or neutral emotion**
- **Interaction: Use of intonation to indicate agreement or understanding vs. confusion**
- **Focus: Use of intonation for emphasis in a sentence**

Remediation Strategies Used with Children with CAS

- Motor Programming Approaches
- Multisensory and Tactile Cueing
  Touch cue, Sensory motor, PROMPT, Cued speech
- Rhythmic and Prosodic Methods
  MIT
- Articulation/Phonological Approaches

CAS is RARE

Shriberg, Aram, & Kwiatkowski (1997)

"5% of the preschool children have phonological disorders of unknown origin. Estimates suggest that DVD has a prevalence rate of 1 to 2% of 1,000 live births, which places it in the category of a "low incidence" disorder. When compared to children with uncomplicated phonological speech delay, the frequency of DVD in the population is quite small."

CAS is Difficult to Diagnosis

Shriberg & McSweeny (2002)

Davis, Jakielski, & Marquardt (1998)

There is probably an 80% "false positive" diagnosis of CAS. This means that approximately 80% of the children labeled as apraxic are actually misclassified!!!

Topic 4

Non-Speech Oral Motor Exercises

Logic, Theory & Evidence Against the use of Non-Speech Oral Motor Exercises to Change Speech Sound Productions

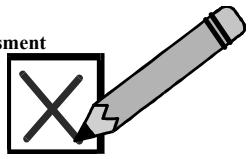
Topic 5

Assessment Issues

Assessment

Procedures that should be accomplished…

- Articulation test
- Continuous speech analysis
- Hearing screening
- Stimulability assessment
- Perception/discrimination assessment
- Oral-peripheral screening
- Case history
- What else???



Assessment

"Always use…"

76%	Case History	51%	Phonological Processes
75%	Intelligibility	36%	Connected Speech Sample
74%	Single Word Test	36%	Phonological Inventory
71%	Hearing Screening	31%	Classroom Observation
68%	Stimulability	13%	Perception/Discrimination
61%	Parent Interview	13%	Phono. Awareness
58%	Oral Motor-Non Speech	11%	Contextual Testing
54%	Oral Motor-Speech	11%	Syllable/Word Shapes

Skahan, Watson, & Lof (2007)

Assessment

Phonetic/Phonemic Inventory

Phonemic Inventory

A listing of the speech sounds produced in comparison to the target sound.

This is a Relational Analysis

Assessment

Phonetic/Phonemic Inventory

Phonetic Inventory

A listing of speech sounds that are produced regardless of the target.

This is an Independent Analysis

Some questions to ask…

Tyler, 2005

How are word/syllable structures affected by error patterns?

- Frequency of different syllable structures
- Match between target & structure productions
- Determine affected syllable structures

Some questions to ask…

Tyler, 2005

Which sound classes are proportionally more affected by error patterns?

- Fricatives? Stops? Liquids? Etc.
- Place/Manner/Voicing analysis is helpful

Some questions to ask…

Tyler, 2005

Are there positional constraints?

- Do the errors occur in all positions?
- Is it an inventory constraint or positional constraint?

Some questions to ask…

Tyler, 2005

What sounds are present/absent in the phonetic inventory?

- Use the phonetic inventory forms
- Do you expand the inventory or do you make the inventory more useful?

Some questions to ask…

Tyler, 2005

What is the stimulability status of the sounds in error?

- Do you select stimulable or nonstimulable sounds?

Potential Targets (Williams, 2003, 2005)

Sound vs. System

Traditional Approaches

Treatment outcome is producing a SOUND correctly

Non-Traditional Approaches

Treatment outcome is phonological restructuring of the system

Target Selection Tip

(Williams, 2003)

- Voiced sounds more marked than voiceless
- Affricates are more marked than fricatives
- Clusters are more marked than singletons

Topic 6

Therapy for Speech Sound Disorders

Broad vs. Deep

Training Deep

- Traditional (Van Riper) therapy
- Emphasis primarily on motor control
- Model-response mode; cue response mode
- Lots of drill
- Schedules of reinforcement

Broad vs. Deep

Deep Training for
phonetic/articulation problems

- **Child is school age or older**
- **Child uses all syllable structures**
- **Intelligibility is slightly to moderately affected**
- **Errors are primarily distortions and substitutions, not omissions**
- **Child may/may not have phoneme-specific perception problems**

Broad vs. Deep

Training Broad

- Target a few exemplars
- Auditory input
- Use of minimal contrasts
- Limited teaching, limited drill

Broad vs. Deep

Broad Training for
cognitive/linguistic/phonemic problems

- **Child is preschool or early school age**
- **Child does not use all syllable structures consistently**
- **Intelligibility is definitely affected**
- **Many errors are omissions, along with substitutes and occasional distortions**
- **Child's difficulty is in figuring out how the ambient language works**

Therapy Concepts

See handout on Traditional Articulation and Phonological Therapy

Topic 7

TREATMENT EFFICACY

Definition of Efficacy

- Does treatment work?

  Treatment effectiveness
- How does treatment alter behavior?

  Treatment effects
- Does one treatment work better than others?

  Treatment efficiency

Treatment Effectiveness

Four Established Approaches

- **Traditional Approaches**
- **Cycles Approach**
- **Minimal Pair**
- **Metaphon**

Treatment Effects (Generalization)

Changes in Treated Sounds

- Train 3 to 5 different words
- May not be necessary to train in other settings

Treatment Effects (Generalization)

Changes in Untreated Sounds

- Within class generalization
- Across class generalization
  - Markedness

Treatment Efficiency

Treatment Methods

Minimal Pairs; Minimal Pairs vs. Cycles;

Minimal Pairs vs. Whole Language

Targeted Sounds

Later Developing Sounds; Nonstimulable Sounds

Mode of Presentation

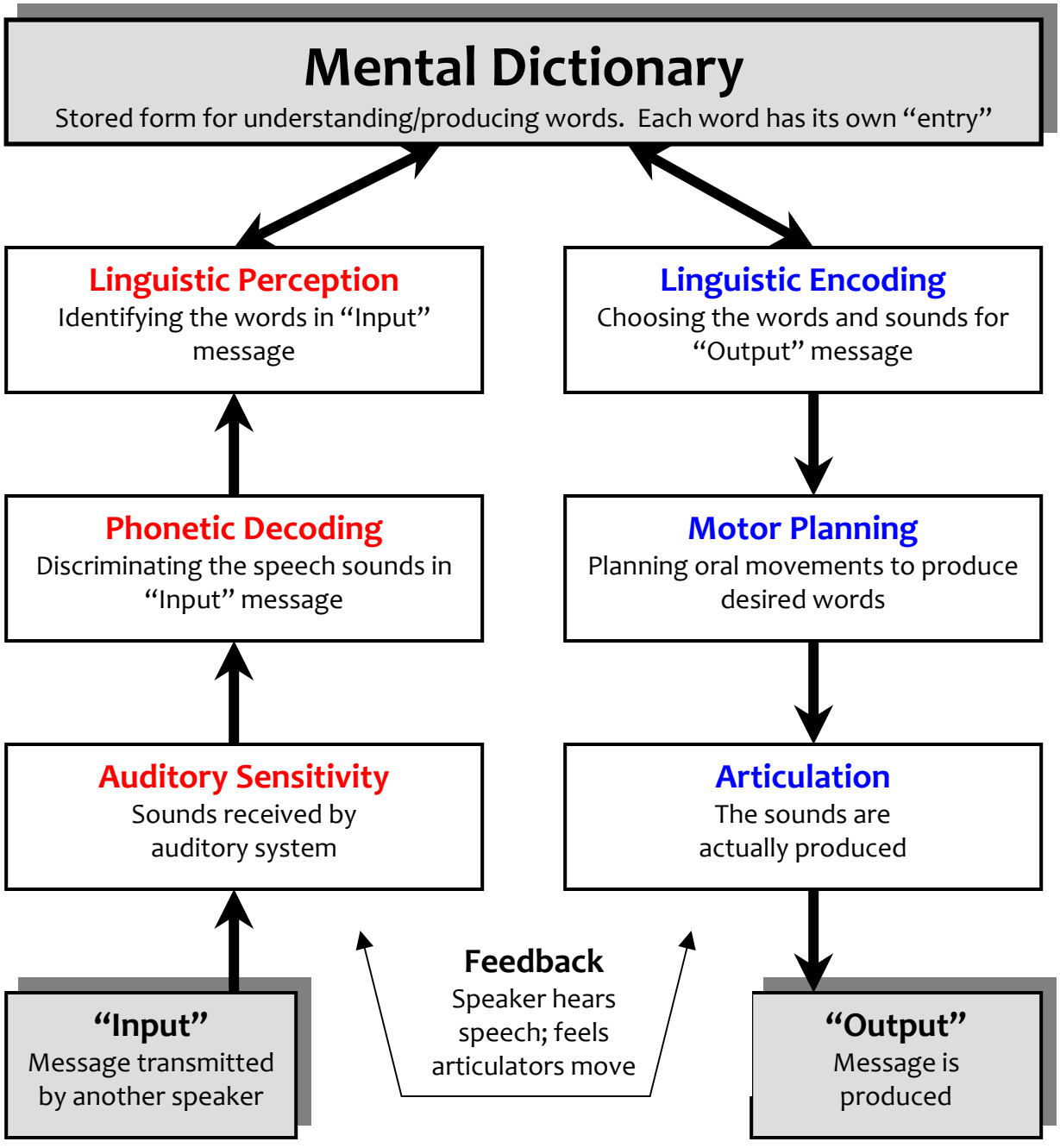
Perception training; Drill-Play; Computers

Interesting Topics

- Vowel errors
- Generalization
- Literacy (reading)
- Fluency/phonology
- Otitis media
- Language/phonology
- Late talkers
- Computers
- Genetics
- Nonlinear phonology
- Phonological awareness
- Multi-cultural issues
- Intelligibility
- Babbling
- Classroom therapy

Processing Model

Elements Needed for
Comprehension and Production of Speech



ORDER OF SPEECH-SOUND ACQUISITION DIVIDED INTO THREE CATEGORIES

The order is derived from continuous speech sampling and is compared with data from an articulation test (Shriberg, 1993)

Order	Continuous Speech	Articulation Test
Early 8	m	m
	b	b
	j	
	n	n
	w	w
	d	d
	p	p
	h	h
		g
Middle 8	t	t
	ŋ	ŋ
	k	k
	g	
	f	f
	v	v
	tʃ	tʃ
	dʒ	dʒ
		j
Late 8	ʃ	ʃ
	θ	θ
	s	s
	z	z
	ð	ð
	l	l
	r	r
	ʒ	

Things to Look for to Help Identify Non-Obvious Speech Production Patterns

- **Phonetic Context**
  e.g., stopping of fricatives which follow high vowels
  stopping of fricatives in words with nasals

- **Position**
  e.g., stopping of final fricatives

- **Intra-Class Variability**
  e.g., stopping of fricatives except for /s/ and /z/
  stopping of non-alveolar fricatives

- **Syllable Structure**
  e.g., stopping of fricatives in CVC words
  stopping of fricatives in multi-syllabic words

- **Morphological Endings**
  e.g., deletion of unstressed morphemes

- **Syllable Stress**
  e.g., stopping of fricatives in unstressed syllables

- **Syllable Boundary**
  e.g. stopping of fricatives when the syllable boundary immediately precedes the fricative

- **Situational Context**
  e.g. stopping of fricatives when playing with younger sister

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Taken from: Klein, E.S. (1996). *Clinical phonology: Assessment and treatment of articulation disorders in children and adults*. San Diego: Singular.

Comparison of Childhood Apraxia of Speech, Dysarthria and Severe Phonological Disorder

(Some or all of these characteristics may be present)

From: Apraxia-kids.org

Verbal Apraxia	Dysarthria	Severe Phonological Disorder
No weakness, incoordination or paralysis of speech musculature	Decreased strength and coordination of speech musculature that leads to imprecise speech production, slurring and distortions	No weakness, incoordination or paralysis of speech musculature
No difficulty with involuntary motor control for chewing, swallowing, etc. unless there is also an oral apraxia	Difficulty with involuntary motor control for chewing, swallowing, etc. due to muscle weakness and incoordination	No difficulty with involuntary motor control for chewing and swallowing
Inconsistencies in articulation performance--the same word may be produced several different ways	Articulation may be noticeably "different" due to imprecision, but errors generally consistent	Consistent errors that can usually be grouped into categories (fronting, stopping, etc.)
Errors include substitutions, omissions, additions and repetitions, frequently includes simplification of word forms. Tendency for omissions in initial position. Tendency to centralize vowels to **/1/**	Errors are generally distortions	Errors may include substitutions, omissions, distortions, etc. Omissions in final position more likely than initial position. Vowel distortions not as common.
Number of errors increases as length of word/phrase increases	May be less precise in connected speech than in single words	Errors are generally consistent as length of words/phrases increases
Well rehearsed, "automatic" speech is easiest to produce, "on demand" speech most difficult	No difference in how easily speech is produced based on situation	No difference in how easily speech is produced based on situation
Receptive language skills are usually significantly better than expressive skills	Typically no significant discrepancy between receptive and expressive language skills	Sometimes differences between receptive and expressive language skills
Rate, rhythm and stress of speech are disrupted, some groping for placement may be noted	Rate, rhythm and stress are disrupted in ways specifically related to the type of dysarthria (spastic, flaccid, etc.)	Typically no disruption of rate, rhythm or stress
Generally good control of pitch and loudness, may have limited inflectional range for speaking	Monotone voice, difficulty controlling pitch and loudness	Good control of pitch and loudness, not limited in inflectional range for speaking
Age-appropriate voice quality	Voice quality may be hoarse, harsh, hypernasal, etc. depending on type of dysarthria	Age-appropriate voice quality

Logic, Theory and Evidence Against the Use of Non-Speech Oral Motor Exercises to Change Speech Sound Productions

Introduction

Non-Speech Oral Motor Exercises (NS-OME) Defined

- *Any technique that does not require the child to produce a speech sound but is used to influence the development of speaking abilities* (Lof & Watson, 2007; 2004).
- *A collection of nonspeech methods and procedures used to influence tongue, lip, and jaw resting postures, increase strength, improve muscle tone, facilitate range of motion, and develop muscle control* (Ruscello, 2007).

Do SLPs use NS-OME? Nationwide survey of 537 SLPs by Lof & Watson (2007; 2004)

- 85% use NS-OME to change speech sound productions.
- Hodge, Salonka, & Kollias (2005): Nationwide survey of 535 SLPs in Canada found that 85% use NS-OME to change speech sound productions, the same result as in the USA!
- Clinicians report being "*Very Familiar*" with the research that has examined the efficacy of NS-OME and the theoretical basis for using them.
- 61% of the clinicians agree with this statement: *"The literature I have read strongly encourages the use of NS-OME."*
- 87% of the clinicians learned to use NS-OME from non peer-reviewed CEU offerings, workshops, and in-services.
- **Most frequently used exercises** (in rank order): Blowing; Tongue Push-Ups; Pucker-Smile; Tongue Wags; Big Smile; Tongue-to-Nose-to-Chin; Cheek Puffing; Blowing Kisses; Tongue Curling.
- **Reported benefits** (in rank order): Tongue Elevation; Awareness of Articulators; Tongue Strength; Lip Strength; Lateral Tongue Movements; Jaw Stabilization; Lip/Tongue Protrusion; Drooling Control; VP Competence; Sucking Ability.
- **These exercises are used for children with** (in rank order): Dysarthria; Apraxia of Speech (CAS); Structural Anomalies; Down Syndrome; Enrollment in Early Intervention; "Late Talker" Diagnosis; Phonological Impairment; Hearing Impairment; Functional Mis-articulations.

Evidence-Based Practice

- **Defined:** The conscientious, explicit, and unbiased use of current best research results in making decisions about the care of individual clients (Sackett et al., 1996). Treatment decisions should be administered in practice only when there is a justified (evidence-based) expectation of benefit.
- **No Child Left Behind** places an emphasis on scientifically-based methods, calling on clinicians to use scientific, research-based interventions.
- **2006 IDEA Part B Regulations:** *"Special education and related services…must now be based on peer-reviewed research to the extent practicable."*

- **The goal** is to use the literature in a savvy process that draws on a number of different factors in which evidence plays a key role.
- **Dollaghan (2004)** reminds clinicians that when using the EBP paradigm, valid and reliable evidence needs to be given more credence than intuition, anecdote and expert authority. Evidence must come from works that are independent and peer-reviewed.
- **Opinions** and clinician's own clinical experiences can be useful, but they can also be biased and even wrong!
- **Therapist Bias**: Halo effect and Rosenthal effect (see Damico, 1988).

Logic

- **Clinical experience cautions:** Finn, Bothe, and Bramlett (2005) provided criteria for distinguishing science from pseudoscience: (1) Treatments remain unchanged even with evidence against its effectiveness because disconfirming evidence is ignored; (2) Anecdotal evidence and personal experience are given extraordinary credence; (3) Inadequate evidence is accepted; (4) Peer review is avoided; (5) Methodology is disconnected from established scientific models; (6) Use of new terms that are not scientific nor conventional; (7) Grandiose outcomes are proclaimed; (8) Claims of success only within a holistic framework.
- **Many claims are made about NS-OME effectiveness** in catalogs selling therapy materials, non-peer reviewed publications, CEU events, etc. But no evidence of effectiveness is provided.
- **Some claims of effectiveness are outrageous** and are actually illogical when carefully examined.

Theory

Part-Whole Training and Transfer

- **Basic questions:** Does training on a smaller portion of the articulatory gesture transfer over to the whole gesture? Is it more efficient with better learning by first training just part of the movement and not the whole movement?
- Tasks that comprise highly organized or integrated movements (such as speaking) will not be enhanced by learning the constituent parts of the movement alone; training on just the parts of these well-organized behaviors can actually diminish learning. Highly organized tasks require learning the information processing demands, as well as learning time-sharing and other inter-component skills.
- "*Fractionating a behavior that is composed of interrelated parts is not likely to provide relevant information for the appropriate development of neural substrates*" (Forrest, 2002).
- Some clinician-researchers believe that it can be more effective to "Train the Whole" (Ingram & Ingram, 2001) and to use "Whole-Word Phonology and Templates" (Velleman & Vihman, 2002*)* rather than breaking up the gesture into small parts.

Strengthening the Articulatory Structures

- **Basic questions**: Is strength necessary for speaking? If so, how much? Are the articulators actually strengthened by using NS-OME? How do SLPs objectively document weakness of articulators and also objectively document supposed increases in strength after NS-OME?
- **Articulatory strength needs are VERY low** for speech and the speaking strength needs do not come anywhere close to maximum strength abilities of the articulators. For example, lip muscle force for speaking is only about 10-20% of the maximal capabilities for lip force, and the jaw uses only about 11-15% of the available amount of force that can be produced (see also Bunton & Weismer, 1994).
- **Agility** and fine articulatory movements, rather than strong articulators, are required for the ballistic movements of speaking. NS-OME encourage gross and exaggerated ranges of motion, not small, coordinated movements that are required for talking.
- **NS-OME may not actually increase articulator strength**. To strengthen muscle, the exercise must be done with multiple repetitions, against resistance, until failure…and then done again and again. Most NS-OME do not follow this basic strength training paradigm so there are probably no actual strength gains occurring due to these exercises.
- **Articulators can be strengthened** (e.g., the tongue for oral phase of swallowing or the VP complex) but these strengthened articulators will not help with the production of speech.
- **Measurements of strength are usually highly subjective** (e.g., feeling the force of the tongue pushing against a tongue depressor or against the cheek or just "observing" weakness), so clinicians cannot initially verify that strength is actually diminished and then they cannot report increased strength following NS-OME. Only objective measures (e.g., tongue force transducers) can corroborate statements of strength needs and improvement. Without such objective measurements, testimonials of articulator strength gains must be considered suspect.
- **Preschool children with speech sound disorders may actually have STRONGER tongues** than their matched typically developing peers according to Sudbery et al. (2006).
- **See Chi-Fishman and Pfaizer (2003)** for information on tongue anatomy, physiology, and strengthening principles.

Relevancy of NS-OME to Speech

- **Relevancy is the only way to get changes in the neural system**; the context in which a skill is learned is crucial. In order to obtain transfer from one skill to another, the learned skills must be relevant to the other skills. *"…muscle fibers are selectively recruited to perform specific tasks, so static non-speech tasks do not account for the precise and coordinated activity needed during speech"* (Hodge & Wellman, 1999).
- For sensory motor stimulation to improve articulation, the stimulation must be done with relevant behaviors, with a defined end goal, using integration of skills. *"The PURPOSE of a motor behavior has a profound influence on the manner in which the relevant neural topography is marshaled and controlled"* (Weismer, 2006).
- **Most NS-OME dis-integrate the highly integrated task of speaking** (e.g., practicing tongue elevation to the alveolar ridge with the desire that this isolated task will improve production of the lingual-alveolar sound /s/). For example, a motor task (e.g., shooting a free throw using a basketball) must be learned in the context of the actual performance goal. By analogy, no one would teach a ballplayer to *pretend* to hold a ball and then *pretend* to throw it toward a non-existent hoop with the eventual hope of improving free throwing

ability. Breaking down basketball shooting or the speaking task into smaller, unrelated chunks that are irrelevant to the actual performance is not effective.

- Another non-speaking example would be the illogical finger pounding on a tabletop to simulate playing on a piano. Learning and improving piano playing must be practiced on a piano, not on a tabletop. Likewise, learning and improving speaking ability must be practiced in the context of speaking. To improve speaking, children must practice speaking, rather than using tasks that only superficially appear to be like speaking.
- Because isolated movements of the tongue, lips and other articulators are not the actual gestures used for the production of any sounds in English, their value for improving production of speech sounds is doubtful. That is, no speech sound requires the tongue tip to be elevated toward the nose; no sound is produced by puffing out the cheeks; no sound is produced in the same way as blowing is produced. Oral movements that are irrelevant to speech movements will not be effective as speech therapy techniques.

Task Specificity

- **Three related concepts**: ①same structures but different functions, ②task specificity, ③domain specific.
- **The same structures used for speaking and other "mouth tasks"** (e.g., feeding, swallowing, sucking, breathing, etc.) function in different ways depending on the task and each task is mediated by different parts of the brain. The organization of movements within the nervous system is not the same for speech and nonspeech gestures. Although identical structures are used, these structures function differently for speech and for nonspeech activities.
- **Weismer (2006):** The control of motor behavior is task (speaking) specific, not effector (muscle or organ) specific. There is strong evidence against the "shared control" for speech and nonspeech. *"Motor control processes are tied to the unique goals, sources of information (e.g., feedback), and characteristics of varying motor acts, even when those share the same effectors and some neural tissue."*
- **Some examples of task specificity:** Babbling and early nonspeech oral behaviors are not related (e.g., Moore & Ruark, 1996); Patients can have dysphagia with and without speech problems (i.e., "double dissociations"; Ziegler, 2003); It is well documented that the VP mechanism can be strengthened, however, reduction of speech nasality does not occur (e.g., Kuehn & Moon, 1994); Breathing for speech is different than breathing at rest or during other activities (e.g., Moore, Caulfield, & Green, 2001). See Weismer (2006) for summary of 11 studies that show that speech and nonspeech are different for a wide variety of structures, including facial muscles, jaw motion, jaw operating space, jaw coordination, lingual movement, lip motions, leavator veli palatini, and mandibular control.
- **An fMRI study** demonstrated that non-speech movements activated different parts of the brain than did speech movements (Bonilha et al., 2006). This showed that the neural basis of motor control in normal subjects is different for speech and non-speech oral movements.

Warm-Up/Awareness/Metamouth

- **Warm-up has a physiological purpose** during muscle exercise: to increase blood circulation so muscle viscosity drops, thus allowing for smoother and more elastic muscle contractions (Safran, Seaber, & Garrett, 1989).
- **Warm-up of muscles** may be appropriate (Pollock et al., 1998) when a person is about to initiate an exercise regimen that will maximally tax the system (e.g., distance running or weight training). However, muscle warm-up is not required for tasks that are below the

maximum (e.g., walking or lifting a spoon-to-mouth). Because speaking does not require anywhere near the oral muscular maximum, warm-up is not necessary.

- If clinicians are not using the term warm-up to identify a physiological task to "wake up the mouth," then perhaps they believe that they are providing some form of "metamouth" knowledge about the articulators' movement and placement.
- **Awareness and its role in therapy** is always questioned. It is well known that young children have difficulty with various metaphonological awareness tasks (Kamhi & Catts, 2005). For articulation awareness, Klein, Lederer and Cortese (1991) reported that children age 5 and 6 years had very little consciousness of how speech sounds were made; 7 year olds were not very proficient with this either. According to Koegel, Keogel, and Ingham (1986), some children older than 7 years were successful during a metalinguistic speech intervention program, but only when they have the *"…cognitive maturity required to understand the concept of a sound…"*
- **It appears that young children cannot take advantage of the non-speech mouth-cues** provided during NS-OME that can be transferred to speaking tasks. More research is needed to determine the minimum cognitive, linguistic, and motor abilities of children that are necessary for such "meta" skills.
- **Mental imagery and motor learning:** Actual physical practice produces changes in the motor cortex but so can mere mental rehearsal and to the same degree as that brought on by physical practice. Motor circuits become active during pure mental imagery. Like actual, physical movements, imagined movement triggers synaptic change at the cortical level. Merely thinking about movement produced brain change comparable to those triggered by actual movement (Pascual-Leone at al., 1995). But children do not have prior knowledge of movements nor do they have the meta-skills necessary for this mental rehearsal.

Childhood Apraxia of Speech (CAS)

- **Children with CAS have adequate oral structure movements for nonspeech activities** but not for volitional speech (Caruso & Strand, 1999), so this would preclude the use of NS-OME because non-speech is not the problem.
- **There is no muscle weakness for children with CAS**, so there is no need to do strengthening exercises. If there is weakness, then the correct diagnosis is dysarthria, not apraxia.
- *"Non-speech therapy activities will not improve a child's (with CAS) speech. Activities that address speech directly are critical for that purpose"* (Velleman, 2003).
- See the quote by Davis & Velleman (2000) below.

NS-OME for Non-Motor Speech Disorders

- Some may believe that motor exercises can help children with motor production speech problems, such as functional misarticulators (phonetic/articulatory problems) or children with structural problems; however the evidence does not support this.
- It makes no sense that motor exercises could help improve the speech of children who have non-motor problems such as language/phonemic/phonological problems like children in Early Intervention diagnosed as late talkers.

Cleft Lip/Palate

- The VP mechanism can be strengthened through exercise (many studies have demonstrated this since the 1960s), but added strength will not improve speech productions.
- See the quotes by Peterson-Falzone, Trost-Cardamone, Karnell, Hardin-Jones (2006) below.

PROMPT

- PROMPT: **P**rompts for **R**estructuring **O**ral **M**uscular **P**honetic **T**argets (Hayden, 2006)
- *"A tactually grounded, sensori-motor, cognitive-linguistic assessment and treatment approach for speech production disorders."*
- **Is PROMPT a NS-OME?** ①PROMPT utilizes developmental prerequisites: YES; ②PROMPT uses exercises for jaw, lip, lingual movements: NO, movement only in the context of speech production; ③PROMPT believes in the relationship between nonspeech movements and speech: NO, must always work in the context of speech; ④PROMPT strengthens the articulators: NO, strength is not the issue, rather the neurological system needs to be "triggered" for motor planning; ⑤PROMPT trains isolated motor movements: NO, it teaches a template of all aspects of the articulation but always uses a speech sound; ⑥PROMPT uses sensory massage, deep tissue pressure, desensitization of the oral-motor system: NO, focus on tactile and proprioceptive sensory input using active touch; ⑦PROMPT uses "tools" or horns, or gadgets: Never; ⑧PROMPT is used for motor "warm-up": YES, to focus the child on the motor control aspects but is only done briefly and in context of speech.
- **Key Points**: There is touch of the muscle; the procedures are ALWAYS done in the context of speech; there is NEVER touch inside the mouth; the emphasis is on the movement and is not static.

Evidence

There are 10 studies evaluating the effectiveness of NS-OME: 9 show no benefits, 1 shows benefits (but it has many methodological flaws).

1. **Christensen & Hanson (1981).** Ten children aged 5;8 to 6;9 years underwent 14 weeks of treatment, with half of the children receiving only articulation therapy and the other half receiving articulation and neuromuscular facilitation techniques. Both groups made equal speech improvements; the exercises did not help for better speech sound production BUT they were effective in remediating tongue-thrusting (probably due to task specificity).
2. **Gommerman & Hodge (1995**). Single Subject Design (A-B-C) with a 16-year-old girl with tongue thrust and sibilant distortions. Therapy was baseline (A phase), myofunctional therapy (B phase), then articulation therapy (C phase). Tongue thrust was eliminated with myofunctional therapy but speech did not change until speech therapy was initiated.
3. **Colone & Forrest (2000)**. Monozygotic twin boys age 8;11 years old took part in a motor treatment for Twin 1 and phonological treatment for Twin 2. No improvements with motor training occurred but there were improvements using a phonological approach; when Twin 1 received phonological treatment, there were the same improvements as for Twin 2.
4. **Occhino & McCane (2001).** Single Subject Design (A-B-C-B-C) with a 5-year-old child. Oral motor exercises alone produced no improvement in the articulation of one of two phonemes and also no improvements in oral motor skills. Oral motor exercises prior to or along with articulation therapy did not have an additive or facilitative effect but productions did improve with articulation therapy.
5. **Abrahamsen & Flack (2002).** Single Subject Design with a 4-year-old child for 10 hours of individual treatment using blowing, licking, and oral stimulation. There was no evidence of effectiveness in changing speech sound productions after this treatment.

6. **Bush, Steger, Mann-Kahris, & Insalaco (2004).** Single Subject Design (ABAB Withdrawal) with a 9-year-old boy. OME added to articulation treatment, then removed, then re-added for the sounds /r/,/s/,/z/,/l/. "Oral motor treatment did not improve or reduce treatment's *success."*
7. **Roehrig, Suiter, & Pierce (2004).** AB or BA Single Subject Design with six 3;6 to 6;0 year old boys and girls for 15 weeks of therapy: (A) Tradition, production-based therapy twice a week for ½ hour; (B) Passive OME and traditional therapy twice a week for ½ hour. *"The addition of OME to the traditional articulation therapy approach did not add to participant's overall progress; improvement following therapy with OME was not different from improvements following articulation therapy alone."*
8. **Guisti & Cascella (2005).** Single Subject Design using two boys and two girls in first grade. Therapy followed *Easy Does it for Articulation: An Oral Motor Approach* for 15 one-half hour individual treatment sessions. No evidence of effectiveness in changing speech-sound productions.
9. **Hayes et al. (In submission).** Six 4-year-olds, five boys and one girl who all had "functional misarticulations" were studied in a counterbalanced intervention design where children were randomly assigned to a specific order for an oral motor approach and traditional articulation approach. The traditional treatment resulted in significant speech sound changes but there was no support for oral motor therapy bringing about any changes. There was some evidence that NS-OME actually hindered learning.

1. **Fields & Polmanteer (2002).** Eight 3- to 6-year-old children were randomly assigned to one of two groups: four children received 10 minutes of oral motor treatment and 10 minutes of speech therapy and four children received 20 minutes of only speech therapy. Fewer errors at the end of 6-weeks of treatment for the children who received the combination of treatments. But there were many methodological and statistical issues that may invalidate this finding, such as: the children in the speech-only group were more severe; there was an unequal gender distribution; and there was no report of what the treated sounds were so there can be no evaluation as to how difficult it was to treat certain sounds.

Combining Treatment Approaches

- Most SLPs use a combination of treatment approaches so it is difficult to "tease apart" which approach is providing therapeutic benefit. Additionally, whenever intervention approaches are combined, it is unknown if and how they actually work in conjunction with each other to enhance performance.
- There is much evidence that the NS-OME portion of combined treatments is irrelevant to speech improvements (see above).
- NS-OME probably do not harm the child when used in combination with traditional approaches (however, Hayes et al. [2006] found that some children may be negatively affected by a combination approach).
- It seems reasonable that if there is no speech improvement using combined approaches, then clinicians should eliminate the approach that is not effective (i.e., the NS-OME) so as to not waste valuable therapy time with an ineffectual technique.

In Conclusion

- **If clinicians want speech to improve**, they must work on speech, and not on things that LOOK like they are working on speech.

- **Phonetic placement cues** that have been used in traditional speech therapy are NOT the same as NS-OME.
- **NS-OME is a procedure not a goal.** The goal of speech therapy is NOT to produce a tongue wag, to have strong articulators, to puff out the cheeks, etc. Rather, the goal is to produce intelligible speech.
- **We have been burned before**. In the 1990s many SLPs inappropriately embraced Facilitated Communication (FC) as a treatment approach because they thought they observed that it worked. Once it was tested using scientific methodology, it was found to not work. Pseudoscientific methodologies can persuade clinicians to provide the wrong treatment.
- **Speech is special** and unlike other motor movements.
- **Following the guidelines of Evidence-Based Practice**, evidence needs to guild treatment decisions. Parents need to be informed that NS-OME have not been shown to be effective and their use must be considered experimental.
- Just remember: **Same structures, different functions. Same structures, different functions.**

Relevant Quotes

- **Weismer, G. (2006).** *"…oromotor nonverbal tasks are unlikely to contribute to an understanding of normal and disordered speech production."*
- **Gerratt et al. (1991).** *"Preference for nonspeech maneuvers is surprising since so little research exists on the relations of these measures to speech…"*
- **Davis & Velleman (2000):** *"There is presently no research available to support the efficacy of oral-motor therapy for improvement of speech productions skills. Thus, it is appropriate to work with children with DAS (Developmental Apraxia of Speech) on nonspeech oral-motor skills themselves, but improvement in speech should not be expected as a result."*
- **Peterson-Falzone, Trost-Cardamone, Karnell, & Hardin-Jones (2006)**:
  - *"Do not invest time or advise a parent to invest time and money addressing a muscle strength problem that may not (and probably does not) exist. It is very frustrating to see clinicians working on "exercises" to strengthen the lips and tongue tip when bilabial and lingua-alveolar sounds are already evident in babble, or when bilabial and lingual/lingua-alveolar functions are completely intact for feeding and other nonspeech motor behaviors."*
  - *"Having a repaired cleft does not mean a child will lack the muscle strength needed to produce consonant sounds adequately. The presence of a cleft palate (repaired or unrepaired) has no bearing on tongue strength or function (why would it?). The majority of children who demonstrate VPI do so because their palate is too short to achieve VP closure. Muscle strength or lack thereof is not a primary causal factor associated with phonological delays in this population."*
  - *"…blowing should never be used to "strengthen" labial or soft palate musculature; it does not work. Children who appear to improve over time in therapy when using these tools are likely demonstrating improvement related to maturation and to learning correct motor speech patterns. Had therapy focused only on speech sound development, these children probably would have shown progress much sooner."*

- **Love, R.J. (2000):**
  - *"…recently the profession has rejected the concept of a direct correlation between oral movements and speech and eating behavior."*
  - *"…speech movement control was mediated at a different level in the nervous system than was nonspeech movement control."*
  - *"…it is clear that the infantile reflexes involved in chewing and swallowing behavior are mediated at brain-stem levels, not at the cortical level of oral-motor control as is speech."*
  - *"…improvement of infantile chewing and swallowing behavior in no way contributes to the development of neural networks for speech production."*
  - *"…oral reflexes and chewing and swallowing behavior are relatively independent of speech production mechanisms."*
  - *"…recent studies of the development of mandibular action in normal children suggests that motor coordination for speech activities is clearly different than it is for nonspeech activities…"*
  - *"…[there is] doubt that muscle weakness or pathological muscle imbalance of oral and mandibular muscles is critical for speech movements."*
- **Hodson, B.W. (1997)**:*"…research data supporting efficacy of oral-motor exercises for unintelligible children as a whole are lacking."*
- **Tyler, A. (2005)**. *"I strongly advise against the use of oral-motor exercises for children with phonological-articulatory disorders…"*
- **National Joint Committee for the Communication Needs of Persons with Severe Disabilities (2006): "***There are different types of oral-motor exercises. Typically, oral-motor treatment consists of three types of activities: active exercise, passive exercise, and external stimulation. Active exercise involves strength training and muscle stretching. Passive exercise involves clinician assistance and may involve massage, stroking, or tapping parts of the oral musculature. Clinicians also may use external stimulation, which includes hot and cold application, vibration, or electrical stimulation to the muscles involved in speech and swallowing. At this time, there is limited data-based evidence to support the use of oral-motor activities to help with speech production. Available evidence is based primarily on expert opinion; randomized clinical trials with a randomized control group, the highest level of evidence, have not been conducted. Data are available on the effectiveness of speech (articulatory and phonological) treatment. Thus, use of oral-motor treatment techniques may take time away from treatment approaches that are known to be effective, such as teaching the correct way to position the tongue to produce a correct speech sound. Some researchers suggest that speech and language treatment should be task specific. That means that treatment techniques should be related to the desired outcomes. If improved speech is the goal, it follows that treatment techniques should be speech-specific. Oral-motor treatment techniques are sometimes applied based on the assumption that oral motor problems contribute to speech problems. However, this may not be an accurate assumption, particularly when no muscle weakness is apparent in the oral mechanism."*
- **Smith (2006)**. *"Infants do not start life with language and motor mappings in place; many years of learning must occur. The speaker must develop a set of maps that include language, motor, and auditory networks."*

References

Abrahamsen, E. & Flack, L. (2002, November). Do sensory and motor techniques improve accurate phoneme production? Paper presented at the annual meeting of the American Speech-Language-Hearing Association, Atlanta, GA.

ASHA (2006). Questions about products or procedures for hearing, balance, speech, language, swallowing, and related disorders. http://www.asha.org/public/speech/ImpQues/questions.htm.

Barlow, S., & Abbs, J. (1983). Force transducers for the evaluation of labial, lingual, and mandibular motor impairments. *Journal of Speech and Hearing Research, 26,* 616-621.

Bernstein Ratner, N. (2006). Evidence-based practice: An examination of its ramifications for the practice of speech-language pathology. *Language, Speech, and Hearing Services in the Schools, 37*, 257-267.

Bernstein Ratner, N. (2005). Evidence-based practice in stuttering: Some questions to consider. *Journal of Fluency Disorders, 30*, 163-188.

Bonilha, L, Moser, D., Rorden, C., Bylis, G., & Fridriksson, J. (2006). Speech apraxia without oral apraxia: Can normal brain function explain the physiopathology*? Brain Imaging, 17*(10), 1027-1031.

Bowen, C. (2006). What is the evidence for oral motor therapy? *Acquiring Knowledge in Speech, Language, and Hearing, 7*, 144-147. *http://www.speech-language-therapy .com/cb-oct2005OMT-ACQ.pdf.*

Bunton, K., **& Weismer, G**. (1994). Evaluation of a reiterant force-impulse task in the tongue. *Journal of Speech and Hearing Research, 37*, 1020-1031.

Bush, C., Steger, M., Mann-Kahris, S., & Insalaco, D. (2004, November). Equivocal results of oral motor treatment on a child's articulation. Poster presented at the annual meeting of the American Speech-Language-Hearing Association, Philadelphia, PA.

Caruso, A., & Strand, E. (1999). *Clinical management of motor speech disorders in children.* New York: Thieme.

Chi-Fishman, G., & Pfaizer, L. (2003, November). Applying exercise physiology principles in oromotor rehabilitation for dysphagia. Invited presentation at the annual meeting of the American Speech-Language-Hearing Association, Chicago, IL. *http://www.asha.org/NR/rdonlyres/A8789 B8E-D475-43E9-8E12-AE51944D0D52/0/1188Handout.pdf.*

Christensen, M., & Hanson, M. (1981). An investigation of the efficacy of oral myofunctional therapy as a precursor to articulation therapy for pre-first grade children. *Journal of Speech and Hearing Disorders, 46*, 160-167.

Clark, H. (2003). Neuromuscular treatments for speech and swallowing: A tutorial. *American Journal of Speech-Language Pathology, 12*, 400-415.

Clark, H. (2005, June 14). Clinical decision making and oral motor treatments. *The ASHA Leader*, 8-9, 34-35.

Colone, E., & Forrest, K. (2000, November). Comparison of treatment efficacy for persistent speech sound disorders. Poster presented at the annual meeting of the American Speech-Language-Hearing Association, Washington, D.C.

Connaghan, K., Moore, C., & Higashakawa, M. (1995). Influence of body position on breathing and its impli-cations for the evaluation and treatment of speech and voice disorders. *Journal of Voice*, 9, 341-347.

Connaghan, K., Moore, C., & Higashakawa, M. (2004). Respiratory kinematics during vocalization and nonspeech respiration in children from 9 to 48 months. *Journal of Speech, Language, and Hearing Research, 47*, 70-84.

Davis, B., & Velleman, S. (2000). Differential diagnosis and treatment of developmental apraxia of speech in infants and toddlers. *Infant-Toddler Intervention, 10*, 177-192.

Damico, J. (1988). The lack of efficacy in language therapy: A case study. *Language, Speech and Hearing Services in Schools, 19*, 51-66.

Dollaghan, C. (2004, April 13). Evidence-based practice: Myths and realities. *The ASHA Leader, 12*, 4-5.

Duffy, J. (2005). *Motor speech disorders: Substrates, differential diagnosis, and management* (2nd ed.). St. Louis: Mosby.

Elliot, N., & Gramming, P. (1995). What happens during vocal warm-up? *Journal of Voice, 9*, 37-44.

Fields, D., & Polmanteer, K. (2002, November). Effectiveness of oral motor techniques in articulation and phonology treatment. Poster presented at the annual meeting of the American Speech-Language-Hearing Association, Atlanta, GA.

Finn, P., Bothe, A., & Bramlett, R. (2005). Science and pseudoscience in communication disorders: Criteria and application. *American Journal of Speech-Language Pathology, 14*, 172-183.

Forrest, K. (2002). Are oral-motor exercises useful in the treatment of phonological/articulatory disorders? *Seminars in Speech and Language, 23*, 15-25.

Gerratt, B, Till, J., **Rosenbeck, J, Wertz, R., & Boysen, A.** (1991). Use and perceived value of perceptual and instrumental measure in dysarthria management. In C. Moore, K. Yorkston, & D. Beukelman (Eds.), *Dysarthria and apraxia of speech: Perspectives on management* (pp. 77-93). Baltimore, MD: Paul Brooks.

Gierut, J. (1998). Treatment efficacy: Functional phonological disorders in children. *Journal of Speech, Language, and Hearing Research, 41*, S85-100.

Gommerman, S., & Hodge, M. (1995). Effects of oral myofunctional therapy on swallowing and sibilant production. *International Journal of Orofacial Myology, 21*, 9-22.

Green, J., Moore, C., Higashikawa, M., & Steeve, R. (2000). The physiologic development of speech motor control: Lip and jaw coordination. *Journal of Speech, Language, and Hearing Research, 43*, 239-255.

Green, J., **& Wang, Y**. (2003). Tongue-surface movement patterns in speech and swallowing. *The Journal of the Acoustical Society of America, 113,* 2820-2833.

Guisti Braislin, M., & Cascella, P. (2005). A preliminary investigation of the efficacy of oral motor exercises for children with mild articulation disorders. *International Journal of Rehabilitation Research, 28,* 263-266.

Hall, P., Jordan, L., & Robin, D. (2007). *Developmental apraxia of speech: Theory and clinical practice.* Austin, TX: Pro-Ed.

Hayden, D. (2006). The PROMPT model: Use and application for children with mixed phonological-motor impairment. *Advances in Speech-Language Pathology, 8,* 265-281.

Hayes, S., Savinellil, S., Roberts, E., & Calidito, G. (In submission). Comparison of an oral motor treatment and traditional articulation treatment in children. *Language, Speech and Hearing Services in Schools.*

Hodge, M. (2002). Nonspeech oral motor treatment approaches for dysarthria: Perspectives on a controversial clinical practice. *Perspectives on Neurophysiology and Neurogenetic Speech and Language Disorders, 12*(4), 22-28.

Hodge, M., Salonka, R., & Kollias, S. (2005, November). Use of nonspeech oral-motor exercises in children's speech therapy. Poster presented at the annual meeting of the American Speech-Language-Hearing Association, San Diego, CA.

Hodge, M., & Wellman, L. (1999). Management of children with dysarthria. In A. Caruso & E. Strand (Eds.), *Clinical management of motor speech disorders in children.* New York: Thieme.

Hodson, B. (2007) *Evaluating and enhancing children's phonological systems*. Greenville, SC: Thinking Publications University.

Hodson, B. (1997). Disordered phonologies: What have we learned about assessment and treatment? *Perspectives in applied phonology*. Gaithersburg, MD: Aspen Publications.

Ingram, D., & Ingram, K. (2001). A whole word approach to phonological intervention. *Language, Speech & Hearing Services in the Schools, 32,* 271-283.

Jacobson, J., Foxx, R., & Mulick, J. (Eds.). (2005). *Controversial therapies for developmental disabilities: Fad, fashion and science in professional practice.* Mahwah, NJ: Lawrence Erlbaum.

Kamhi, A. (2006). Treatment decisions for children with speech-sound disorders. *Language, Speech, and Hearing Services in the Schools, 37,* 271-279.

Kamhi, A., & Catts, H. (2005). Language and reading: Convergences and divergences. In H. Catts & A. Kamhi (Eds.). *Language and reading disabilities* (2nd ed.), Boston: Allyn & Bacon.

Kent, R. (2000). Research on speech motor control and its disorders: A review and prospective. *Journal of Communication Disorders, 33,* 391-428.

Klein, H., Lederer, S., & Cortese, E. (1991). Children's knowledge of auditory/articulator correspondences: Phonologic and metaphonologic. *Journal of Speech and Hearing Research, 34,* 559-564.

Koegel, L., Koegel, R., & Ingham, J. (1986). Programming rapid generalization of correct articulation through self-monitoring procedures. *Journal of Speech and Hearing Disorders, 51,* 24-32.

Koenig, M., & Gunter, C. (2005). Fads in speech-language pathology. In J. Jacobson, R. Foxx, & J. Mulich (Eds.), *Controversial therapies for developmental disabilities: Fad, fashion, and science in professional practice.* Mahwah, NJ: Lawrence Erlbaum.

Kuehn, D., **& Moon, J.** (1994). Levator palatini muscle activity in relation to intraoral air pressure variation. *Journal of Speech and Hearing Research, 27,* 1260-1270.

Lass, N., & Pannbacker, M. (2007). The application of evidence-based practice to oral motor treatment**.** *Language, Speech, and Hearing Services in Schools* (October) .

Lof, G. L. (2002). Two comments on this assessment series. *American Journal of Speech-Language Pathology, 11,* 255-257.

Lof, G. L. (2003). Oral motor exercises and treatment outcomes. *Perspectives on Language, Learning and Education, 10*(1), 7-12.

Lof, G. L. (2004). What does the research report about non-speech oral motor exercises and the treatment of speech sound disorders?*http://www.apraxia-kids.org/site/c.chKMI0PIIsE/b.980831/apps /s/content.asp?ct=46446.*

Lof, G. L. (2006, November). Logic, theory and evidence against the use of non-speech oral motor exercises to change speech sound productions. Poster presented at the annual meeting of the American Speech-Language-Hearing Association, Miami Beach, FL.

Lof, G. L., & Watson, M. (2007). A nationwide survey of non-speech oral motor exercise use: Implications for evidence-based practice. *Language, Speech and Hearing Services in Schools* (October).

Lof, G. L., & Watson, M. (2005, November). Survey of universities' teaching: Oral motor exercises and other procedures. Poster presented at the annual meeting of the American Speech-Language-Hearing Association, San Diego, CA.

Lof, G. L., & Watson, M. (2004, November). Speech-language pathologist's use of nonspeech oral-motor drills: National survey results. Poster presented at the annual meeting of the American Speech-Language-Hearing Association, Philadelphia, PA.

Love, R. (2000). *Childhood motor speech disability* (2nd ed.). Boston: Allyn & Bacon.

Martin, R. (1991). A comparison of lingual movement in swallowing and speech production. Ph.D. dissertation, University of Wisconsin–Madison.

Meline, T., & Paradiso, T. (2003). Evidence-based practice in schools: Evaluating research and reducing barriers. *Language, Speech, and Hearing Services in Schools, 34,* 273-283.

Milbarth, R., & Solomon, N. (2003). Do vocal warm-up exercises alleviate vocal fatigue? *Journal of Speech, Language, Hearing Research, 46,* 422-436.

Moore, C., Caulfield, T., & Green, J. (2001). Relative kinematics of the rib cage and abdomen during speech and nonspeech behaviors of 15-month-old children. *Journal of Speech, Language and Hearing Research, 44,* 80-94.

Moore, C., & Ruark, J. (1996). Does speech emerge from earlier appearing motor behaviors? *Journal of Speech and Hearing Research, 39,* 1034-1047.

Moore, C., Smith, A., & Ringel, R. (1988). Task-specific organization of activity in human jaw muscles. *Journal of Speech and Hearing Research, 31,* 670-680.

National Joint Committee for the Communication Needs of Persons with Severe Disabilities (2006). Frequently asked questions. *http://www.asha.org/NJC/faqs-disabilities.htm.*

Occhino, C., & McCane, J. (2001, November). Do oral motor exercises affect articulation? Poster presented at the annual meeting of the American Speech-Language-Hearing Association, New Orleans, LA.

Pascual-Leone, A., Dang, N., Cohen, L., Brasil-Neto, J, Cammarota, A., & Hallett, M. (1995). Modulation of muscle responses evoked by transcranial magnetic stimulation during the acquisition of new fine motor skills. *Journal of Neurophysiology, 74,* 1037-1045.

Peter-Falzone, S., Trost-Cardamone, J., Karnell, M., & Hardin-Jones, M. (2006). *The clinician's guide to treating cleft palate speech.* St. Louis, MO: Mosby.

Pollock, M., Gaesser, G., Butcher, J., Despres, J-P, Dishman, R., Franklin, B., & Ewing Garber, C. (1998). The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Medicine & Science in Sports & Exercise, 30,* 975-991.

Robbins, J., Gangnon, R., Theis, S., Kays, S., Wewitt, A., & Hind, J. (2005). The effects of lingual exercise on swallowing in older adults. *Journal of the American Geriatrics Society, 53,* 1483-1489.

Roehrig, S., Suiter, D., & Pierce, T. (2004, November). An examination of the effectiveness of passive oral-motor exercises. Poster presented at the annual meeting of the American Speech-Language-Hearing Association, Philadelphia, PA.

Ruscello, D. (2007). Oral motor treatment issues related to children with developmental speech sound disorders. *Language, Speech and Hearing Services in Schools(October).*

Sackett D., Rosenberg, W., Gray, J., Haynes, R., & Richardson, W. (1996). Evidence based medicine: What it is and what it isn't. *British Medical Journal, 312,* 71-72.

Safran, M., Seaber, A., & Garrett, W. (1989). Warm-up and muscular injury prevention. *Sports Medicine, 8,* 239–249.

Schmidt, R., & Lee, T. (1999). Conditions of practice. In R. Schmidt & T. Lee (Eds.), *Motor control and learning: A behavioral emphasis* (3rd ed.). Champaign, IL: Human Kinetics Publishers Inc.

Smith, A. (2006). Speech motor development: Integrating muscles, movements, and linguistic units. *Journal of Communication Disorders, 39,* 331-349.

Smith, T. (2005). The appeal of unvalidated treatments. In J. Jacobson, R. Foxx, & J. Mulich (Eds.), *Controversial therapies for developmental disabilities: Fad, fashion, and science in professional practice.* Mahwah, NJ: Lawrence Erlbaum.

Stathopoulous, E., & Duchan, J.F. (2006). History and principles of exercise-based therapy: How they inform our current treatment. *Seminars in Speech and Languages, 27,* 227-235.

Sudbery, A., Wilson, E, Broaddus, T., & Potter, N. (2006, November). Tongue strength in preschool children: Measures, implications, and revelations. Poster presented at the annual meeting of the American Speech-Language-Hearing Association, Miami Beach, FL.

Tayler, A. (2005). Planning and monitoring intervention programs. In A. Kamhi & K. Pollock (Eds.), *Phonological disorders in children: Clinical decision making in assessment and intervention.* Baltimore: Paul Brooks.

Velleman, S. (2003). *Childhood apraxia of speech: Resource guide.* Clifton Park, NY: Thomson.

Velleman, S., & Vihman, M. (2002). Whole-word phonology and templates: Trap, bootstrap, or some of each? *Language, Speech & Hearing Services in Schools,* 33**,** 9-23.

Weijnen, F., Kuks, J., van der Bilt, A., van der Glas, H., Wassenberg, M., & Bosman, F. (2000). Tongue force in patients with myasthenia gravis. *Acta Neurologica Scandinavica, 102,* 303-308.

Weismer, G. (1996). Assessment of non-speech gestures in speech-language pathology: A critical review. *Telerounds 35* (videotape). National Center for Neurologic Communication Disorders, University of Arizona,.

Weismer, G. (2006). Philosophy of research in motor speech disorders. *Clinical Linguistics & Phonetics, 20,* 315-349.

Ziegler, W. (2003). Speech motor control is task-specific: Evidence from dysarthria and apraxia of speech. *Aphasiology, 17,* 3-36.

PLACE/MANNER OF ARTICULATION—PHONETIC INVENTORY FORMS

Word-Initial Position

Manner of Articulation	Place of Articulation							
	Bilabial	Labiodental	Interdental	Alveolar	Postalveolar	Palatal	Velar	Glottal
Oral Stop	p b			t d			k g	
Fricative		f v	θ ð	s z		ʃ		
Affricate					tʃ dʒ			
Nasal Stop	m			n				
Liquid								
Central				r				
Lateral				l				
Glide	w					j		h

Word-Final Position

Manner of Articulation	Place of Articulation							
	Bilabial	Labiodental	Interdental	Alveolar	Postalveolar	Palatal	Velar	Glottal
Oral Stop	p b			t d			k g	
Fricative		f v	θ ð	s z		ʃ ʒ		
Affricate					tʃ dʒ			
Nasal Stop	m			n			ŋ	
Liquid								
Central				r				
Lateral				l				

Phonetic and Phonemic Inventory Form

m		n				ŋ	
p	b	t	d	tʃ	ʤ	k	g
f	v	θ	ð	ʃ			
		s	z				
w		r		j		h	
		l					

Prevocalic Clusters	Intervocalic Clusters	Postvocalic Clusters

Some Factors to Consider When Selecting Treatment Targets

Powell, T.W. (1991). Planning for phonological generalization: An approach to treatment target selection. *American Journal of Speech-Language Pathology, 1,* 21-27.

- **Age of child**
- **Age-appropriateness of error(s)**
- **Ease of production**
- **Effect on intelligibility**
- **Error consistency**
- **Frequency of sound occurrence**
- **Homonymy**
- **Markedness**
- **Morphological status**
- **Normative order**
- **Number of errors**
- **Perceptual saliency**
- **Phonetic inventor**
- **Phonetic error type**
- **Phonological error type**
- **Phonotactic constraints**
- **Phonological knowledge**
- **Relevance to child**
- **Severity of disorder**
- **Stimulability**
- **Resources available to clinician**

Consonant Cluster Pattern Analysis

Client's Name: _____

Date: _____

Clinician's Name: _____

Segments:	p	b	t	d	k	g	f	v	Θ	ð	s	ʃ	m	n	ŋ	l	r	w	pr	tr	kr	pl	kw
Singleton C:																							
Word Initial																							
C + /w/			1		2						3												
C + /j/	4	5			6		7	8					9										
C + /l/	10	11			12	13	14				15												
C + /r/	16	17	18	19	20	21	22		23			24											
/s/+ C	25		26		27								28	29		15		3	30	31	32	33	34
Word Final																							
/s/ + C	35		36		37																		
C + /s,z/	38	39	40	41	42	43		44		45			46	47	48	49	50						
/l/ + C			51	52	53		54																
/r/+ C	55		56	57	58								59	60									
[+ nasal] + C	61		62	63	64																		

Words for Assessing Consonant Cluster Production

1.	twin	tw		33.	splash	spl	
2.	queen	kw		34.	squirrel	skw	
3.	sweep	sw		35.	wasp	sp	
4.	pew	pj		36.	west	st	
5.	beauty	bj		37.	ask	sk	
6.	cue	kj		38.	caps	ps	
7.	few	fj		39.	cabs	bz	
8.	view	vj		40.	cats	ts	
9.	music	mj		41.	kids	dz	
10.	play	pl		42.	box	ks	
11.	blue	bl		43.	dogs	gz	
12.	clay	kl		44.	caves	vz	
13.	glue	gl		45.	bathes	ðz	
14.	fly	fl		46.	combs	mz	
15.	sleep	sl		47.	cans	nz	
16.	pray	pr		48.	kings	ŋz	
17.	bread	br		49.	calls	lz	
18.	tree	tr		50.	cars	rz	
19.	drum	dr		51.	belt	lt	
20.	cry	kr		52.	cold	ld	
21.	grow	gr		53.	milk	lk	
22.	fry	fr		54.	wolf	lf	
23.	three	Θr		55.	sharp	rp	
24.	shrub	ʃr		56.	cart	rt	
25.	spy	sp		57.	card	rd	
26.	stay	st		58.	work	rk	
27.	sky	sk		59.	warm	rm	
28.	smell	sm		60.	barn	rn	
29.	snw	sn		61.	camp	mp	
30.	spray	spr		62.	tent	nt	
31.	stray	str		63.	hand	nd	
32.	screw	skr		64.	ink	ŋk	

TRADITIONAL ARTICULATION AND PHONOLOGICAL THERAPY

Three Principles Of Phonologically Based Therapy That Provides A Good Test For Whether A Phonological Paradigm Is Indeed Being Followed

1. **Principle of Rule-Governed Knowledge:** If children are going to learn the phonological rules of their language, they must be presented with circumstances that allow them to discover those rules.
2. **Principle of Communicative Function:** For therapy is to be successful, children must be given opportunities to see the relationship between appropriate phonological output and effective communication.
3. **Principle of Treatment by Sound Class:** Programs that are phonologically based concentrate on remediation of classes of sounds that seem to be treated similarly by children. Thus, all phonologically-based programs target errors at the feature or rule level, not the isolated sound level.

Difference Between Traditional And Phonological Frameworks For Therapy

- The major emphasis is not the sound; instead it is teach the child a rule.
- The rule is always taught in the context of its contrast.
- No value judgment is made regarding correct or incorrect production of particular sounds.
- There should be a de-emphasis on motoric manipulation or placement of the articulators.
- Modeling and the need for direct imitation on the part of the child is avoided if possible.
- No more than one phonological rule is expected to be altered in a given word at one time.
- There is a de-emphasis on auditory discrimination training.

The Premises of Phonological Therapy

- The child has a developmental phonological disorder (i.e., a disorder in learning to pronounce the phonological system); therapy must be aimed at remediating this disorder.
- In learning to pronounce this phonological system, children are developing a system of sound contrasts that function to signal meaning contrasts.
- In learning their phonological, children are organizing their phonological system (i.e., not just learning the correct pronunciation of individual words).
- The cognitive organization of the phonological system is based on similarities and differences between sound sequences into structures.
- The aim of therapy, therefore, is to facilitate cognitive reorganization of the child's phonology and his/her phonological strategies for perceptual, organizational, and production processing.

Principles of Phonological Therapy

- The treatment is based on a phonological assessment, and the aims are defined by the phonological assessment.
- Therapy is based on the principle that there are regularities in the child's pronunciation patterns (i.e., "order in disorder").
- Therapy is based on the principle that the primary function of phonological organization is communicative (i.e., differences in sounds and sequences signal meaning differences).
- Therapy aims to facilitate change in the child's pronunciation patterns in order to build up a more adequate system of sound contrasts and sound structures.
- Therapy is designed to make maximally effective use of the organization of phonological patterning in the target system by introducing and establishing changes in the child's patterns through use of natural classes of contrastive phones and structures.

REFERENCES AND RESOURCES

American Speech-Language-Hearing Association. (2007). *Childhood Apraxia of Speech* [Position Statement]. Available from www.asha.org/policy.

Apraxia Kids Webpage: http://www.apraxia-kids.org/site/c.chKMI0PIIsE/b.980831/apps/s/content.asp?ct=464135.

Anderson, R., & Antonak, R. (1992). The influence of attitudes and contact on reactions to persons with physical and speech disabilities. *Rehabilitation Counseling Bulletin, 35*, 240-247.

Black, B., & Hazen, N. (1990). Social status and patterns of communication in acquainted and unacquainted preschool children. *Developmental Psychology, 26*, 379-387.

Clase, J. (1969). A comparison of responses of speech clinicians and laymen to the effects of conspicuous articulation deviations on certain aspects of communication. Ph.D. Dissertation. State University of New York at Buffalo.

Davis, B., Jakielski K., & Marquardt, T. (1998). Developmental apraxia of speech: Determiners of differential diagnosis. *Clinical Linguistics & Phonetics, 12*, 25-45.

Davis, B. L., & Velleman, S. L. (2000). Differential diagnosis and treatment of developmental apraxia of speech in infants and toddlers. *Infant-Toddler Intervention, 10*, 177-192.

Felsenfeld, S., & Broen, P. (1992). A 28-year follow-up of adults with a history of moderate phonological disorder. *Journal of Speech & Hearing Research, 35*, 1114-1125.

Forrest, K. (2003). Diagnostic Criteria of Developmental Apraxia of Speech Used by Clinical Speech-Language Pathologists. *American Journal of Speech-Language Pathology, 12*, 376-380.

Gertner, B., Rice, M., & Hadley, P. (1994). Influence of communicative competence on peer preferences in a preschool classroom. *Journal of Speech and Hearing Research, 37*, 913-923.

Gierut, J., Morrisett, M., Hughes, M., & Rowland, S. (1996). Phonology treatment efficacy and developmental norms. *Language, Speech and Hearing Services in the Schools, 27*, 215-230.

Goldman, R., & Fristoe, M. (2000). *Goldman-Fristoe Test of Articulation*. Circle Pines, MN: American Guidance Service.

Hall, P.K (2000). Clinical exchange: Letters to the parent(s) of a child with developmental apraxia of speech. *Language, Speech, & Hearing Services in the Schools, 31*, 169-181.

Hazen, N.& Black, G. (1989). Preschool peer communication skills: The role of social status and interaction context. *Child Development, 60*, 867-876.

Kamhi, A. (1999). To use or not to use: Factors that influence the selection of new treatment approaches. *Language, Speech, and Hearing Services in Schools, 30*, 92-98.

Klein, E.S. (1996). *Clinical phonology: Assessment and treatment of articulation disorders in children and adults.* San Diego: Singular.

Lewis, B., Shriberg, L., et al. (2006). The genetic bases of speech sound disorders: Evidence from spoken and written language. *Journal of Speech, Language and Hearing Research, 49*, 1294-1312.

Lof, G.L. (2002). Two comments on this assessment series. *American Journal of Speech-Language Pathology, 11*, 255-256.

Morrison, J. A., & Shriberg, L. D. (1992). Articulation testing versus conversational speech sampling. *Journal of Speech and Hearing Research, 35*, 259–273.

Mowren, D., Wahl, P., & Doolan, S. (1978). The effects of lisping on audience evaluation of male speakers. *Journal of Speech and Hearing Disorders, 42, 148-148.*

Perrin. E. (1954). The social position of the speech defective child. *Journal of Speech and Hearing Disorders, 19*,250-262.

Place, K., & Becker, J. (1991). The influence of pragmatic competence on the likability of grade-school children. *Discourse Processes, 14*, 227-241.

Pollock, K., & Berni., M. (2003). Incidence of non-rhotic vowel errors in children: Data from the Memphis Vowel Project. *Clinical Linguistics & Phonetics, 17*, 393-401.

Powell, T. (1995). A clinical screening procedure for assessing consonant cluster production. *American Journal of Speech-Language Pathology, 4*, 59-65.

Prather, E., Hendrick, D., & Kern, C. (1975). Articulation development in children aged two to four years. *Journal of Speech and Hearing Disorders, 40, 179*-191.

Rice, M. (1993). Don't talk to him; he's weird: A social consequence account of language and social interactions. In Kaiser, A. & Gray, D. (eds.), *Enhancing children's communication: Research foundations for intervention.* Baltimore: Brooks.

Rice, M., Hadley, P., & Alexander, A. (1993). Social biases toward children with specific language impairment: A correlative causal model of language limitations. *Applied Psycholinguistics, 14,* 443-472.

Rice, M., Sell, M., & Hadley, P. (1991). Social interactions of speech-and language-impaired children. *Journal of Speech and Hearing Research, 34,* 1299-1308.

Rvachew, S., & Nowak, M. (2001). The effect of target-selection strategy on phonological learning. *Journal of Speech, Language and Hearing Research, 44*, 610-623.

Sander, E. (1972). Do we know when speech sounds are learned? *Journal of Speech and Hearing Disorders, 37,* 55-63.

Shriberg, L. (1993). Four new speech and prosody-voice measures for genetics research and other studies in developmental phonological disorders. Journal of Speech and Hearing Research, 36, 105-140.

Shriberg, L., Aram, D., & Kwaitkowski, J. (1997). Developmental apraxia of speech. *Journal of Speech, Language and Hearing Research, 40,* 286-312.

Shriberg, L., Green, J.; Campbell, T., Mcsweeny, J., & Scheer, A. (2002). A diagnostic marker for childhood apraxia of speech: the coefficient of variation ratio. *Clinical Linguistics & Phonetics, 17,* 575-595.

Shriberg, L.D., & Kwiatkowski, J. (1982). Phonological disorders II: Conceptual framework for management. *Journal of Speech and Hearing Disorders, 47*, 242-256.

Shriberg, L. D., Lewis, B.A., Tomblin, J. B., McSweeny, J. L., Karlsson, H. B., & Scheer, A. R. (2005). Toward diagnostic and phenotype markers for genetically transmitted speech delay. *Journal of Speech, Language, and Hearing Research, 48,* 834-852.

Silverman, F., & Paulus, P. (1989). Peer reactions to teenagers who substitute /w/ for /r/. *Language, Speech, and Hearing Services in the Schools, 20*, 219-221.

Skahan, S., Watson, M., & Lof, G. L. (2007). Speech-Language Pathologists' Assessment Practices for Children With Suspected Speech Sound Disorders: Results of a National Survey. *American Journal of Speech-Language Pathology, 16,* 246-259.

Smit, A., Hand, L. Freilinger, J., Bernthal, J. & Bird, A. (1990). The Iowa articulation norms project and its Nebraska replication. *Journal of Speech and Hearing Disorders, 55, 779-798.*

Templin, M. (1957). *Certain Language Skills in Children.* Minneapolis: University of Minnesota Press.

Velleman, S., & Strand, K. (1994). Developmental verbal dyspraxia. In J.E Benthal & N.W. Bankson (Eds.), *Child phonology: Characteristics, assessment, and intervention with special populations* (pp. 110-139). New York: Thieme.

Walton, J., & Pollock, K. (1993). Acoustic validation of vowel error patterns in developmental apraxia of speech. *Clinical Linguistics & Phonetics, 7,* 95-111.

Whitmire, K., Karr, S., & Mullen, R. (2000). Action: School services. *Language, Speech, & Hearing Services in Schools, 31,* 402-406.

Reference List of Helpful Books Related to Speech-Sound Disorders

Bliele, K. (2007). *The late eight.* Plural Publishing.

Bliele, K. (2004). *Manual of articulation and phonological disorders: Infancy through adulthood (2nd ed.).* Thomson Delmar Learning.

Jacobson, J., Foxx., R., & Mulick, J. (2005). *Controversial therapies for developmental disabilities: Fad, fashion and science in professional practice.* Lawrence Erlbaum.

Golding-Kushner, K. (2001). *Therapy techniques for cleft palate speech and related disorders.* Thomson Delmar Learning.

Hall, P., Jordan, L., & Robin, D. (2007). *Developmental apraxia of speech: Theory and clinical practice (2nd ed.).* Pro-Ed.

Hodson, B.W. (2007). *Evaluating and enhancing Children's phonological systems: Research and theory to practice.* Thinking Publications.

Kamhi, A. G., & Pollock, K. E. (2005). *Phonological disorders in children: Clinical decision making in assessment and intervention.* Brooks.

McLeod, S. (2007). *The international guide to speech acquisition.* Thomson Delmar Learning.

Peterson-Falzone, S., Trost-Cardamone, J., Karnell, M., & Hardin-Jones, M. (2006). *The clinician's guide to treating cleft palate speech.* Mosby Elsevier.

Sagan, C., & Druyan, A. (1997). *The demon-haunted world: Science as a candle in the dark.* Ballantine Books.

Secord, W., Boyce, S., Donohue, J., Fox, R., & Shine, R. (2007). *Eliciting sounds: Techniques and strategies for clinicians.* Thomson Delmar Learning.

Smit, A.B. (2004). *Articulation and phonology resource guide for school-age children and adults.* Thomson Delmar Learning.

Velleman, S. (2003). *Childhood apraxia of speech resource guide.* Thomson Delmar Learning.

Williams, A. L. (2003). *Speech disorders resource guide for preschool children.* Thomson Delmar Learning.