Childhood Dyspraxia of Speech: Theory, Definitions, and Differential Diagnosis

Presented by
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Theory and Treatment Methods
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What is Childhood Verbal Dyspraxia

Definition*:* *Childhood verbal dyspraxia (CVD) is a speech disorder, due to delays or deviances in those processes involved in planning and programming movement sequences for speech. Children with CVD will have difficulty reaching and maintaining specific articulatory configurations, as well as difficulty moving from one articulatory configuration to the next. Unless they have a coexisting dysarthria, they will not have difficulty moving muscles with the correct range, speed and force for non-speech activity, including chewing or swallowing. Respiration and phonation will be unimpaired as the primary difficulty is planning movement to reach articulatory configurations. While great many of these children also have linguistic (phonologic, semantic, syntactic) deficits, the term "dyspraxia" relates to their movement difficulties.*

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Outline of Today's Presentation

Many of you have probably seen this definition, or other similar descriptions of CVD. It is sometimes hard to understand descriptions such as these until we put it into the context of a broader description of speech and language processing. In this presentation, we will discuss:

1. The terms Language and Speech and how they are different
2. Discuss the basic neural (brain) mechanisms involved in language and speech, as well as the basic anatomy of the speech production system
3. Discuss a basic model of how speech is produced – how does CVD fit in?
4. Definitions and Discrimination of CVD
   a) What is it?
   b) Why does it happen?
   c) What do we call it?
   d) How do we recognize it?
   e) Does it change?

As children go through the process of acquiring speech and language, they use a number of different neural (brain) processes: These involve:

- Cognition (thinking)
- Linguistic processing (language)
- Motor processing (speech)

Note: CVD is a speech (vs. language disorder). This will be more clear as we go along.

First – let's differentiate language and speech, including definitions of a number of terms:

Language – This term refers to processing that involves symbolization. It is the use of symbols to convey communicative intent. For example, using a meaningful gesture, using sign language, writing a message, or talking, are all examples of using language.

A. **Receptive language** – understanding language **(Comprehension)**
- Auditory comprehension – understanding words and sentences we hear
- Reading – understanding written language

B. **Expressive Language** – conveying a message **(Expression)**
- Gesture or sign language
- Writing
- Talking

What mechanisms are involved in using language?

Many people divide language into three areas:

Content – meaning (often the word ***semantics*** is used for this)

Form – grammar and/or syntax

Morphology - rules govern the formation of words (like past or future tense).

Syntax - rule system for sequencing words into sentences

Use – social rules for language (taking turns; staying on topic)

Another important term for us to understand in language is Phonology

Phonology – rule governed system of sounds of a language
Sounds are made up of distinctive features such as place, manner and voicing
There are rules for how sounds in a particular language can be combined (e.g. in English we can't put a /p/ and a /b/ together as in "pbam").

Notes:

Speech – Speech is the verbal form of language -- or "Talk". This term refers to the actual movements a child makes to create meaningful sound.
(We'll be discussing how speech happens a little later in this talk)

Physiologic Processes involved in speech are:

- *Respiration
- *Phonation
- *Resonance
- *Articulation

Notes:

How Language might be Impaired:

Semantic problems - has to do with *content,* or meaning

- A slow acquisition of words and word meanings - early sign of language disorder
- Child's vocabulary does not grow at the normal rate
- Words that are learned may not be readily used
- The child may have difficulty remembering words
- Semantic problems are also evident in the kinds of words a child learns
  - -child tends to learn simpler and more frequently learned words
  - -concrete words more readily learned than abstract ones.
  - - vocabulary may be limited; abstract words may be missing
- Child with semantic problems will/may also have difficulty understanding the meaning of spoken words. (Perhaps because they have difficulty in learning the concepts that underlie word meanings.)

Morphologic Problems - refers to the ways words are formed and modified to change the meaning. ***Problem with form and with content***

- May make errors with grammatical morphemes such as plural and possessives
- May make errors by omitting articles (the and a); or on regular or past tense, etc.

Syntactic Problems – Difficulty in sentence construction**.** ***Form***

- Children will use short or incomplete sentences
- Word order may be incorrect
- Only simple, active sentences may be use. Complex may be delayed or not used at all.
- Child may not be able to understand longer or more complex sentences

Pragmatic Problems - Difficulty with Language ***Use***

- Child may have acquired language structures, but is not appropriately using them in context.
- Limited language may not be used at all or may be used inappropriately
- More likely to respond than initiate
- Difficulty maintaining a topic; may interrupt with irrelevant utterances
- May not take turns appropriately;
- May not understand or notice if the listener has not heard or understood

Phonologic Problems (Articulation) – Difficulty acquiring the rule governed system of sounds

- Child may not be able to produce all the sounds in their language
- They may substitute consonants or vowels
- They may omit sounds
- They may have error patterns such as "fronting" all sounds (e.g. /t/ instead of /k/, or omitting all final sounds

How <u>Speech</u> May be Impaired

Apraxia of Speech – Difficulty with planning and programming movement

Most definitions of developmental verbal apraxia focus on the inability or difficulty with the ability to carry out purposeful voluntary movements for speech - in the absence of a paralysis of the speech musculature. Most also point out the articulatory aspects and the inability to sequence speech **<u>movements</u>**.

Dysarthria:

This is a collective term for a group of related motor speech disorders resulting from disturbed muscular control of the speech mechanism. Dysarthria is manifest as disrupted or distorted oral communication due to paralysis, weakness, abnormal tone or incoordination of the muscles used in speech.

1. Processes of phonation, respiration, resonance, articulation and prosody are affected.
2. Movements may be impaired in force, timing, endurance, direction and range of motion.
3. In some types of dysarthria involuntary movements (dyskinesias) occur, disrupting articulatory output.
4. Sites of lesion include bilateral cortical damage; cranial nerves involvement; spinal nerve involvement (respiration); basal ganglia and cerebellum.

Dysarthria speech characteristics may include:

1. slurred speech
2. imprecise articulatory contacts
3. weak respiratory support and low volume
4. incoordination of the respiratory stream
5. hypernasality
6. involuntary dyskinesias of the oral facial muscles
7. spasticity or flaccidity of the oral facial muscles

Note: Children with Dyspraxia of Speech have phonologic or articulation problems. To make a differential diagnosis, the clinician must decide if the sound errors are:

(1) linguistic in nature (difficulty learning the rule governed system of sounds in their language) – and/or

(2) if the articulation problem is due to motor planning problems (dyspraxia), and/or,

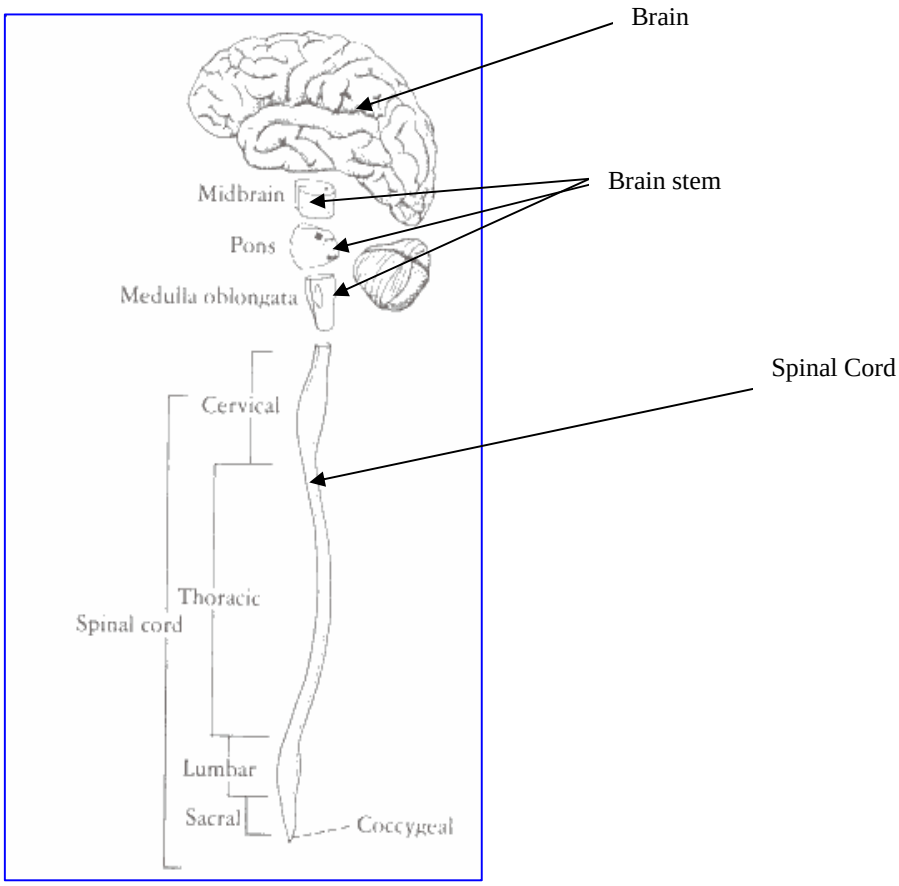
(3) if the articulation problem is due to a problem with the muscles themselves, such as weakness, paralysis, etc. (dysarthria)

If the errors are due at least in part to problems with motor planning, then we say the child has verbal dyspraxia (or apraxia of speech). The phonologic,dyspraxic or dysarthric contribution may be mild, moderate or severe. Our challenge is to determine the relative contribution of each.

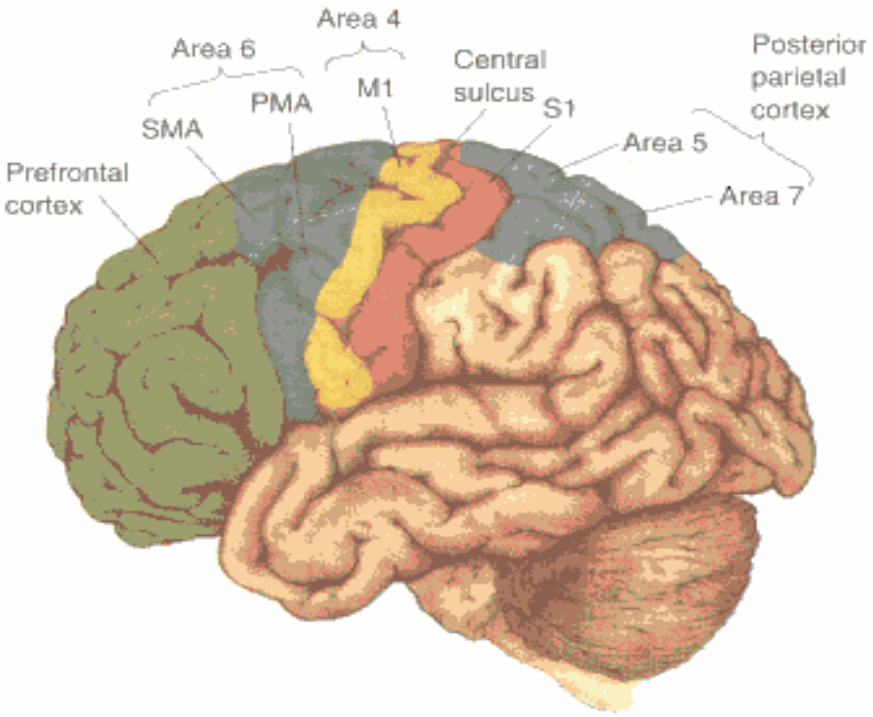
Basic Anatomy and Neurology of the Speech Production System

How does the Nervous System (Brain) make all this happen?

A basic schematic drawing of the central nervous system – which is the brain and the spinal cord.



A brief overview of the brain – what do the different parts of the brain do?



Lobes

Frontal – Affect; judgment (prefrontal)
Speech motor planning
Motor Strip -

Parietal – Receiving and integrating (perception of) sensory information

Temporal – Receives auditory information
Understanding speech/language

Occipital - Vision

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Notes:

Speech Motor Control is dependent on a great deal on ongoing <u>sensory information</u>:

Tactile -

Proprioceptive -

This information tells the brain what is moving, in what direction, how far and how fast, with how much force, and with how much muscle contraction.

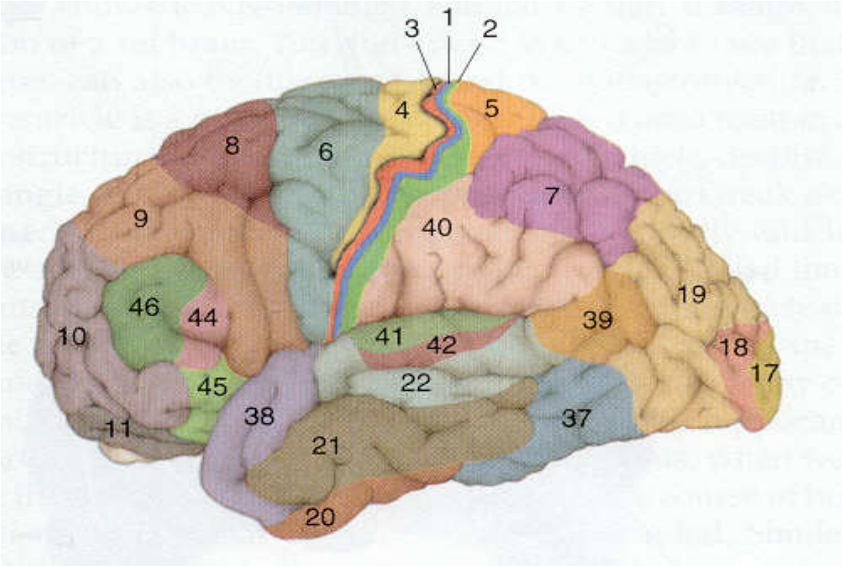
This information goes to and is integrated by:

Cerebellum

Subcortical areas (e.g. basal ganglia)

Thalamus

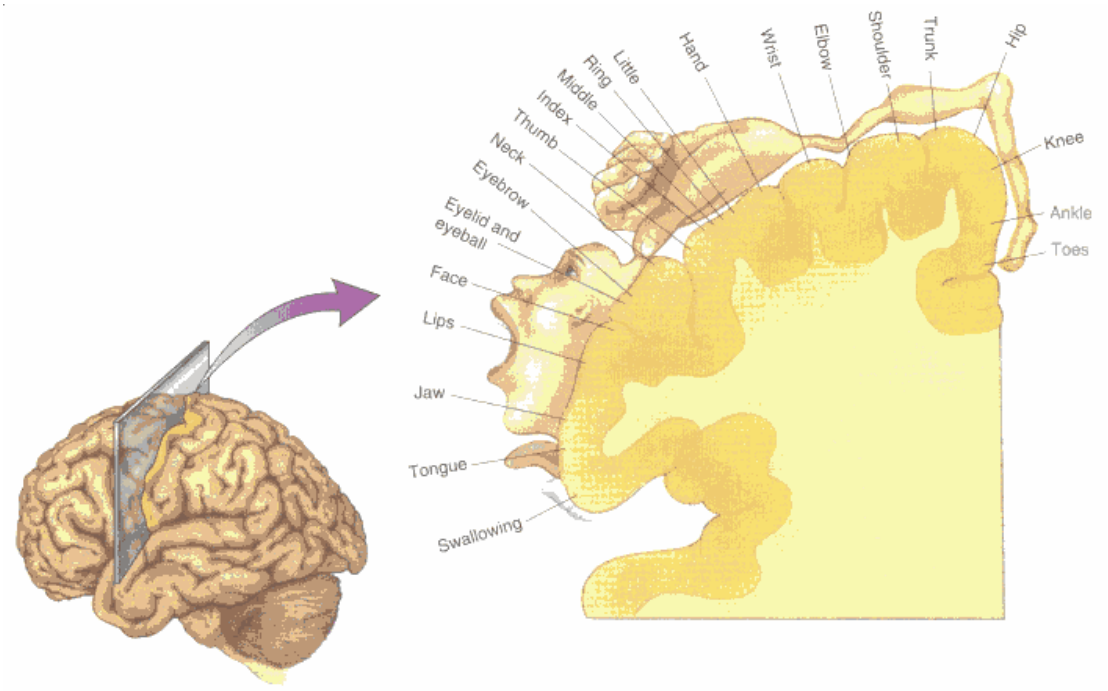
After the information is processed (integrated) – it goes to different areas of cortex, including motor planning areas.



Motor planning areas then formulate the plan and program the movement parameters:

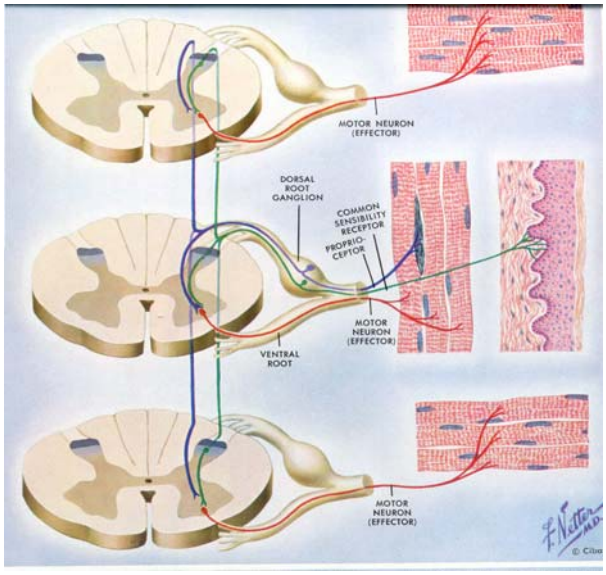
- Range of motion
- Speed of the movement
- Force
- Direction
- Degree of muscle contraction

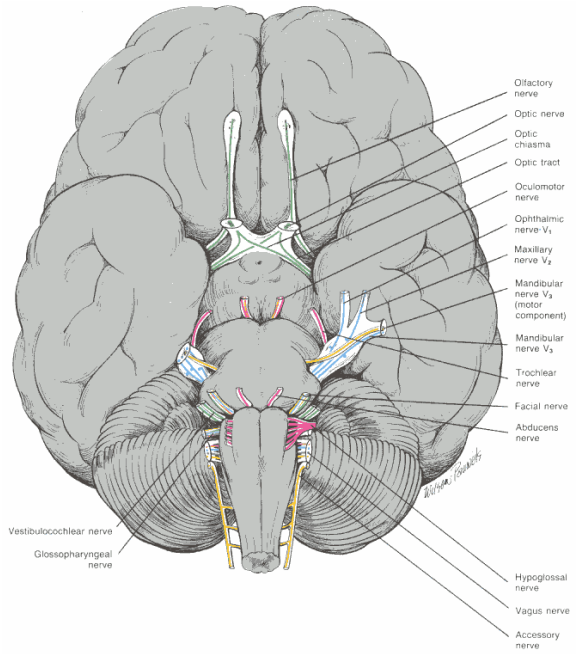
That information must then go to motor strip which is the part of the brain that sends the messages down to the brain stem – and then out to the muscles.



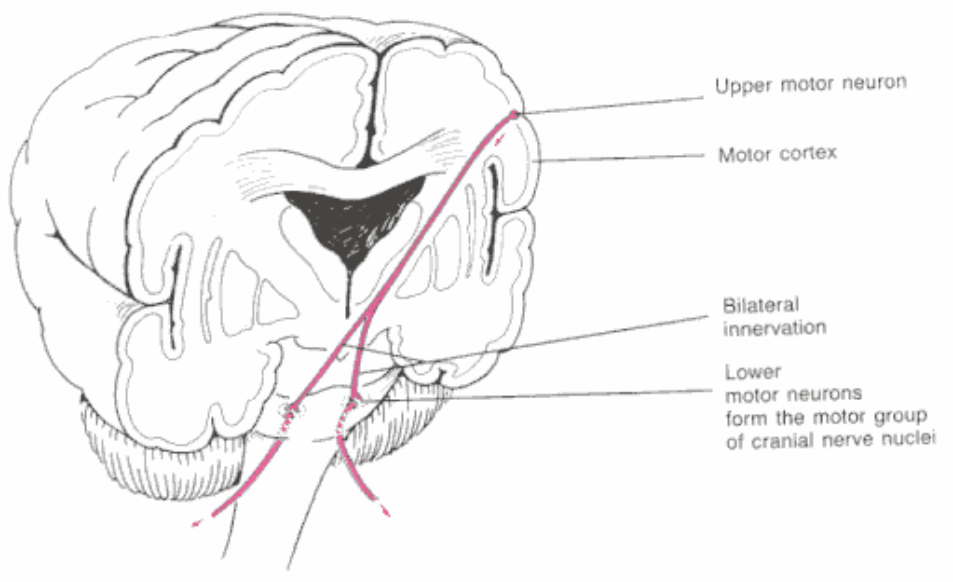
The areas for the face (lips, jaw, tongue), larynx and respiratory system then send messages down axons (nerve fibers) to the brain stem, where nuclei (groups of neurons) exist. Those neurons then integrate the message again, and send the specific message out to the muscles to contract.

An example of spinal nerves – how the fibers go out to innervate muscle.



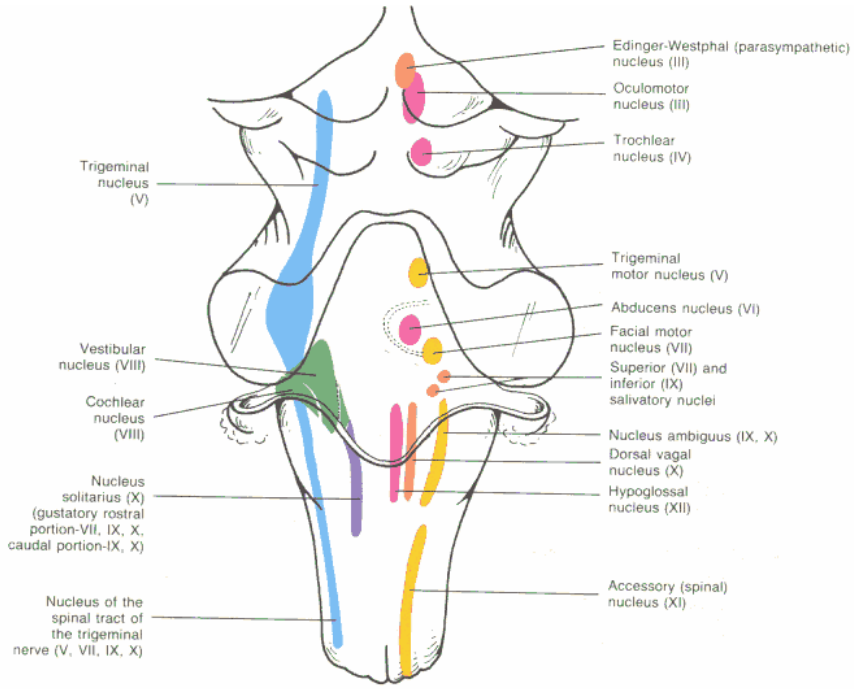


These are the 12 cranial nerves, which take the message for movement out to the muscles of speech.

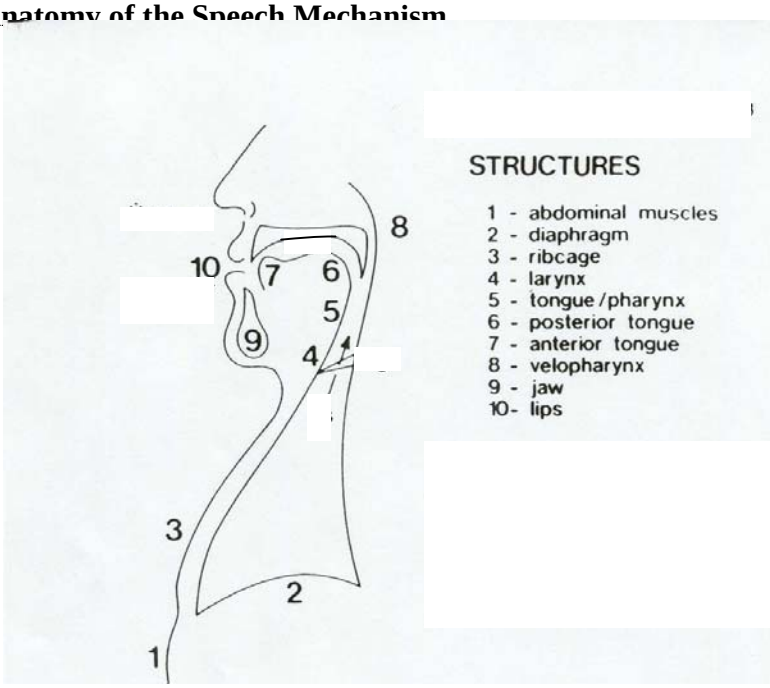


Schematic view of how the message comes from the brain to the brainstem.

Below, is a view of the different nuclei in the brainstem. They each send out fibers to the muscles themselves, telling them to contract.



Basic Anatomy of the Speech Mechanism



(After Netsell, 1986)

How speech happens:

- There is a tube open at one end, closed at the other
- The lungs become full of air, then the diaphragm pushes the air up to the level of the vocal folds.
- Pressure is built up under the closed vocal folds (subglottal air pressure) which sets them into periodic vibration, creating a noise source
- The vibrating air then bounces off the walls of the throat, the nasal cavity (nose) and the oral cavity (mouth). This is called resonance.
- The air is then constricted, or closed off intermittently, by the lips, jaw and tongue to create specific speech sounds.
- These sounds are produced in a particular order to make words that are meaningful to a listener.

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Notes:

Now let's consider a very basic model of Speech Production

Speech Processing

Ideation	Communicative Intent	(Cognitive)
Language		
	word retrieval phonological mapping syntactic/grammatical ordering	(Linguistic)
Motor Planning & Motor Programming	***Specify Movement Parameters*** ***range of motion*** ***strength*** ***speed*** ***direction*** ***degree of muscle contraction***	***(Motor - Praxis)***
Acoustic Output	Execution of Movement	(Motor - Execution)

How Speech Might be Impaired:

Phonologic Impairment – learning the rule governed system of sounds

Planning the movement - CVD

Difficulty with sensory and proprioceptive processing

The brain has to know exactly where each structure is, whether it is still or moving, how it is moving, whether the muscles are tight or loose, etc.)

Then the motor planning areas take that information, integrate it and specify the movement parameters for the speech movements.

Executing the movement - Dysarthria

The motor strip sends messages down to the brain stem, which then sends messages out to the muscles to tell them to contract. If there is a problem here, then the child may have weakness, or reduced range of motion. That is called dysarthria. (Dysarthria often affects respiration and/or voice where dyspraxia does not.)

Childhood Dyspraxia of Speech

What is it??

Most definitions of developmental verbal dyspraxia focus on the inability or difficulty with the ability to carry out purposeful voluntary movements for speech - in the absence of a paralysis of the speech musculature. Most also point out the articulatory aspects and the inability to sequence speech **movements**.

Others view childhood dyspraxia from a broader perspective, and include linguistic processing as part of the definition and description. This results in the variety of symptoms often mentioned in the literature.

Why all the confusion and controversy?

- Controversy exists because of the interaction of motor and linguistic processing, especially during development.
- Often - both language and motor systems may be impaired
- The presence of a motor deficit will necessarily influence the development of phonology and other language processes

My View:

CVD is a motor speech disorder due to delays or deviances in those processes involved in planning and programming movement sequences for speech

- Children with CVD will have difficulty reaching and maintaining specific articulatory configurations, as well as difficulty moving from one articulatory configuration to the next
- They will not have difficulty with ROM, strength, speed, etc. (unless they also have dysarthria).
- They may or may not have a non-verbal oral dyspraxia
- Although linguistic deficits may be identified, they should be considered concomitant
- Since many children will have language deficits concomitant with motor planning/programming deficits, it is important to determine the relative contribution of linguistic to motoric deficits - in order to plan treatment.

Why does it happen?

- Sometimes it is due to a stroke, tumor or trauma, just as it can be in adults.
- Many times, we don't know.
- There is some evidence for a genetic problem leading to a form of dyspraxia that has been identified in a large family in England, implicating the FOXP2 gene.
- Many children have normal MRI and EEG findings, others may show evidence of migrational disorders or abnormal EEG activity.
- Often it is associated with other neurologic "soft signs" such as gross or fine motor problems, but some children exhibit dyspraxia with no other deficits

What do we call it?

Many variations of terminology have been used

- *Dyspraxic dysarthria (Morley, Court & Miller, 1995)*
- *Developmental articulatory dyspraxia (Morley,1965)*
- *Verbal dyspraxia (Edwards, 1973; Chapell, 1973)*
- *Developmental Apraxia of speech (Rosenbek & Wertz, 1972;Yoss & Darley, 1974; Strand, 1995).*
- *Developmental Verbal Apraxia (Crary, 1984)*
- *Developmental Verbal Dyspraxia (Velleman, 1994)*
- *Childhood Apraxia of Speech (2001 Research Symposium)*

How do we recognize it?

Diagnostic markers:

- Physiologic markers: (e.g. Ach receptor antibodies for MG)
- Behavioral Markers:
  - observed in habitual performance
  - observed in carefully controlled contexts

There are no physiologic markers for many diagnoses: e.g.

» dementia	autism
» schizophrenia	SLI
» learning disabilities	asthma

These diagnoses are made primarily by clinical observation and meeting a number of clinical inclusionary and/or exclusionary criteria.

A number of behavioral characteristics have been suggested for the identification of CVD - many of which may be useful as potential behavioral/clinical markers:

- Difficulty reaching and maintaining specific articulatory configurations
- Difficulty moving from one articulatory configuration to another
- Groping and/or trial and error behavior
- Vowel distortions
- Limited consonant and vowel repertoire
- Use of simple syllable shapes
- Frequent omissions of sounds
- Difficulty completing a movement gesture for a phoneme easily produced in a simple context, but not in a longer one.
- Connected speech poorer than isolated word production
- Altered suprasegmentals
  - lexical and sentential stress
  - overall prosodic contours
- Altered timing between sounds and syllables
- Inconsistent error patterns

Markers I Find Most Compelling For the Younger Child

- Difficulty achieving and maintaining articulatory configurations
- Limited consonant and vowel repertoire
- Presence of vowel distortions
- Use of simple syllable shapes
- Difficulty completing a movement gesture for a phoneme easily produced in a simple context, but not in a longer one.

Markers Essential to the Phenotype (Childhood Dyspraxia of Speech Research Symposium, 2002)

- Difficulty achieving and maintaining articulatory configurations
- Presence of vowel distortions
- Difficulty completing a movement gesture for a phoneme easily produced in a simple context, but not in a longer one.

Notes:

Differential Diagnosis: How do we determine if dyspraxia is contributing to the child's communicative disorder?

In order to come to a differential diagnosis (and therefore focus appropriate treatment), the clinician must determine the relative contribution of levels of deficit: phonology vs. motor planning vs. execution (dysarthria). The following tasks are most important in making this determination and thus focusing the appropriate treatment approach.

A. History
B. Description of the Child's Sound System
    1. Independent analysis
    2. Relational Analysis
C. Assessment of the Child's Motor System
    1. Examination of Neuromuscular Condition
    2. Structural-Functional Examination
    3. Motor Speech Examination
    4. Examination of Physiological Parameters

In this short lecture, we will briefly discuss the two most important tasks to determine/differentiate motor speech impairment – the structural/functional examination and the motor speech examination.

Structural Functional Examination:

Purpose – to determine or rule out (1) dysarthria, and (2) oral, non-verbal apraxia

Involves examination of:

1. Structures
2. Tissue characteristics (see Hodge, 1988, pg.106)
3. Sensation
4. Function of each structure (Cranial nerve exam)
    - * Range of Motion
    - * Strength
    - * Speed
    - * Coordination
    - * Ability to Vary Muscular Tension
    - * Limits of Function

References for norms and additional information related to examination of structure, tissue characteristics and limits of function:

Strand, E. and McCauley, R. (1999) Assessment Procedures for Treatment Planning in Children with Phonologic and Motor Speech Disorders. In Caruso, A. and Strand, E. (Eds.) Clinical Management of Motor Speech Disorders in Children, New York, Thieme

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Robbbins, J. and Klee, T. (1987). Clinical assessment of oropharyngeal motor development in young children. Journal of Speech and Hearing Disorders. Vol.52, 271-277.

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Notes:

Structural-Functional Examination Worksheet

A. General Observations: (also refer to history re: chewing, swallowing, oral aversion, etc.

Facial symmetry _____

Drooling _____

Dentition _____

Tissue Characteristics _____

Other _____

B. Examination of Structure

Relative size _____

Abnormalities _____

Other _____

C. Sensation (observations; by report)

Tactile _____

Proprioceptive _____

D. Function (suggest a small multidimensional scale: 0=WNL; 1=mild; 2=moderate; 3=severe)

	ROM	Strength	Speed	Coordination	AVMT
Jaw					
Lips					
Tongue					

	Immediate/ delay with Phonation	Range	Symmetry	Fatigue	Coordination with repeated short phonation
Velar Elevation					

Examination for Oral non-verbal apraxia:

0= imitates immediately — **3= groping; sequential efforts then success**

1= imitates after delay — **4= could not achieve imitation**

	Blow	**Pucker**	**Smack Lips**	**Cough**	**Tongue position & movement**	**Sequential imitative movement**
Score						

Note Presence of:

	Present	**Weak/or Occasional**	**Absent**
Gag reflex			
Nasal Reflux			
Stridor			
Other Airway Restriction			

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Notes:

Motor Speech Examination

Purpose –

1. To examine the child's ability to sequence phonetic segments in various contexts.
2. To Examine ability to produce particular phonetic sequences while varying the temporal relationship between stimulus and response.

These observations allow the clinician to determine:

1. The degree to which motor planning deficits may contribute to the child's difficulty with speech acquisition
2. The severity
3. Helps with stimulus choice: phonetic content, syllable shapes, and size of stimulus set

Procedure

- ♦ Ask the child to repeat utterances that progressively get longer and more phonetically correct.
- ♦ Start just below the point where you feel the child will begin to have difficulty
- ♦ Hierarchy to follow
  - * Isolated vowels (V) [for children who exhibit numerous vowel errors or only undifferentiated vowels.
  - * CV; VC; CVC (using various vowels)
  - * Monosyllabic word repetition
  - * Multisyllabic word repetition
  - * Phrase repetition
  - * Repetition of sentences of increasing length

- ♦ Vary the Temporal Relationship between the stimulus and the response

1. Simultaneous
2. Immediate Repetition
3. Delayed Repetition
4. Delayed Consecutive Repetition

> ⇓ ⇓ ⇓
> *This is just a **TOOL** helpful in dx. and treatment planning, and tx. doing.*

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Notes:

** Keep in mind that the tasks you choose and the order in which you present them depends on the severity of the particular child and the predictions you have made regarding his/her performance.

** The worksheet below is focused toward eliciting behaviors that will help you determine the presence/absence of apraxia of speech. Determination of oral apraxia would have been made during the structural functional examination.

** Discussion of procedures for assessment of respiration, phonation, resonance, articulation and prosody, important for differential diagnosis and treatment planning of dysarthria, will follow. Keep in mind that procedures overlap. Not all will be done with every patient. There is no particular order of presentation of these tasks - other than the logical hierarchy you determine is appropriate for the particular patient you are assessing.

Motor Speech Examination Worksheet

A. **Observations during connected speech:**

	Vowels	**Consonants**	**Typical/Max Syllable length per word**	**Syllable Shapes Noted**	**MLU**
Conversation					
Picture Description					
Narrative					

Notes:

B. Observations during Elicited Utterances

Example for child with very severe impairment

	Immediate Repetition	Repetition after delay – no cues	Needs Simultaneous	Needs gestural or tactile cues
Vowels				
CV				
VC				
CVC				

Example for child with moderate impairment, but vowel distortions

	Immediate Repetition	Repetition after delay – no cues	Needs Simultaneous	Needs gestural or tactile cues
Vowels Note the different. Coarticulatory Contexts tested				
Words of Increasing Length				
Multisyllabic Words				
Sentences of Increasing Length				

Examples of utterances that might be elicited for each level.

1. Vowel Production
   - ***** Sustained phonation will be part of the cranial nerve exam and part of the phonatory examination. At this point we are considering production of vowel phoneme segments.)
   - * Make sure to sample a variety of vowels (***using varying temporal relationships between model and response if appropriate.)***

2. Word Repetition
   - ***** Monosyllabic words with the same first and last phoneme
   - * Monosyllabic words with different first and last phonemes
   - * Multisyllabic words
   - * Words of increasing length e.g.

me	zip	ball
meat	zipper	baseball
meeting	zippering	basketball

3. Sentence Repetition
   - ***** Sentences of increasing length e.g.

I eat	I go
I eat lunch	I go home
I eat lunch every day	I go home with mom

or, for more advanced kids

I play baseball
I play baseball after school
I play baseball after school and on Saturday

4. Sentences of varying phonetic complexity e.g.
   I want more to do.
   Mom and Dad sit on my bed.
   I like to eat ice cream after school.
   We ordered pepperoni and sausage pizza.
   Please put the groceries in the refrigerator.

5. Evaluating Automatic Vs. More Controlled Contexts
   Counting 1-10
   Naming particular numbers
   Familiar phrases
   Unfamiliar phrases

<u>Examination of Physiologic Parameters</u> *(See Yorkston, Beukelman, Strand and Bell, 1999; Duffy, 1995; Dworkin, 199, for additional information.)*

Respiration	**Respiration**
Phonation	**Resonance**

Prosody

Does Dyspraxia Change?

- CVD should not necessarily be considered a clinically distinct entity
- Children with difficulty with speech acquisition will vary in terms of the degree to which motor planning impairment may be contributing.
- This is a disorder that is dynamic
  - due to neural maturation
  - due to treatment effects
- Therefore, diagnostic markers may vary
  - with age
  - with neural maturation
  - as a result of treatment

How Do We Treat It?

There will be lots of information about treatment strategies, approaches and programs later in this conference. No matter what type of treatment is chosen by the SLP, they still have a number of decisions to make regarding:

- Number of sessions per week
- Length of sessions
- Number of stimuli with which to work
- How practice on those stimuli will be organized
- What type and how much feedback will be given.
- At what rate the practice will be done?

When working with children who have dyspraxia, all these decisions are best guided by the **Principles of Motor Learning.**

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Notes:

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