Singing through

Adolescent voice change

Calvin Peter Baker, PhD Candidate
A concise description of 'normative' physiological vocal developments in male and female adolescents.

1) Problem – What and Why?
2) MAVC – Who said What, How, and When?
3) FAVC – Who said What, How, and When?
4) Pedagogy – Teaching through AVC
5) Resources and Questions
What's the problem?

Little empirical data is currently available regarding FAVC acoustic and physiological characteristics.

Despite more and more research becoming available on AVC in general, assessors can still assume a positive linear correlation between age and vocal maturity and skill. This can lead to inequality in interstudent assessment practices and grade outcomes.
Definition of Terms

- **AVC** – Adolescent voice change.
- **Morphometry** – in this instance the measurements of the cartilages of the larynx.
- **Mutation** – physical growth and development.
- **F0** – fundamental frequency. The rate at which the vocal folds oscillate (determines perceived pitch).
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MAVC – What we know

- MAVC begins after the onset of puberty – direct result of increase and interaction of sex hormones.

- Average of 18 months, but ranges from eight to 37 months (Hollien et al., 1994).

- Greatest changes in F0 are seen between 14 and 18 years (Curry, 1940; Hollien, 2012) – circum-NCEA.
  - As a generalisation, F0 correlates with body mass (Evans, Neave, & Wakelin, 2006)
    - ie larger body, lower voice.

Cartilages  Vocal Folds  Acoustic Characteristics
Cartilages

- Thyroid cartilage growth most prominent across the anteroposterior aspect (EE'; 15.04mm) and posterior height (AD; 12.87mm).

- Cricoid cartilage growth most significant in width (H'H; 10.15mm) and length (J'J; 9.50mm).

- Rapid increase in laryngeal cartilaginous mass (increase of approximately 10.6g) often results in incoordination of intrinsic laryngeal musculature and nervous system control (Boltezar, Burger, & Zargi, 1997).

- Increased bulk can affect vocal agility (Hook, 2005).

- Physical laryngeal and vocal fold growth continue from puberty into late adolescence.
  - Laryngeal cartilages only begin ossification in early adulthood.
Vocal Folds

- Increase in anteroposterior aspect of thyroid results in vocal fold length increase.
  - Average of 63% (Kahane, 1978; 1982).
  - Longer VFVs correlate with lower F0 (Titze, 1989).

- Glottal insufficiency acoustically linked to breathiness and common during adolescent vocal mutation (Graham et al., 2012).

- While the three (or five) layer structure of the vocal folds are developed by approximately 17 (Tateya and Tateya, 2015), laryngeal growth can result in glottal instability past this point.

F0 and VF mass

Hollien, 2012, p e30.
Interesting research

An increase in vocal fold thickness is often quoted as the reason for a drop in F0. However, F0 is dependent on the relationship between mass and tension, not simply one or the other (Titze 1993, 2011). The main impact that vocal fold mass has on voice production is that of registral shift.

Larger VF mass changes the shape of the vocal fold margin from wedged to rectangular, thus requiring an adjusted muscular antagonism for the maintenance of oscillation.

ie registral breaks or squeaking voices during AVC
Acoustic Characteristics

- Lowering of F0 results in perceptually lower voice
  - approximately one octave over puberty.

- Breathiness.
  - glottal insufficiency.

- Increased musculoskeletal tension to 'control' the voice.
  - psychosocial impact (Freer, 2009).
  - impact of vocal efficiency and health

- Pitch instability
  - result of lagging neurological connections (Boltezar, Burger, & Zargi, 1997) and, often, musculoskeletal tension (Pfordresher & Brown, 2007).

- Increase in vocal fold mass can lead to greater magnitude of registral breaks (Titze, 1989).
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FAVC – What (little) we know

• FAVC is a secondary sex characteristic of the pubertal growth spurt.
  • Begins with menarche (11–14, ± 1.5 years).
• Sexual dimorphism becomes apparent in cartilages, vocal folds, and acoustic characteristics.
• Generally a much more subtle change than that experienced by males.
  • Requires more attention from teacher (Hayden, 1907, cited in May & Williams, 1989).
• Majority of the literature available is dated (15+ years) and largely perceptual or commentary.
• Little research including participants between 16 and 20 (late adolescence).
Cartilages

- The thyroid grows most prominently across the posterior height (AD; 7.81mm) and the posterior inferior thyroid width (CC’; 5.28mm).
  - increases distance of VF approximation.
  - anterioposterior aspect (EE’) increases by 4.47mm.

- Weight of
  - thyroid increases by 62% (2.17g).
  - cricoid increases by 46% (1.65g).
  - Arytenoid increases by 55% (.11g).
  - Total: 3.93.

- Increased weight and bulk can affect vocal agility (Hook, 2005).

- All measurements < male counterparts expect angle of thyroid cartilage (Jain & Dhall, 2008).

- Physical laryngeal and vocal fold growth continue from puberty into late adolescence (Duffy, 1970, p 23).
  - Laryngeal cartilages only complete ossification from approximately 28–32 years (Thurman & Klitze, 2000, p 698).
Vocal Folds

- Increase in anteroposterior aspect of thyroid results in vocal fold growth.
  - Average of 34% (1978; 1982)
  - Longer VF = lower F₀ (Titze, 1989).

- Glottal insufficiency acoustically linked to breathiness and common during adolescent vocal mutation (Graham et al., 2016; Thurman, 2012).

- Posterior glottal chink common during FAVC, and does not resolve through training (Gackle, 1987), but rather through physiological maturation (Vennard, 1967, cited in May & Williams, 1989).
Menstruation – Something to consider...

Following ovulation (luteal phase of the menstrual cycle) the reduction of oestrogen and increase in progesterone can have an oedemic effect of the vocal tract lining and mucosal layers of the vocal folds (Abitbol, Abitbol, & Abitbol, 1999; Abitbol et al., 1989; Hägg & Taranger, 1980), affecting intonation, aerodynamic efficiency, and agility (Gackle, 2002; Thurman et al., 2000).
Acoustic Characteristics

• Duffy (1970)
  • significant of total F0 decrease (43%) after 15 (NCEA).
  • increased instances of voice ‘breaks’ between 13 and 15 (eldest measured).

  • breathiness of tone (glottal ‘chink’/mutational gap).
  • lowered range.
  • insecurity of pitch.
  • voice cracks.
  • hoarseness (?) and/or breathiness due to menstruation and/or misuse.
  • discomfort
    • feelings of heaviness, thickness, or stiffness
  • reduced range.
  • higher PTP.

• Williams, Larson, & Price (1996)
  • inconsistencies, breathiness, breaks, and day-to-day variation all perceived as more frequent post-menarcheal (ie peri- and post-pubertal).
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Mitigating the effects

Distinguish the difference between vocal-technical and vocal-mutational voice characteristics. Issues such as breathiness and poor intonation can be symptoms of AVC and therefore should not be treated in the same manner as a teacher might in an adult student.

Freedom freedom freedom.

Suggestions given are formulated on contemporary vocal-pedagogical literature and practitioner experience. They are concepts that can and should be adapted to each student's voice, so are not overly prescriptive.
Tension

Many muscles participate in speech and singing, including intrinsic and extrinsic muscles surrounding the larynx and musculature in the torso.

Inappropriate muscle tension is, however, extremely common in paediatric voices and contribute to vocal fatigue, intonation inaccuracy, inefficient breath use, and decreased range (Lauchsinger & Arnold, 1965, pp 303–306).

Inappropriate physical tensions can accrue through adolescence hindering vocal skill development and increasing chances of vocal injury.

1) Physical Check

Have the student observe where he or she is holding tension. The body and voice change day to day, so the voice needs to be treated as a new one, with unique conditions, each lesson.

2) Movement

Shoulder rolling, stretches (not head back), Feldenkrais and/or Alexander Technique.

Movements should be focused on quality rather than range of stretch.
Warmups

Vocal warmups are essential to the singer’s vocal health (Bishop, 2003; Gish et al., 2012; Pomfret, 2012).
- Provides a mindful moment for focus.
- Allows the teacher to observe the student’s voice that day.

Explain why you have chosen each task and talk to the student about how his or her voice feels and what you hear in it.
- Student perception is extremely valuable.
- Develops autonomy and proprioceptive skills.

Goal specific warmups
- Target specific areas of the voice that need attention in that moment.

Noise releasing vs Voice making
- Letting go of the voice and allowing free vocal function.

Example

A student comes into her lesson, first thing in the morning. During the initial warmup you hear that her voice sounds heavy, thick, somewhat breathy and quite inflexible.
To stretch and get the vocal folds oscillating freely would you prescribe

a) a descending 5, 4, 3, 2, 1 scale on a dark [a] vowel from the middle of her range, or

b) siren on a voiced consonant ([v], [ð]) from middle range, within an octave at first then extending the range?
Most likely b... ✓

A descending passage on a dark vowel would encourage thickening and slackening of the vocal folds – i.e. the state they are in when we wake up (cadaverous state).

Sirening on voice consonants encourages balanced resonance, adductor coordination, and easier and more even vocal-fold oscillation (Croake, Andreatta, & Stemple, 2017; Dargin & Searl, 2015). These have similar effects to semi-occluded exercises as prescribed by Titze.
different voice = different approach

During adolescence when physical growth and mutation is at peak velocity and magnitude, it is important to remember that the voice can be in a state of flux for varying lengths of time. It may seem sometimes that from week to week the student has a different voice or that completely different seemingly unrelated issues are arising each lesson.

View the voice as something new each week – give it and the student what they need then and there, to find stability and healthy function of their instrument, through the instability of AVC.
Breathing
Appropriate breathing for singing should be taught from the start, regardless of age.

Not all singers (or teachers) feel the need to understand the ins and outs of voice science and aerodynamic-myoeelastic theory. But... an accurate knowledge of the breathing process and its relationship to healthy phonation is necessary for diagnostic teaching.

Breathing for singing is always dynamic and requires constant adjustment (Watson, 2019).

Miller says...

1) Subglottal pressure too high
Aggressive contraction and pulling in of abdominal muscles forces viscera to push against the diaphragm, compresses the lower portion of the thorax. VFs must thicken and tighten to maintain phonation.

2) Subglottal pressure too low
The inspiration is not energised and so adequate volume and pressure is not achieved in the thorax. Phonatory threshold pressure is not reached or is not stable, and VFs cannot sustain even oscillation (Bernoulli effect).
There is no reason why junior high or high school students cannot comprehend the primary mechanics of breathing, if those concepts are properly explained....An explanation of the actions of the musculature of the torso lies well within the comprehension of youthful singers....By identifying and drilling these natural processes, development of the musculature requisite to the appoggio begins. Flexibility replaces tension; the singing timbre improves; phrase duration is extended.

Breathiness in adolescent singing does not always equate with 'not enough support'.

Particularly in FAVC, because of weakness and/or incoordination of adductor muscles, glottal insufficiency is common and resolves with maturity. Pushing more air though the vocal folds will only make it more difficult for the vocal folds to come together, thus necessitating extrinsic muscular tension to force closure.
Modal transitions

Increase in vocal fold mass during AVC can contribute to difficulty in negotiating passaggi/registral transition points.

It is vital that both male and female adolescent singers learn to transition between 'head' and 'chest' registers freely. Doing so will allow boys to switch to 'head voice' when needed more freely (Barlow & Howard, 2002; Conrad, 1964; Herman, 1988; Phillips, 2014; Stockton, 2015; Williams, 2013), and will encourage a more balanced voice use in girls (mixture of TA and CT sounds).

The young chorister...

One group of male singers reported that they continued singing in HV long after their voices had changed, as they had the notes available and were encouraged to do so by choral directors (Baker, 2018). This will put excessive strain on the voice and can lead to a sudden loss of an instrument when the small muscles of the larynx can no longer sustain a prepubescent vocal posture.

Yodelling on a 'bright' open [a] vowel.
Not about beautiful sounds but rather freedom of laryngeal movement and VF position.
Allow the 'clunk'!
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References


• Hove, S. (2005). Vocal agility in the male adolescent changing voice (Deseretion, University of Pennsylvania, Columbus, USA)


Recommended Reading


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