Perceptual and Acoustic Evaluation of Pediatric Voice

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Disclosures

- Financial Disclosures
  - Salary from University of Wisconsin
  - Royalties from Medbridge
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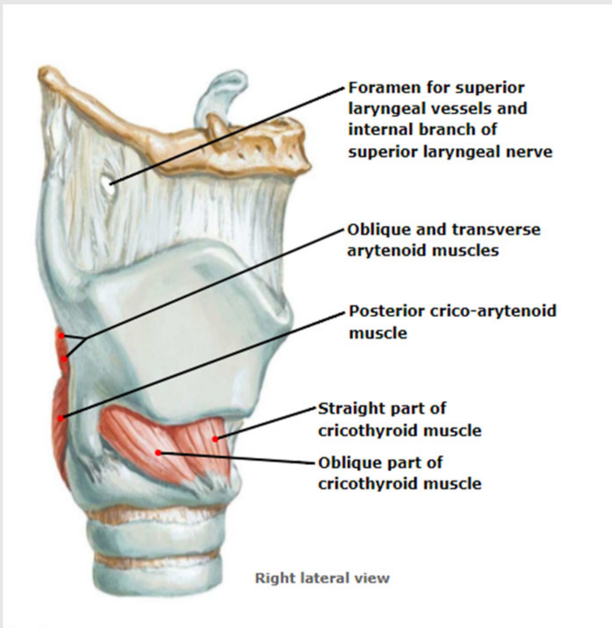
  - Honorarium from Lavi Institute
- Non-financial disclosure
  - ASHA Special Interest Group 3 Committee Member at large

Goals for today

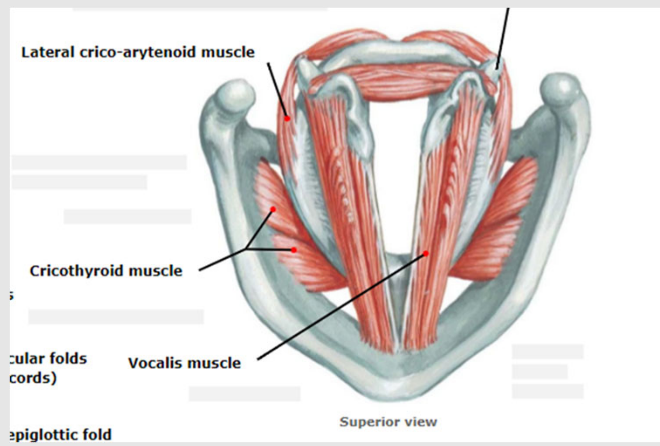
- Provide overview of normal pediatric vocal function
- Provide overview of voice problems that can occur in children
- Present the components of the ideal pediatric voice evaluation
- Discuss available normative data
- Interpretation of results
- Translating results of evaluation to beginning treatment

Learning outcomes

- Participants will describe typical pediatric laryngeal anatomy and function
- Participants will identify the component parts of a comprehensive voice evaluation
- Participants will interpret results of a voice evaluation and identify appropriate treatment pathways



Right lateral view



Superior view

Anatomy and Physiology of the pediatric vocal mechanism

- Size
- Position
- Cartilages
- Vocal fold histology
- Respiratory capacity and function
- Neuromuscular control and coordination

Laryngeal position and shape

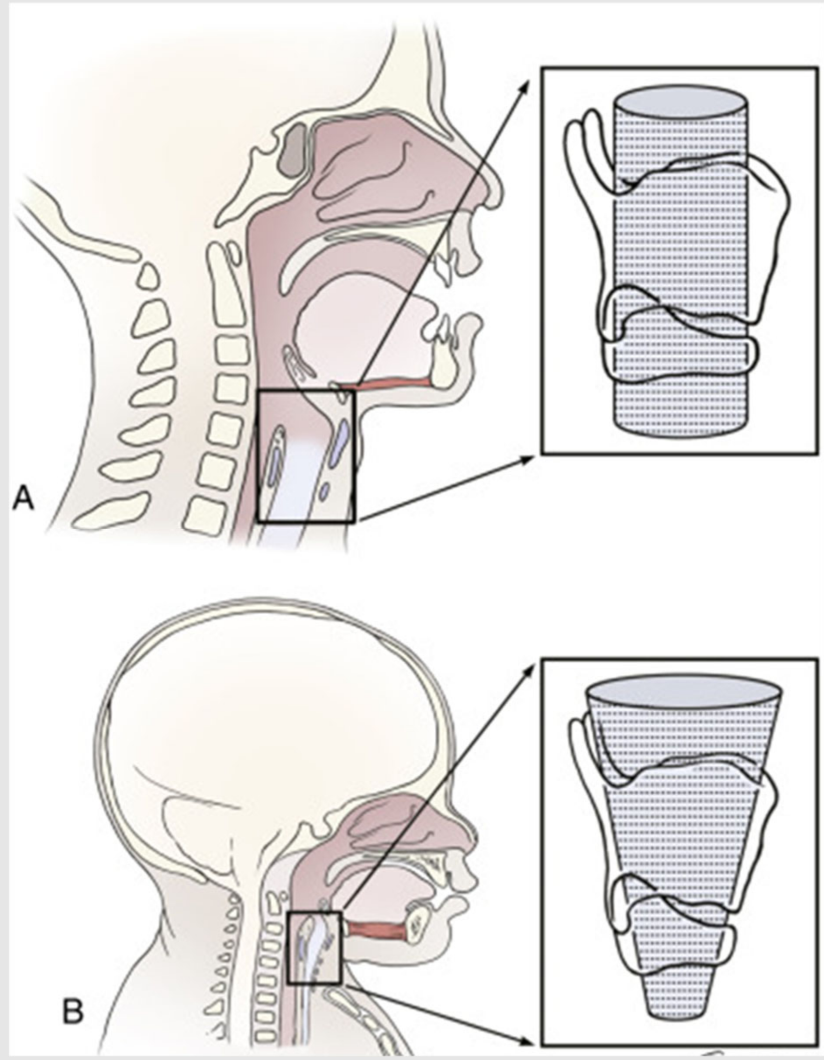
In a newborn, base of cricoid cartilage is at C4

By age 2, it has descended to C5

By 5, C6

By 15, adult position of C6-C7

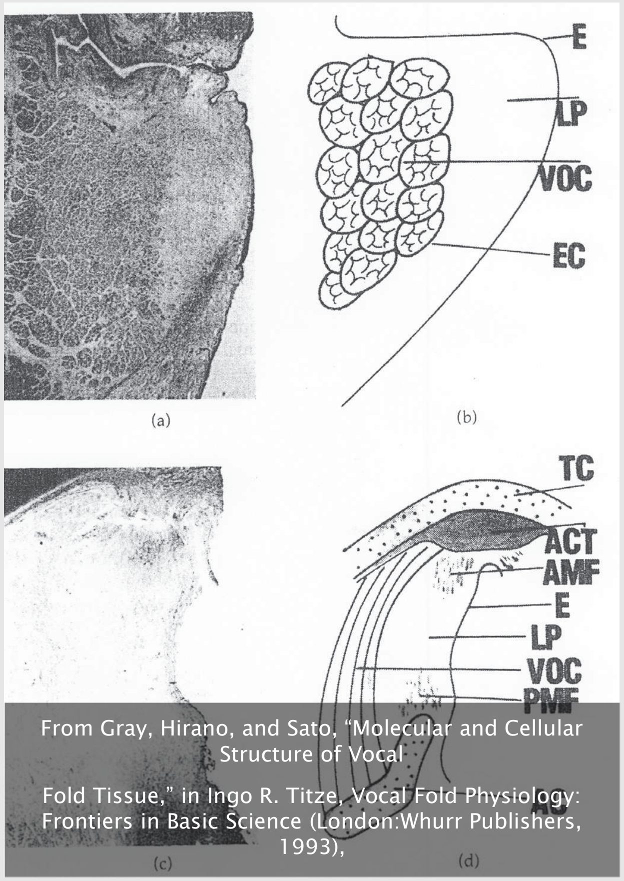
Adult larynx cylindrical, child more funnel shaped



Pediatric Pharmacosedation and General Anesthesia. Oral and Maxillofacial Surgery
Parworth et al., 2018

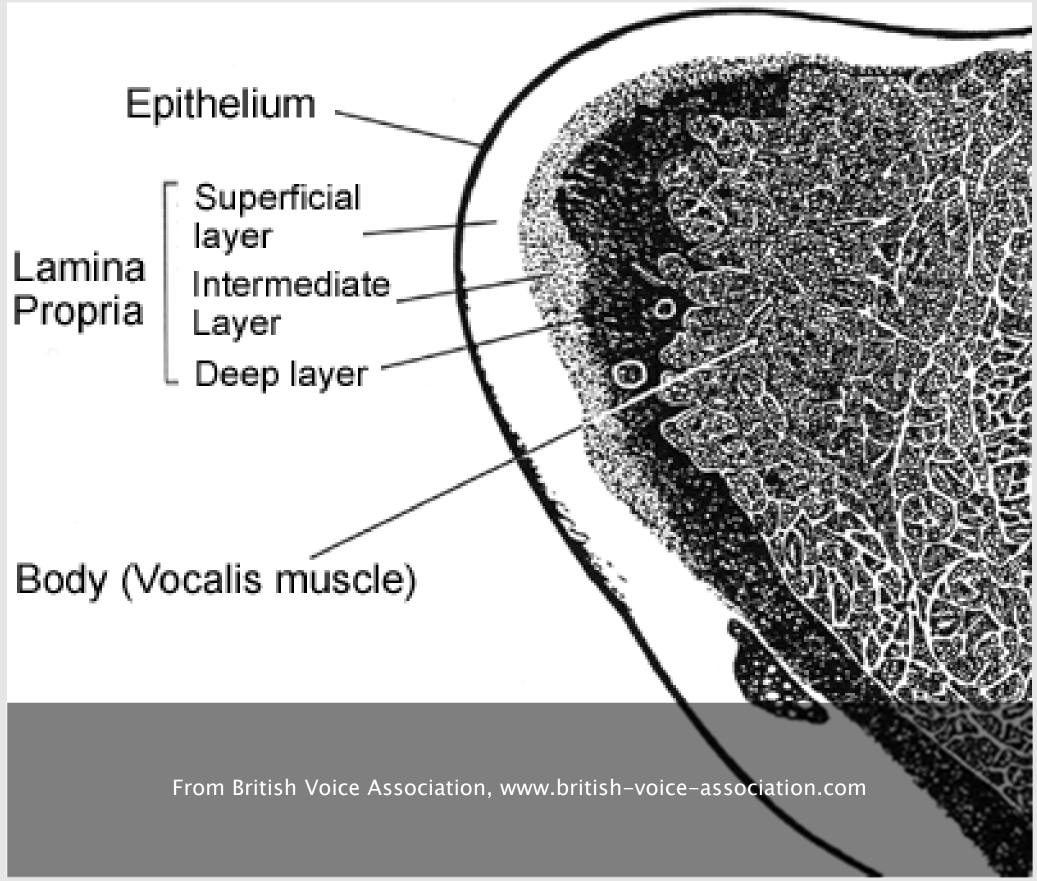
- Cartilages
  - Laryngeal cartilages gradually ossify
    - Very young children have softer cartilages
  - Thyroid cartilage becomes more wedge-shaped in males in puberty

Vocal fold histology



From Gray, Hirano, and Sato, "Molecular and Cellular Structure of Vocal

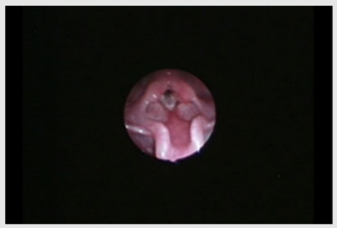
Fold Tissue," in Ingo R. Titze, Vocal Fold Physiology: Frontiers in Basic Science (London:Whurr Publishers, 1993),



From British Voice Association, www.british-voice-association.com

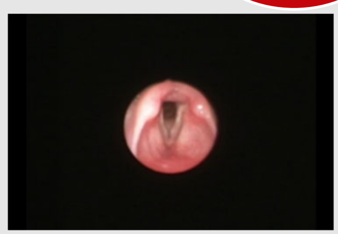
Vocal fold histology

Birth



Infancy – no layer structure

Age 4 years – immature ligament forms



Age 7 – lamina propria near adult depth

Agee 14-17 layer structure matures

Age 6-12

- Have to work harder for same loudness as adults
- Shorter breath groups
- Developing fine motor control of breathing and pitch
- Narrower pitch range than adults
- Some breathiness is normal
- May have difficulty with register transitions

Vocal development Age 12+

- Rapid changes occurring in larynx and whole body
- Range is changing in boys and girls
- Frequent difficulty with register transitions
- Some breathiness is normal
- May strain and tense to regain control
- May strain to sound older
- Voice classification may be constantly shifting

Male voice change

- Between 12 and 18
- Most dramatic change takes ~ 1 year
- Vocal tract lengthens
- Vocal folds lengthen – nearly double
- Thyroarytenoid muscle increases in bulk, changing voice quality
- Lowest pitch lowers by 1 octave
- Highest pitch lowers by approximately a sixth
- Range lowers, decreases, and gradually grows again
- Transition (passagio) points change and are more unstable

Female voice change

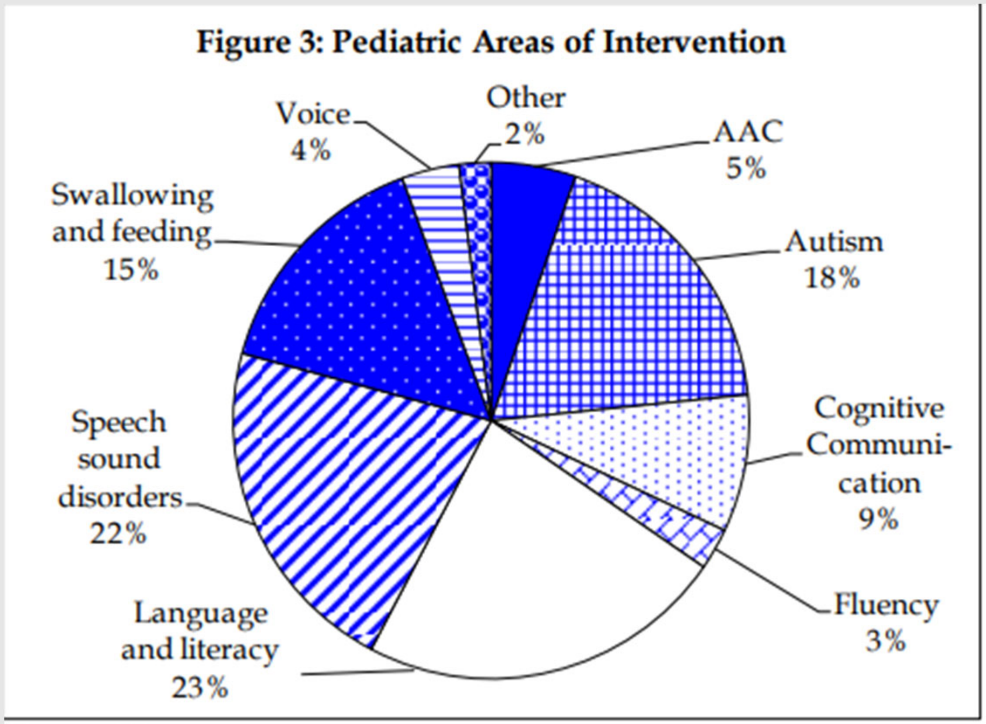
- Occurs gradually and in spurts throughout puberty
- Speaking F0 decreases
- Lower limit of pitch range decreases by about 4 semitones, upper limit rises slightly
- Breathiness/ “huskiness” increased during transition
- Increased pitch inaccuracy
- Inconsistent pitch range
- Voice “cracks” in speech and singing

How many kids have voice disorders?

- Prevalence 1.4%-23.9% (Bhattacharyya, 2014; Powell, Filter, & Williams, 1989)
  - 3.9% in preschoolers (Duff et al 2004)
  - 94% of children born extremely preterm
    - 58% mod-severe dysphonia (French et al., 2013)
  - 76-100% of children post laryngotracheal reconstruction (Clary et al., 1996, Smith et al., 1993; Zalzal et al., 1991)

But relatively few SLPs see pediatric voice

- Voice 4% of caseload in pediatric medical settings. (ASHA 2019).
- In schools, 15.1% serve children with voice and/ or resonance disorders (ASHA 2020)



ASHA Healthcare Survey 2019

Underidentified or underserved?

- Perception of growing out of it
- Perception that it isn’t important
- Lack of training/ knowledge

Voice disorders in children

- Benign lesions
  - Nodules
  - Cyst
  - (polyps rare in children)
- Mobility impairment
- Papilloma
- Congenital anomalies (cleft, web)
- Scar/ sulcus
- Posterior glottic insufficiency post intubation
- Dysphonia after laryngotracheal reconstruction

Vocal fold nodules

- Most common cause of voice disorder in children (von Leden 1985; Gramuglia 2014)
- Bilateral lesions at point of most contact on vocal folds
- Thick fibronectin deposits in superficial lamina propria, disorganization of basement membrane zone
- Assumed to be caused by repeated impact forces
- Usually improve or resolve with therapy

Vocal fold nodules

- Usually pliable
- Sometimes cause “hourglass” closure pattern
- Result in rough, breathy, lower pitch, more effort, harder to get quiet voice or high voice

Vocal fold cysts

- Sacs lined by epithelium, within lamina propria
- Epidermoid or mucus retention
- Acquired or congenital
- Usually unilateral, sometimes with reactive lesion
- Voice therapy can help voice quality and effort, but lesion usually requires surgery to resolve
- Reduces pliability, increases mass
- Voice often rough, strained, breathy, lower pitch

Vocal fold polyps

- Sub-epithelial lesion
- Often looks like a blood blister
- Can be hemorrhagic
- Usually unilateral, sometimes with reactive lesion
- Increases mass on one side
- *In my experience* less common in children
- Voice often rough, strained, diplophonic

Vocal fold paralysis/ paresis

- Partial or complete immobility of 1 or both vocal folds
- Most often caused by injury to RLN
  - BUT – vincristine, Chiari malformation, neck trauma, virus can all cause
- In children, most frequently after heart surgery
- Effect depends on position, degree, unilateral or bilateral
- If bilateral, can cause airway obstruction needing trach
- Can cause incomplete vocal fold closure resulting in weak, quiet, breathy voice or aphonia
- If well compensated, may have minimal vocal impact
- Effectiveness of voice therapy depends on ability to get closure

Papilloma

- HPV – juvenile onset usually maternally transmitted
- Papilloma are fast growing and can obstruct airway
- Infants and young children require frequent surgeries
- Impedes vibration
- Repeated surgeries can lead to scarring, glottal gap, stiffness
- Therapy can be helpful in managing voice between and after surgeries

Muscle tension dysphonia

- Muscular imbalance/ maladaptive muscle use resulting in dysphonia
- Can be primary or secondary
- Can be compensatory, psychological, muscular imbalance
- Voice quality variable – can be severely strained, can be aphonic
- Usually responds to therapy, often quickly
- Non voice laryngeal functions (cough, hum, laugh) often unaffected

The voice evaluation

Why evaluate?

- Identify the underlying reason for the voice problem
  - Is it dangerous?
  - Does it need surgery?
  - What sort of treatment is necessary?
- Determine goals for therapy
- Establish a baseline to compare pre- and post-treatment
- Ongoing assessment to determine effectiveness of treatment
- Establish a database for research with consistent measures in evaluation

How do we evaluate?

- Listen
- Measure
- Look
- Put it together

ASHA Recommendations

- Use ICF framework for eval
- Case History
- Patient's self assessment of quality of life
- Oral peripheral evaluation
- Assessment of respiration
- Perceptual evaluation of voice quality and resonance
- Phonation (onset, offset, ability to sustain voice, vocal diadokokinesis)
- Rate
- Laryngeal imaging
- Acoustic assessment
  - Vocal amplitude
  - Vocal frequency
  - Vocal signal quality
- Aerodynamic assessment
  - Glottal airflow
  - Subglottal air pressure
  - Mean SPL and F0

https://www.asha.org/practice-portal/clinical-topics/voice-disorders/#collapse_5

Case history

- Intake form, verbal interview
- Ask caregiver AND child
- Onset
- Severity
- Variability
- Impact on quality of life
- Other medical issues

Patient self-assessment of quality of life

- Pediatric measures challenging
- Many use parent report only
- Adapted from adult measures
- Usually do not meet the criteria for a high quality patient reported outcome measure

Patient self-assessment of quality of life

- PVOS (Hartnick 2002)
  - 4 item questionnaire
  - Completed by parents
- PVRQOL (Boseley, Cunningham & Volk, 2006)
  - 10 item questionnaire
  - Based on VRQOL
  - Completed by parents
  - Adapted to be completed by children too
- pVHI (Zur et al., 2007)
  - 21-item questionnaire with 3 subsections
  - Based on VHI
  - Completed by parents
  - Validated on children post laryngotracheal reconstruction

Oral peripheral examination

- No standardization for this
- Many forms available
- Should include at minimum:
    - Lips, tongue, jaw appearance, strength, symmetry and ROM
    - Velar elevation and appearance
    - Diadokokinetic movements
    - Vocal diadokokinesis (/uuʔii/x5, /papapa/x5)

Assessment of respiration

- s/z ratio
- Maximum phonation time
- Observe respiratory patterns
  - Breath holding
  - Shallow, clavicular breathing
  - Stridor

Assessment of respiration

- Maximum phonation time dependent on size and age

ELSEVIER
Journal of Voice
Volume 26, Issue 5, September 2012, Pages 675.e1-675.e4

Maximum Phonation Time and s/z Ratio in a Large Child Cohort

Elaine Lara Mendes Tavares *, Alcione G. Brasolotto †, Sérgio A. Rodrigues ‡, Adriana Bueno Benito Pessin *, Regina Helena Garcia Martins *

Age	Gender	MPT	s/z ratio
4;0-6;11	F	6.22 +/- 1.99	0.96 +/- 0.15
4;0-6;11	M	6.02 +/- 1.77	0.97 +/- 0.17
7;0-9;11	F	7.90 +/- 1.98	0.99 +/-0.27
7;0-9;11	M	8.05 +/- 1.98	0.95 +/- 0.15
10;0-12;0	F	9.05 +/- 2.02	1.01 +/- 0.17
10;0-12;0	M	9.22 +/- 2.33	0.99 +/- 0.15

Pediatric voice team

- Pediatric voice specialized speech language pathologist
- Pediatric laryngologist
- Other possible team members
  - Nursing
  - Pulmonology
  - Gastroenterology
  - Psychology
  - Child
  - Parent
  - Teacher
  - School SLP
  - PT
  - OT

Perceptual voice evaluation

- CAPE-V or GRBAS
- Resonance
- Phonation onset/ offset, laryngeal diadokokinesis
- Rate

Auditory perceptual evaluation

- Dysphonia is identified with the ear
- Pitch, loudness or quality are inappropriate for their age, gender or geographic location, or call negative attention (e.g., Aronson and Bless 2009)
- Various ways of quantifying or describing

Perceptual characteristics of voice

- Pitch - perceptual correlate of frequency
- Loudness - perceptual correlate of intensity
- Breathiness – perception of excess air escape
- Roughness – perceived irregularity in the voicing source
- Strain – perceived excessive vocal effort

Limitations of perceptual evaluation

- Subjective
- Need shared terminology and recognition of what constitutes meaningful change
- Biases
  - Confirmation bias
  - Recency bias
- Vary based on stimulus, pitch, loudness, ambient noise
- Relatively poor inter/ intra-rater reliability
- Impossible to isolate different aspects of perceptual assessment

Why use it?

GRBAS

- Grade
- Roughness
- Breathiness
- Asthenia
- Strain
- 0-3, 0=normal, 1=mild, 2= moderate, 3=severe
- G2R2B2A0S1 = a moderately dysphonic voice characterized by moderate roughness, moderate breathiness, no asthenia and mild strain

(Isshiki et al., 1969)

CAPE-V

- Consensus Auditory Perceptual Evaluation of Voice
- 100 mm visual analog scale 0=normal, 100=profound
- Available on www.asha.org for download for non-commercial purposes
- Rater makes a mark on the 100 mm visual analog scale that corresponds with their perception
  - Overall severity
  - Roughness
  - Breathiness
  - Strain
  - Pitch
  - Loudness

(Kempster GB, Gerratt BR, Verdolini Abbott K, Barkmeier-Kraemer J, Hillman RE, 2009.)

Resource for ear training

- https://voicefoundation.org/health-science/videos-education/pvqd/

- Patrick Walden, PhD developed a database of 296 audio files, with CAPE-V ratings by 2 or 3 voice specialized SLPs

Walden, Patrick R (2020), “Perceptual Voice Qualities Database (PVQD)”, Mendeley Data, v2, https://data.mendeley.com/datasets/9dz247gnyb/1

CAPE-V Stimuli

- Sustained vowels /a/ and /i/ for 3-5 seconds each
- Sentences
  - The blue spot is on the key again
  - How hard did he hit him?
  - We were away a year ago?
  - We eat eggs every Easter
  - My mama made lemon muffins
  - Peter will keep at the peak
- Connected speech

Adapting for children

- Sustained /a/ and /i/
- Simpler sentences retaining the salient characteristics
  - You and Bob are eating
  - Harry has a hat
  - We were away
  - We eat eggs
  - Mama made muffins
  - Pet the puppy
- Connected speech on child's choice of topic

NOTE: these sentences were created by this speaker and are *not* part of the official CAPE-V

Practice with voices

Acoustic evaluation

Acoustic assessment

- Vocal intensity dB SPL
- Vocal frequency (f0)
- Vocal signal quality (Cepstral Peak Prominence)

- Jitter, shimmer, noise to harmonic ratio
- Voice range profile
- CSID

AJSLP

Tutorial

Recommended Protocols for Instrumental Assessment of Voice: American Speech-Language-Hearing Association Expert Panel to Develop a Protocol for Instrumental Assessment of Vocal Function

Rita R. Patel,[a] Shaheen N. Awan,[b] Julie Barkmeier-Kraemer,[c] Mark Courey,[d] Dimitar Deliyski,[e] Tanya Eadie,[f] Diane Paul,[g] Jan G. Švec,[h] and Robert Hillman[i]

Acoustic assessment

- Know the equipment
- Calibrate
- Use a high quality microphone
- Steady mic to mouth distance
- Give simple, straightforward instructions
- Watch for artifacts or irregularities
- Limit background noise

Acoustic systems

- Pentax CSL/ Visi-pitch
- Praat (freeware)
  - Phonanium
- Wevosys
- Probably more

F0 and F0 range

- Can be obtained with relatively low-tech measures, and apps
- F0 changes quite a bit with male puberty, less with female puberty

Perturbation measures

- Cycle-to-cycle variability in acoustic signal
  - *Jitter: cycle-to-cycle variability in frequency*
  - *Shimmer: cycle-to-cycle variability in amplitude*
- Some variability is normal – complete periodicity of the signal would sound robotic
- With pathologic conditions, increased aperiodicity is expected (Colton, Casper & Leonard 2011)

Jitter and shimmer

+

- Provides measurable data on voice
- Some correlation with other measures of dysphonia
- Some normative data available

-

- Only obtained on sustained vowels
- Can be difficult for child to be consistent
- Weak correlation with other measures of dysphonia
- Not valid in Type 2 and Type 3 signals (too aperiodic/ chaotic)

Acoustic normative data

		4;0-6;11	7;0-9;11	10;0-12;11	13;0-15;11	16;0-19;11
F0 (Hz)	Female	257.0 (SD 15.0)	244.8 (SD 22.9)	253.9 (SD 24.8)	219.2 (SD 32.2)	214.5 (SD 27.7)
F0 (Hz)	Male	245.2 (SD 25.48	241.6 (SD 31.08)	239.4 (SD 29.33)	151.4 (SD 43.33)	107.3 (SD 20.33)
Jitter %	Female	2.53 (SD 3.72)	2.35 (SD 1.69)	1.84 (SD 0.91)	1.54 (SD 0.91)	1.38 (SD 0.86)
	Male	2.17 (SD 1.36)	1.14 (SD 0.48)	1.89 (SD 0.78)	1.20 (SD 0.72)	0.90 (SD 0.94)
Shimmer %	Female	6.67 (SD 2.58)	6.81 (SD 2.46)	5.58 (SD 2.11)	4.92 (SD 1.84)	4.39 (SD 0.98)
	Male	6.86 (SD 3.12)	4.48 (SD 1.43)	5.00 (SD 1.58)	4.78 (SD 1.84)	6.05 (SD 2.43)


Contents lists available at ScienceDirect
International Journal of Pediatric Otorhinolaryngology
journal homepage: www.elsevier.com/locate/ijporl
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Acoustic parameters of voice in typically developing children ages 4–19 years

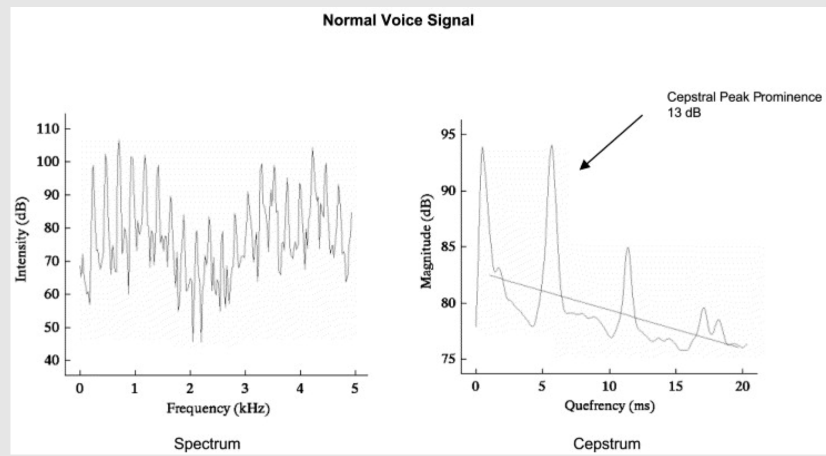
Raymond D. Kent*, Julie T. Eichhorn, Houri K. Vorperian
Waisman Center, University of Wisconsin-Madison, 1500 Highland Ave., Madison, WI, 53705, USA

Noise to harmonic ratio/ Harmonic to noise ratio

- Voice has two components: periodic waves and random noise (Baken & Orlikoff)
- Time-based perturbation measure
- Ratio of aperiodic energy to periodic energy in a voice signal
- With increased hoarseness, there is more aperiodic noise (Yumoto et al, 1982)

Cepstral peak prominence

- Spectral measure
- Fourier transform of spectrum to cepstrum
- Measures the amplitude of dominant cepstral peak relative to the other noise in voice
- HIGHER CPP associated with BETTER voice
- CPP measures on Pentax and Praat are different – CAN'T use same norms



From Heman-Akah et al., 2002

Literature on CPP

- Higher CPP in non-dysphonic children (Aydlini et al., 2018)
- Decreases with age in children (Infusino et al., 2015)
- Correlated with breathiness (Eadie & Baylor, 2006; Hillenbrand & Houde, 1996)
- Correlated with listener perception of dysphonia (Awan, Roy & Dromey, 2009)

International Journal of Pediatric Otorhinolaryngology
Volume 148, September 2021, 110815

Investigating the cepstral acoustic characteristics of voice in healthy children

Ayşe Nur Demirci [a], Ayşen Köse [a], Fatma Esen Aydinli [a], Önal İncebay [a], Taner Yilmaz [b]

International Journal of Pediatric Otorhinolaryngology
Volume 116, January 2019, Pages 107-113

Use of cepstral analysis for differentiating dysphonic from normal voices in children

Fatma Esen Aydinli, Esra Özcebe, Önal İncebay

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Cepstral/ spectral measures

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- Can be taken from running speech
- Can be taken from more aperiodic signals
- Have shown robust correlation with perceptual measures in adults
- Have shown sensitivity to change over time
- Normative data available

-

- Children have high F0 and short vocal tract, could influence reliability
- Vary by vowel and context

CPP norms (age 4-17)

Gender	Cpp vowel	Cpp voiced sentence	Cpp running speech
Male	10.2 st 1.94	5.39 sd .418	4.77 sd 1.16
Female	10.3 sd 1.69	6.21 sd 1.30	4.86 sd 0.64

From Demirci et al., 2021
Using Pentax system


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Cepstral Spectral Index of Dysphonia (CSID)

Clinical Linguistics & Phonetics, September 2010; 24(9): 742–758

informa
healthcare

Quantifying dysphonia severity using a spectral/cepstral-based acoustic index: Comparisons with auditory-perceptual judgements from the CAPE-V

SHAHEEN N. AWAN[1], NELSON ROY[2], MARIE E. JETTÉ[3], GEOFFREY S. MELTZNER[4], & ROBERT E. HILLMAN[5]

[1]*Department of Audiology & Speech Pathology, Bloomsburg University of Pennsylvania, Bloomsburg, PA, USA,* [2]*Department of Communication Sciences and Disorders, The University of Utah, Salt Lake City, UT, USA,* [3]*University of Wisconsin-Madison, Wisconsin Institutes for Medical Research, Madison, WI, USA,* [4]*BAE Systems, Inc., Burlington, MA, USA, and* [5]*Center for Laryngeal Surgery and Voice Rehabilitation, Massachusetts General Hospital, Surgery and Health Science and Technology, Harvard Medical School, Boston, MA, USA*

Toward Validation of the Cepstral Spectral Index of Dysphonia (CSID) as an Objective Treatment Outcomes Measure

***Elizabeth A. Peterson, *Nelson Roy, †Shaheen N. Awan, ‡Ray M. Merrill, *Russell Banks, and §Kristine Tanner,**
**Salt Lake City and ‡§Provo, Utah, and †Bloomsburg, Pennsylvania*

CSID

- CPP
- CPP (SD)
- L/H Spectral ratio
- L/H Spectral ratio (SD)

- Takes these, and with an algorithm gives a # on a 100 point scale, 0 being normal, 100 being severely dysphonic

Acoustic Voice Quality Index

- Analysis of steady vowel and connected speech – uses Praat
- 6 measures (weighted, with final score)
  - Smoothed CPP from connected speech
  - Harmonic to Noise Ratio
  - Shimmer local
  - Shimmer local dB
  - Slope
  - Tilt
- Correlates with perceptual evaluation
- Sensitive to changes with therapy

(Barsties &Maryn 2015, 2016; Maryn, deBodt & Roy, 2010, Reynolds et al., 2012)


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Journal of Voice
Volume 26, Issue 5, September 2012, Pages 672.e1-672.e7

Objective Assessment of Pediatric Voice Disorders With the Acoustic Voice Quality Index

Victoria Reynolds *, Ali Buckland *, Jean Bailey *, Jodi Lipscombe *, Elizabeth Nathan †, Shyan Vijayasekaran ‡, §, Rona Kelly ‖, Youri Maryn ¶, Noel French ‖, #

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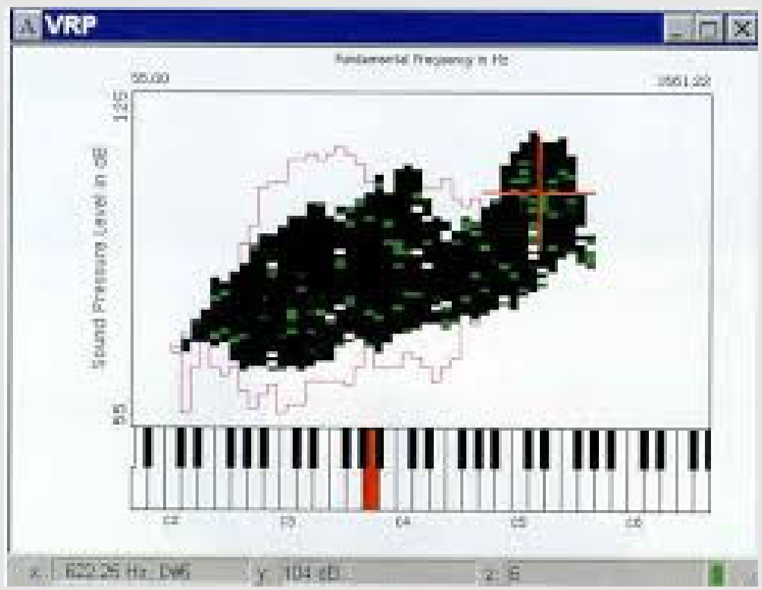
Voice range profile/ phonetogram

- Measures maximum frequency range across the intensity range. Differences by age and gender



Obtaining acoustic measures from children

- Modeling
- Practice
- Competition
- Multiple attempts might be needed

Interpretation of acoustic data

- Severity
- Variability
- Stimulability for change
- Change over time

Aerodynamic assessment

Aerodynamic assessment

- Mean airflow
- Subglottal air pressure
- Mean SPL and F0
- Phonation threshold pressure
- Laryngeal resistance

Aerodynamic measures

- Pressure
  - Subglottal pressure
  - Supraglottal/intraoral
  - Transglottal
  - Phonation threshold pressure
- Flow
  - Mean airflow during voicing
- Laryngeal resistance
  - Ratio of transglottal pressure to transglottal flow
- Maximum flow declination rate
  - How fast the glottis closes (measure of efficiency)

Phonation threshold pressure

- PTP = *minimum* P_s needed to initiate phonation
- Perceived phonatory effort
  - ↑ effort ≈ ↑ PTP
- PTP *increases* with:
  - Increased tissue viscosity
  - Increased mucosal wave velocity
  - Increased fundamental frequency

Aerodynamic norms

Measure	Ages	Norm	Source
Phonation threshold pressure	4;0-17;0	4.05 cm H2O, SD 0.87	Hoffman et al, 2019
Subglottic pressure during comfortable phonation	6;0-10;11	8.69-10.05 cm H20	Weinrich et al., 2012

Laryngeal visualization

Laryngeal visualization

- NEED to look at the larynx
- Can be done by flexible or rigid scope
- Scopes can use halogen light or stroboscopy
- High speed digital imaging of the larynx

Who performs endoscopy?

- Regulations vary by state
- In most places, SLP or physician can pass the scope
- SLP can interpret, but physician makes medical diagnoses

AAO and ASHA Special Interest Group joint statement:

- “Strobovideolaryngoscopy (including rigid and flexible endoscopy) is a laryngeal imaging procedure that may be used by otolaryngologists and other voice professionals as a diagnostic procedure. Physicians are the only professionals qualified and licensed to render medical diagnoses related to the identification of laryngeal pathology as it affects voice. Consequently, when used for medical diagnostic purposes, strobovideolaryngoscopy examinations should be viewed and interpreted by an otolaryngologist with training in this procedure. Speech-language pathologists with expertise in voice disorders and with specialized training in strobovideolaryngoscopy are professionals qualified to use this procedure for the purpose of assessing voice production and vocal function. Within interdisciplinary settings, these diagnostic and vocal function assessment procedures may be accomplished through the combined efforts of these related professionals. Strobovideolaryngoscopy may also be used as a therapeutic aid and biofeedback tool during the conduct of voice treatment. Care should be taken to use this examination only in settings that assure patient safety.” (1998)

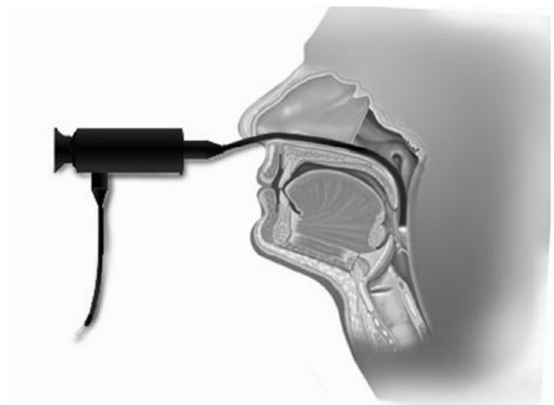
ASHA Position statement

"It is the position of the American Speech-Language-Hearing Association (ASHA) that vocal tract visualization and imaging for the purpose of diagnosing and treating patients with voice or resonance/aeromechanical disorders is within the scope of practice of the speech-language pathologist" (2003)

Role of otolaryngologist and SLP

- Either may pass scope, unless state or local regulations prohibit
- Only otolaryngologist can render medical diagnosis
- SLP with expertise in voice disorders can use the procedure to assess voice production and function
- In a multidisciplinary clinic, this is sometimes done jointly

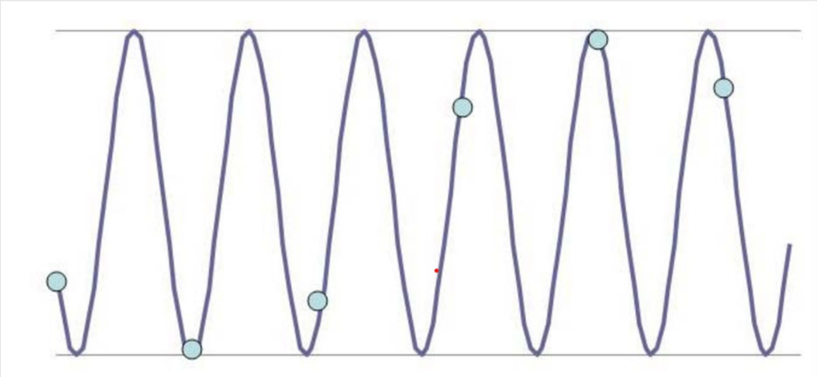
Rigid endoscopy



Flexible endoscopy

How does stroboscopy work?

- Vocal folds vibrate fast! (between 80 and 1000x/ second)
- Too fast for human eye to perceive
- Flickering light source at rate slightly slower or faster than vocal fold vibration
  - If exactly matched, it would look frozen
- Takes advantage of 2 phenomena of visual perception:
  - A flicker free, uniformly lit background
  - Perception of apparent motion when 2 objects are displaced in rapid succession
  - Human eye perceives this as continuous motion – this is slowed from the actual speed



What can be evaluated with each?

- Rigid endoscopy
  - Better look at tissues
  - Often better look at vibratory characteristics
  - Can only evaluate sustained vowels and breathing
  - Best when lesions are suspected
- Flexible endoscopy
  - Can be fiberoptic or distal chip
  - Distal chip gives better image – often as good as rigid
  - Can evaluate during connected speech, singing, breathing and sustained vowels
  - Best when paralysis/ paresis/ neurologic pathology suspected
  - Best to evaluate laryngeal breathing disorder or chronic cough
  - Only endoscopic way to evaluate velopharyngeal function

What can be evaluated with each?

- Halogen
  - Arytenoid mobility
  - Vocal fold edge
  - Supraglottic compression
  - Tissue color and integrity
- Stroboscopy
  - Glottic closure
  - Amplitude
  - Mucosal wave
  - Vertical level/ height
  - Adynamic segments
  - Phase closure
  - Phase symmetry
  - Periodicity
  - (and all features rated on halogen)

    Requires sustained vowel and periodic signal

Halogen parameters

Arytenoid mobility	Symmetry and completeness of adduction and abduction of arytenoid cartilages	Normal, reduced, immobile
Vocal fold edge	The smoothness of the vocal fold edge	Smooth and straight, concave, convex, irregular, rough - describe
Supraglottic compression	Degree of compression of supraglottic tissues	Can be mediolateral, anteroposterior, or both
Tissue color/ integrity	Color and appearance of laryngeal tissues	Could be erythematous, whitish, rough appearing

Stroboscopic parameters

Glottic closure	Appearance of glottis during most closed part of cycle (during phonation)	Hourglass, spindle, complete, incomplete, anterior gap, posterior gap, irregular
Amplitude	Excursion from midline of vocal fold edge during vibration	Normal, increased, decreased (~50% is normal)
Mucosal wave	Degree to which the cover "waves" over the body – looks like a shimmer	Normal, increased, decreased (~50% is normal)
Adynamic segments	Any non-vibrating segments	
Vertical level match	Is one vocal fold higher than the other	
Phase symmetry	Degree to which vocal folds are mirror images of each other	
Periodicity	Periodicity of vibration	

ELSEVIER

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Voice-Vibratory Assessment With Laryngeal Imaging (VALI) Form: Reliability of Rating Stroboscopy and High-speed Videoendoscopy

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Pediatric considerations

- Most often use flexible endoscopy with very young children
- Some kids as young as 3 can participate in a rigid scope
- Some kids as young as 2 can do a strobe
- Need support from parents/ caregivers
- Comfort positioning
- Child Life Specialist

Stimulability testing

- Ability to make changes in voice
- Receptiveness to following directions/ models
- Readiness for change
- Motivation

Putting it together – what does it mean?

- Elevated perturbation measures (jitter, shimmer, noise to harmonic ratio)
  - Irregular vibration of the vocal folds
  - Could be due to
    - Mass lesion
    - Scar
    - Glottic gap
    - Stiffness
    - Hyperfunction

Putting it together – what does it mean?

- Low cepstral peak prominence
  - Irregular vibration of the vocal folds
  - Could be due to
    - Mass lesion
    - Scar
    - Glottic gap
    - Stiffness
    - Hyperfunction
  - Poor filter utilization
    - Back focus
    - Strain
    - Supraglottic hyperfunction

Putting it together – what does it mean?

- F0 too low
  - Increased mass of vocal folds
    - Edema
    - Lesion
- F0 too high
  - Decreased mass of vocal folds
    - Laryngeal web
    - scar/ sulcus

Putting it together – what does it mean?

- Reduced F0 range
  - Increased mass of vocal folds (lesion/ edema)
  - Reduced pliability/ stretch (scar/ lesion)
  - Neurologic deficit (SLN injury, RLN injury)
  - They haven't learned how yet
- Reduced maximum phonation time
  - Glottal gap (lesion, paralysis, scar)
  - Poor respiratory/ phonatory coordination
  - Stiffness (lesion/ scar)

Case

- History
  - 8 year old male with history of dysphonia for 4 months
  - Reports pain/ discomfort by the end of the day
  - Says he can’t sing
  - Plays hockey and sometimes yells
  - Has become less talkative
  - Unremarkable medical history
- P-VRQOL 62/100 (100 is no handicap)

Case

Case

- CAPE-V
  - Overall 66
  - Roughness 73
  - Breathiness 67
  - Strain 85
  - Loudness 34 (too soft)

Respiration

- MPT 3.52 sec
- Shallow, clavicular breathing
- Breath holding noted

Acoustics and Aerodynamics

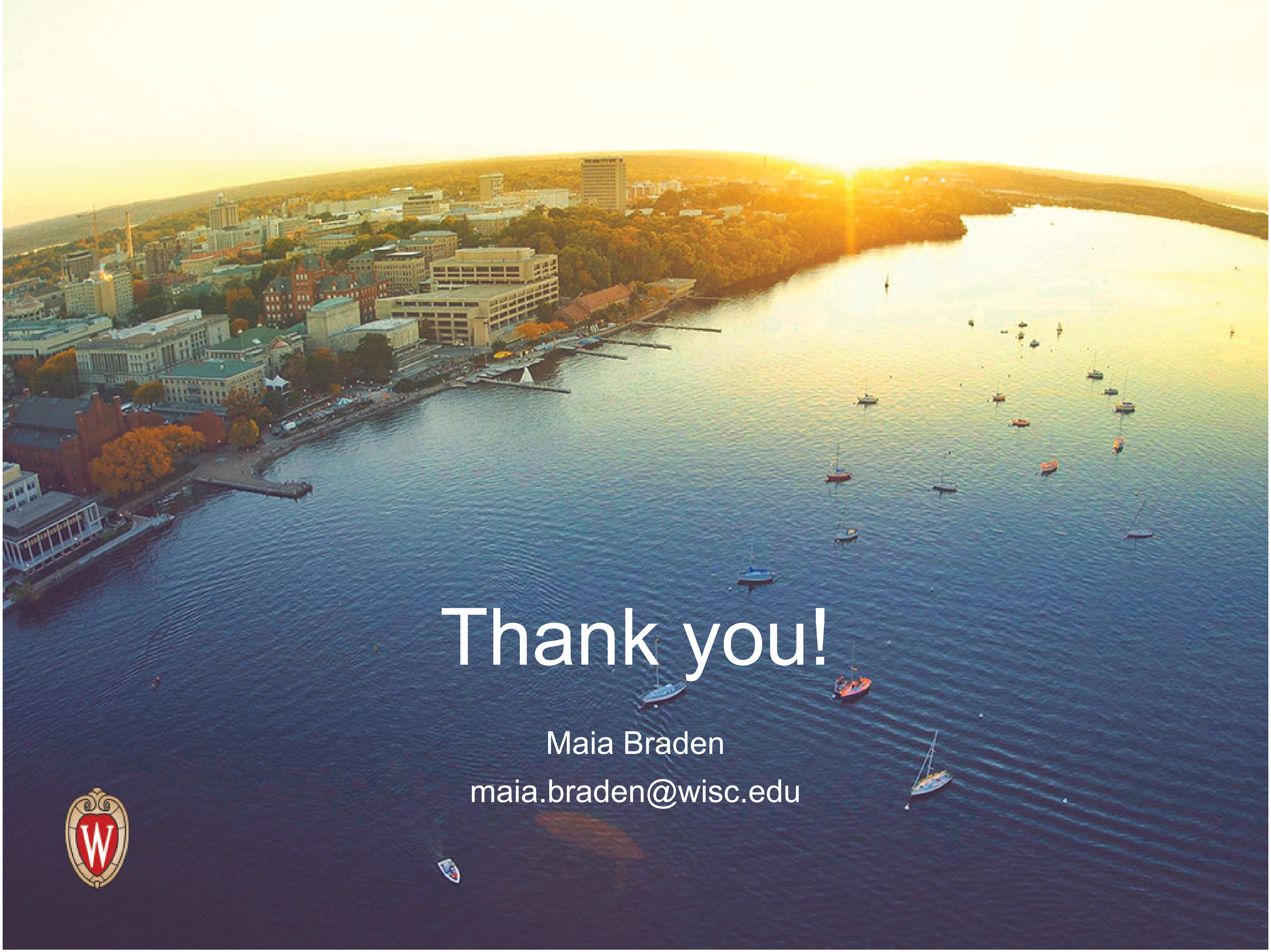
	Scores	Interpretation
Jitter	3.107	elevated
Shimmer	7.532	elevated
MPT	3.52 sec	reduced
Pitch range	145.34-327.43 Hz	limited
Ptp	7.84 cm H2O	elevated
Mean airflow during voicing	0.28 L/sec	elevated
Mean peak pressure	13.54 cm H2O	elevated
CPP on connected speech	4.82	low

Stimulability testing

- Difficulty coordinating airflow and voice
- Reduced discomfort and increased ease with straw bubbles, sustained “v”
- What would we recommend?

Summary

- Comprehensive pediatric voice evaluation consists of multiple components
- Complete evaluation is needed to plan treatment
- Most children can participate in a full voice evaluation
- Normative data are available to compare



Thank you!

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