VOICED PHONATION (=VOICING or MODAL VOICE)
A review

There are different ways in which the larynx can produce sounds: the process is called *phonation*.

Phonation is the use of the *laryngeal system*, with the help of an *airstream* provided by the respiratory system, to generate an *audible source of acoustic energy* which can be *modified by the articulatory actions of the vocal apparatus*.

PHONATION TYPES: (only two types will be reviewed here)

1. VOICELESSNESS

   a. NIL PHONATION

   - the vocal folds can be widely abducted or they can be fully adducted

   - when abducted, the glottis is widely open → the acoustic input to the vocal tract will be *zero*
     ↓
     if the rate of *transglottal airflow* is below the level that would generate local turbulence in the glottis.

A smooth (=laminar) airflow is *silent*.

A turbulent airflow creates an *audible hiss*.

Whether the flow is laminar or turbulent depends on two factors:
i. rate of airflow
ii. area of the glottis

(A man with a large glottis will require a higher rate of airflow to reach the threshold of turbulence than a woman or a child).

NIL PHONATION:

silent, smooth (laminar) airflow through the wide open glottis

or

zero airflow with the glottis closed

b. BREATH PHONATION

- The threshold of airflow through a typical adult male glottis for creating turbulence: 200-300 cc/s (cubic centimetres/second)
- Below this threshold the airflow is laminar: NIL PHONATION
- Above this threshold the airflow is turbulent: AUDIBLE
  ↓
  very gentle, rustling sound
  (e.g. <u>h</u>at)

c. WHISPER PHONATION

- The airflow through the glottis is turbulent → *hissing* quality.
- More intense than in breath phonation -- the vocal folds are positioned much closer (or completely together) except between the arytenoids: triangular opening at the back of the larynx (one third of the length of the larynx);
  the pulmonic air flows at high velocity into the pharynx with considerable turbulence.
- Whisper can also be produced with a slightly more open glottis → as long as the wide open position for breath phonation is not reached.
- Breath and whisper phonations: they represent different degrees of constriction on a scale of decreasing width of glottis opening.

Breath phonation: voiceless adjustment of the glottis is set between 60-95% of the maximum glottal area.
Whisper phonation: the adjustment is less than 25% of the maximum glottal area; the rate of airflow through the very constricted glottis for whisper is 25-30 cc/s.

2. VOICED PHONATION (= VOICING *or* MODAL VOICE)

- Acoustically different from the breath and whisper phonation states:

breath phonation
whisper phonation
} *CONTINUOUS acoustic input into the vocal tract*

voiced phonation: *PULSED input, with the frequency of the pulsing being the product of muscular and aerodynamic factors*

The muscle activity needed to adduct and tense the vocal folds simply makes them ready for vibration, BUT DOES NOT CAUSE THE VIBRATION ITSELF.

The two aerodynamic forces which produce vibration of the vocal folds are:

i. SUBGLOTTAL AIR PRESSURE applied to the lower part of the folds, forcing them to open (= POSITIVE PRESSURE!)

ii. BERNOULLI EFFECT → The vocal folds cannot stay apart due to the reduced pressure (= NEGATIVE PRESSURE!)

These positive and negative pressures set the vocal folds vibrating due to the ELASTICITY OF THE FOLDS.

MYOELASTIC-AERODYNAMIC THEORY OF VOICE PRODUCTION

Course of events during voiced phonation:

- The glottis is closed or nearly closed

- Respiratory pressure from the pulmonic egressive airstream builds up → *subglottal pressure rises.*

- When the subglottal pressure becomes high enough to overcome the muscular forces which are holding the vocal folds together, the vocal folds are blown slightly apart.
- The compressed air bursts through the narrow gap into the pharynx; the airflow will reach high velocity *because of the narrow constriction.*

  Consequence: Drop in pressure in the zone of glottal constriction; the high speed airflow will suck the vocal folds together → BERNOULLI EFFECT!

- The elastic tension of the laryngeal muscles is at work to close the larynx against the diminishing subglottal pressure → when the combined force of the myoelastic and aerodynamic factors is sufficient to overcome the force of the respiratory pressure, the vocal folds snap shut.

- in the instant of glottal closure an acoustic shock-wave will travel up through the vocal tract:

THE ACOUSTIC OUTPUT OF THE LARYNX IS MOST INTENSE AT THIS POINT

↓

THIS ACOUSTIC OUTPUT PROVIDES MAXIMUM ENERGY TO THE RESONANCES OF THE VOCAL TRACT.

- With the vocal folds closed, the subglottal pressure, driven by the respiratory system, begins to rise again → the cycle of events will be repeated.

- The repetition of the cycle of events is very rapid:
  about 120 cycles per second (male)
  220 cycles per second (female)

Review the role of the intrinsic laryngeal muscles in the control of vocal fold behaviour (abduction, adduction and tensioning).

The production of all speech sounds is the result of *manipulation of air from the lungs*.

Methods used for making the air audible:

a. VOICING: The creation of near-periodic sound waves by the rapid opening and closing of the vocal folds.
The air from the lungs is chopped into tiny puffs of air which are audible.

b. CONSONANT NOISE: Part of the speech mechanism is positioned in such a way that aperiodic sound waves are created in the vocal tract.

c. COMBINED METHOD:
Combinations of periodic and aperiodic sound waves are created (voiced consonants)