Differential diagnosis and treatment of dysarthria in children

Presented by K. Farinella, Ph.D., CCC-SLP
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1:30 – 3pm

Dysarthria

• General diagnostic term for a group of speech disorders resulting from disturbances in the central (brain and spinal cord) and peripheral (cranial and spinal nerves) nervous systems that control the muscles of speech production

  — (Duffy, 2013; Hodge & Wellman, 1999).

Review of the Dysarthria Types

• Flaccid
• Spastic
• Ataxic
• Hypokinetic
• Hyperkinetic
• Mixed
  — (Duffy, 2013)

Dysarthria Review

• Flaccid
  — Damage to lower motor neurons (cranial and spinal nerves)
  • Flaccid paralysis
    — Weakness
    — Hypotonia
    — Diminished reflexes
    — Atrophy
    — Fasciculations
    — Spontaneous motor unit discharges seen on the surface of the skin (brief localized twitches)
    — Fibrillations

Speech Characteristics – Flaccid

• Phonatory Incompetence
  — Breathiness (continuous)
  — Short phrases
  — Audible inspiration

• Respiratory Incompetence
  — Hypernasality
  — Imprecise consonants
  — Nasal emission

• Phonatory-Prosodic Insufficiency
  — Harsh voice
  — Monouloudness
  — Monopitch

  — (Darley, Aronson, & Brown, 1968; Duffy, 2013)

Dysarthria Review (con’t)

• Spastic
  — Damage to upper motor neurons (direct and indirect pathways)
  **bilateral** (for speech)

  • Spasticity: condition of increased muscle tone and increased reflex contraction in response to rapid stretch, usually more pronounced in the flexors of the upper extremity and the extensors of the lower extremity.
Speech Characteristics - Spastic

- Prosodic excess
  - Excess and equal stress
  - Slow rate

- Articulatory-Resonatory Incompetence
  - Imprecise consonants
  - Distorted vowels
  - Hypernasality

- Phonatory Stenosis
  - Harshness
  - Strain-strangled voice
  - Pitch breaks
  - Short phrases
  - Slow rate
  
  (Darley, Aronson, & Brown, 1969; Duffy, 2013)

Dysarthria Review (con’t)

- Ataxic
  - Damage to cerebellum or cerebellar circuitry

Speech Characteristics - Ataxic

- Articulatory Inaccuracy
  - Imprecise consonants
  - Irregular articulatory breakdowns
  - Distorted vowels

- Prosodic Excess
  - Excess and equal stress
  - Prolonged phonemes
  - Prolonged intervals
  - Slow rate

- Phonatory-Prosodic Insufficiency
  - Harshness
  - Monopitch
  - Monoloudness
  
  (Darley, Aronson, & Brown, 1969; Duffy, 2013)

Dysarthria Review (con’t)

- Hypokinetic

- Hyperkinetic
  - Damage to basal ganglia circuitry
  - Direct vs. indirect pathways

Speech Characteristics - Hypokinetic

- Prosodic Insufficiency
  - Monopitch
  - Monoloudness
  - Reduced stress
  - Short phrases
  - Variable (accelerated) rate
  - Short rushes of speech
  - Imprecise consonants

  (Darley, Aronson, & Brown, 1969; Duffy, 2013)

Speech Characteristics - Hyperkinetic

- Prosodic abnormalities
  - Prolonged intervals
  - Prolonged phonemes
  - Inappropriate silences
  - Excess loudness variations
  - Voice stoppages
  - Transient breathiness
  - Sudden forced inspiration or expiration

  (Darley, Aronson, & Brown 1969; Duffy, 2013)
**Etiologies**

- **Congenital**
  - Cerebral palsy
  - Muscular Dystrophy
  - Down syndrome (Trisomy 21)
  - 22q11.2 deletion syndrome (i.e., VCFS)

- **Acquired**
  - Traumatic brain injury
  - Hypoxia
  - Stroke

**Cerebral Palsy**

- Heterogeneous group of non-progressive, permanent disorders of movement and postural development.
  - Abnormal muscle tone (often hypertonia), loss of selective motor control, muscle weakness, and impaired balance (Narayanan, 2012)
  - Motor disorders often accompanied by disturbances of sensation, perception, cognition, communication, and behavior.

- Most common cause of chronic physical disability in pediatric population (2 and 3 per 1000 children) (Narayanan, 2012; Rosenbaum et al., 2007)

**Speech Production Subsystems**

- **Respiratory** – provide necessary drive to the larynx; quick muscular adjustments to mark stress
- **Phonatory** (laryngeal) – pitch, loudness, vocal quality
- **Resonatory** – velopharyngeal closure for all vowels and consonants (except /m/, /n/, /ng/)
- **Articulatory** – precision of speech sounds

**Cerebral Palsy**

- Lesion location and consequent motor signs:
  - **Spastic**
    - Increased muscle tone
    - Flexor spasms
    - Labored and stiff movements
  - **Athetoid** (dysskinetic/hyperkinetic)
    - Abnormal involuntary movements
    - Abnormal infantile reflexes
    - Low muscle tone
  - **Ataxic**
    - Incoordination of movement

  - (Solomon & Charron, 1998)

**Video Example**

**Assessing the Respiratory System**

- **Air Pressure** – specifies magnitude of mechanical drive provided by breathing apparatus; generated by combination of active (muscular) and passive (gravity) forces.
- **Lung Volume** – air contained within pulmonary apparatus; reflects size of the breathing apparatus.
- **Chest Wall Shape** – refers to the configuration of the chest wall surface; derived from combined positioning of the rib cage wall, diaphragm, and abdominal wall.

  - (Hixon & Hoit, 2005)
Respiratory System

• Normal Speech Breathing (adults)
  – Alveolar pressure (pressure in the lungs delivered to the larynx) increases quickly at the start of an utterance, is steady during the utterance, and decreases quickly at the end of the utterance.
  – Lung volume decreases at a constant rate during speech.
  – (Chest wall shape) Rib cage wall volume and abdominal volume decrease at constant rates during speech production.
  • (Hixon & Hoit, 2005)

Normal Speech Breathing (Children)

• Alveolar Pressure
  – Generate pressures for speech that are generally higher than those of adults.
  – Younger children use even higher tracheal pressures than older children.

• Lung Volume
  – Children and adults use similar lung volume levels when initiating speech.
  – Younger children begin speech breathing at larger lung volumes than older children, taking advantage of higher passive recoil forces.

• Chest Wall Shape
  – Abdomen is smaller, rib cage is larger (inverted pear shape).
  – At least by age 7 (perhaps by age 4), children use similar muscular mechanisms of the chest wall to those of adults during speech.
  • (Boliek et al., 1997; Hoit et al., 1990; Solomon & Charron, 1998)

Respiratory System: Cerebral Palsy

• Breathing problems are the second most common problem of the speech mechanism.
  • (Wolfe, 1950)

Respiratory System: Spastic Cerebral Palsy

• Breathing characterized by shallow inspirations and forced, uncontrolled expirations
  – Due to weak, spastic muscles of the chest wall.

• Stiff chest wall due to hypertonicity.
  • (Clement & Twitchell, 1959; Hoberman & Hoberman, 1960; Solomon & Charron, 1998)

Respiratory System: Athetoid Cerebral Palsy

• May present with irregular and uncontrolled breath patterns, with sudden bursts of air during inspiration or expiration
  – Due to abnormal involuntary movements of the chest wall and structures of the upper airway (e.g., tongue and pharynx)

• Speech and breathing problems are reported to be more severe in individuals with athetoid cerebral palsy than with other types.
  • (Palmer, 1952; Solomon & Charron, 1998)

Respiratory System: Ataxic Cerebral Palsy

• Approximately 50% may be expected to have breathing problems, characterized by irregular rate, rhythm, and depth of tidal breathing.

• The respiratory system is uncoordinated, resulting in difficulties with loudness control and possibly rate.
  • (Hoberman & Hoberman, 1960; Palmer 1952; Blumberg, 1955; Wolfe, 1950; Solomon & Charron, 1998)
**Water-Glass Manometer**

- Infer respiratory driving pressure for speech breathing purposes.
- Glass is calibrated by placing a vertical strip of tape on its side and marking it in centimeter (cm) intervals.
- Fill glass to zero level on the calibration tape.
- Air pressure exerted through the straw to generate a bubble must be greater than the level at which the straw is submerged (i.e., 5-6 cm H2O).

  *(Hixon, Hawley, & Wilson, 1982)*

**“How To”**

- Water-Glass Manometer
  
  *(Hixon, Hawley, & Wilson, 1982)*

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**Assessing the Respiratory System:**

- **Alveolar Pressure Estimation**
  - Video: Sammy
- **Lung Volume**
  - Video: Sammy; Vowel Prolongation
- **Chest Wall Shape**
  - Posture (upright)
    - At rest (tidal breathing)
    - Running speech (speech breathing)

**Assessing the Phonatory System:**

- **Non-speech tasks**
  - Glottal Coup (sharpness)
  - Cough (sharpness)
  - Production of /i/, /I/, /I/
    - Spasticity at the level of the larynx
  - Inhalatory stridor (noisy or phonated inspiration)
    - Due to weakness of vocal fold abduction
  - Running speech (e.g., reading passage)

  *(Duffy, 2013)*

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**Assessing Velopharyngeal Closure**

- **Nonspeech Tasks (inferences)**
  - Puff out cheeks
  - Modified tongue-anchor test
    - Puff out cheeks while protruding tongue
  - Nasal airflow on a mirror held at the nares during vowel prolongation
  - Production of “pa” with nares occluded versus unoccluded

  *(Duffy, 2013)*

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**Assessing Velopharyngeal Closure**

- **Speech Tasks:**
  - Sentence Repetition
    - Buy Bobby a puppy.
    - Build a big building.
    - The blue spot is on the key.
    - We see three geese.
Assessing the Articulatory System

• Nonspeech Tasks
  – Oral articulators (i.e., face, jaw, lips, tongue) at rest and during sustained postures
    • Symmetry
    • Strength
    • Speed
    • Range of motion
  • (Duffy, 2013)

Assessing the Articulatory System (con’t)

• Nonspeech Tasks:
  • Cranial nerve function
    – Trigeminal (CN V)
    – Facial (CN VII)
      • Peripheral versus Central?
    – Vagus (CN X)
    – Hypoglossal (CN XII)
      • Fasciculations (check perioral region also)
  • Video – Sammy “non-speech”
  • (Duffy, 2013)

Central vs. Peripheral Damage

Bilateral Innervation of the Face

Assessing the Articulatory System

• Speech Tasks
  – Sentence Repetition
  – Reading passage
    • Caterpillar Passage (Patel et al., 2012)
  – Speech AMRs (i.e., alternating motion rates)
  – Speech SMRs (i.e., sequential motion rates)
    • Video – Sammy “AMRs; SMRs”

Management of Dysarthria in Children

• Speech Intelligibility
  – “The degree to which a listener understands speech on the basis of the acoustic signal produced by the speaker.”

• Speech Comprehensibility
  – “The degree to which a listener understands speech on the basis of the acoustic signal plus all other information that may contribute to understanding what has been said.”

• Efficiency
  – “The rate at which intelligible or comprehensible information is conveyed.”
  • (Duffy, 2013; Yorkston, Strand, & Kennedy, 1996)
Management (con’t)

• Increasing speech intelligibility
  – Pausing/phrasing strategy
  – Decreasing speech rate
    • “Are we having steak/ for dinner?”
    • “Bring a friend/ to the party.”
    • (Tjaden & Liss, 1995)

• Maximizing prosody
  – “Moving the voice”

Management (con’t)

• Increasing prosodic contours
  • (Patel & McNab, 2011)

  The girl raised slowly by the river.

• Other prosodic variables
  – Pitch and duration control
  – Computer games (iPad apps?)
    • (Patel & Salata, 2006)

Marking Lexical Stress

• Increase duration of stressed syllable

• Increase loudness of stressed syllable

• Increase pitch on stressed syllable

Lee Silverman Voice Treatment (LSVT)

• CP Treatment Video

Phase I LSVT LOUD with CP

Auditory-perceptual Analysis

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5 kids with predominately spastic CP (all 4 limbs) 5-7 years of age

Management of Loudness Inadequacies

• Abdominal Binder – decreased respiratory dysfunction; chest wall shape

• Personal amplifier – poor respiratory drive; poor vocal fold adduction
Postural Adjustments

- Upright seated position
  - Seat base parallel to the ground
  - Reclined at 30 degrees (vertical)
  - Hip angle at 90 degrees
    - Minimizes extensor muscle tone

- Individually adjusted seating systems
  - Anterior-tipped systems
  - Arm support

- Improvements in respiratory muscle control
  - (Solomon & Charron, 1998)

Combined Speech and Physical Therapies

- Traumatic brain injury
  - Adult with hypokinetic-spastic dysarthria
    - Can infer similar chest wall compliance problems in children with spastic CP also
  - PT stretch exercises + LSVT

    - (Solomon, McKee, & Garcia-Barry, 2001)

Physical Therapy Exercises

- Video 1
  - Corner Stretch

- Video 2
  - “Towel Stretch”

- Video 3
  - Seated Torso-Extension Stretch

- Video 4
  - Peripheral Neuromuscular Facilitation (PNF)

Management (con’t)

- Increasing speech comprehensibility
  - Alphabet cue supplementation
    - Video
  - Identifying the conversational topic
    - Topic board
    - (Hustad, Jones, & Dailey, 2003)

- Creating a conducive environment for speaking
  - Using gestures
  - Listener familiarization
    - (Tjaden & Liss, 1995)

Principles of Motor Learning

- Practice conditions
  - Blocked versus random
  - Mass versus distributed
  - Constant versus variable

- Feedback Frequency
  - Sixty percent versus 100%
  - Knowledge of performance versus knowledge of results
  - Three-second rule!

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- Families of children with dysarthria
References


References (con’t)


