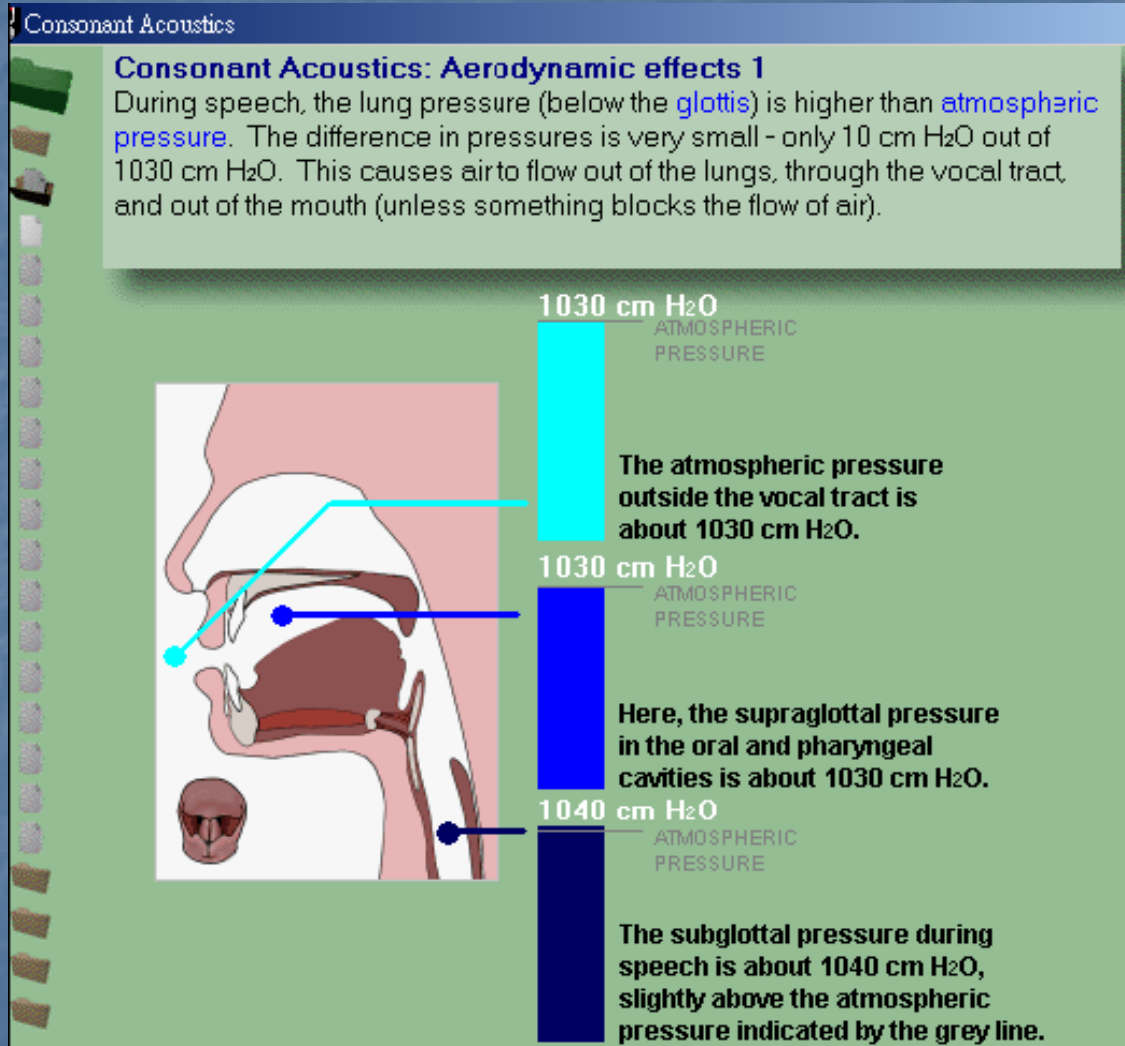


Chapter 6

Airstream Mechanisms and Phonation Types

The general concept



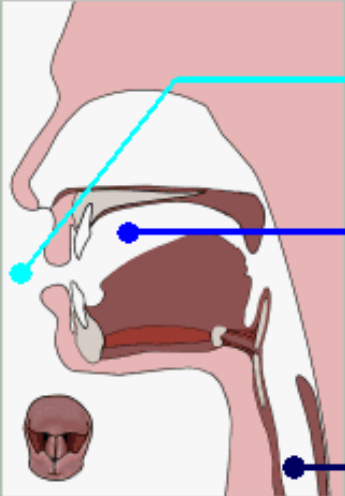
What happens when we pronounce a sound?

The general concept

Consonant Acoustics

Consonant Acoustics: Aerodynamic effects 2

We will concentrate on pressures relative to atmospheric pressure, since the difference between the **subglottal** pressure and the atmospheric pressure is what causes air to flow through the vocal tract. During speech, the subglottal pressure is about 10 cm H₂O above atmospheric pressure.



The atmospheric pressure outside the vocal tract is our reference level.

ATMOSPHERIC PRESSURE

Here, the supraglottal pressure is the same as the atmospheric pressure.

ATMOSPHERIC PRESSURE

10

The subglottal pressure during speech is about 10 cm H₂O above atmospheric pressure.

ATMOSPHERIC PRESSURE

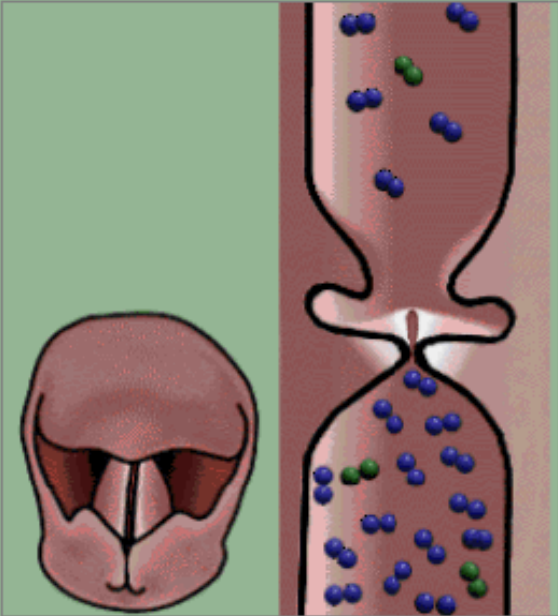
That means that we “exhale” 10 cm H₂O when we pronounce a sound.

The general concept

Consonant Acoustics

Consonant Acoustics: Aerodynamic effects 4

As the vocal folds vibrate, air flows through the glottis (the opening between the folds). As the glottis changes size, the air flow through it fluctuates, producing sound. The sound produced by vibrating vocal folds is phonation or **voicing**. This animation shows air molecules flowing from the subglottal region of higher pressure to the supraglottal region of lower pressure.



The diagram illustrates the vocal tract during phonation. On the left, a sagittal cross-section of the larynx shows the vocal folds vibrating. On the right, a vertical cross-section of the glottis shows air molecules (represented by blue and green spheres) flowing from the subglottal region (lower pressure) to the supraglottal region (higher pressure). The air flow is depicted as a series of pulses, indicating the fluctuating nature of the flow during vibration. Below the diagram are navigation controls: a left arrow, a central play button, and a right arrow.

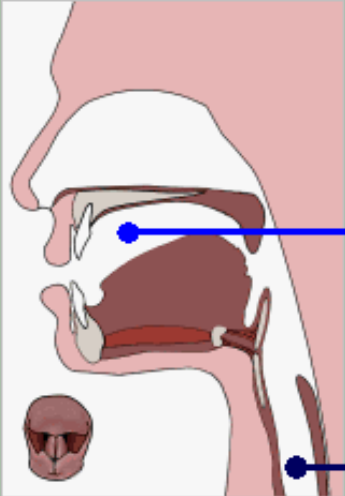
This shows that how the air goes through the vocal folds.

The general concept

Consonant Acoustics

Consonant Acoustics: Aerodynamic effects 5

In a vowel, a **nasal stop**, or an **approximant**, the airflow out of the vocal tract is not blocked. Thus, air flows freely out of the vocal tract, and the supraglottal air pressure is about equal to the atmospheric pressure.



The supraglottal pressure in vowels, nasals and approximants is about the same as the atmospheric pressure.

ATMOSPHERIC PRESSURE

10

The subglottal pressure during speech is about 10 cm H₂O above atmospheric pressure.

ATMOSPHERIC PRESSURE

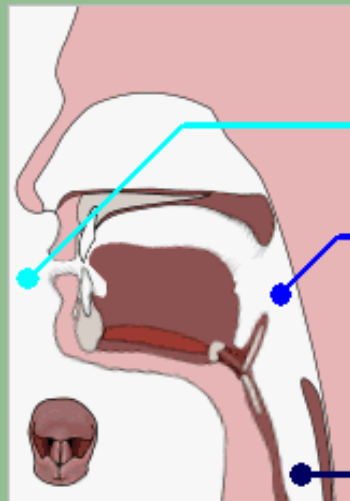
What about the nasal stop sound?

The general concept

Consonant Acoustics

Consonant Acoustics: Aerodynamic effects 7

In a **fricative**, the constriction of the vocal tract produces a resistance to the airflow, just as pinching a garden hose creates a resistance to the flow of water. This decreases the total airflow in the vocal tract and creates an increase in the supraglottal pressure. The flow through the narrow constriction also becomes **turbulent**, producing fricative noise.



The pressure outside the vocal tract is atmospheric pressure.

ATMOSPHERIC PRESSURE

5

The supraglottal pressure in fricatives is higher than atmospheric pressure.

ATMOSPHERIC PRESSURE

10

The subglottal pressure during speech is about 10 cm H₂O above atmospheric pressure.

ATMOSPHERIC PRESSURE

What about the fricative sound?

The general concept

Consonant Acoustics

Consonant Acoustics: Aerodynamic effects 9

In a **voiced oral stop**, the articulation completely blocks the flow of air. This causes the air flowing through the glottis to collect in the oral and **pharyngeal cavities**, raising the supraglottal air pressure. This increase begins before articulatory closure - it begins when the **articulators** constrict the vocal tract enough to produce a resistance to the airflow



Supraglottal pressure:
increases during vocal
tract closure.

ATMOSPHERIC
PRESSURE

10

Subglottal pressure:
about 10 cm H₂O above
atmospheric pressure.

ATMOSPHERIC
PRESSURE

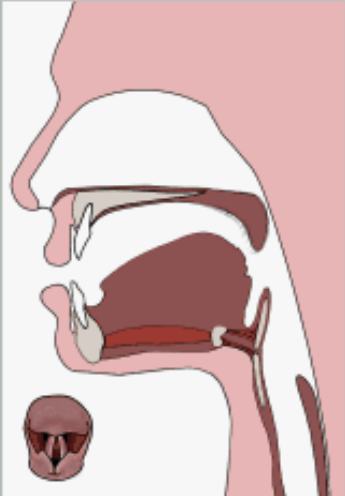
What about the
voiced
consonants?

The general concept

Consonant Acoustics

Consonant Acoustics: Aerodynamic effects 11

In a **voiceless** stop, the vocal folds **abduct** immediately after the **oral closure**. This opens the glottis, allowing air to flow freely from the **trachea** into the **pharynx**. This causes the supraglottal pressure to rise immediately, bringing phonation to a halt.



The diagram illustrates the vocal tract in profile, showing the oral cavity and the glottis. A small inset shows a cross-section of the glottis. A blue bar labeled '10' indicates the subglottal pressure level, which is 10 cm H₂O above atmospheric pressure. The supraglottal pressure is shown to increase when the glottis opens, rising above the atmospheric pressure level.

Supraglottal pressure:
increases when glottis opens.

ATMOSPHERIC PRESSURE

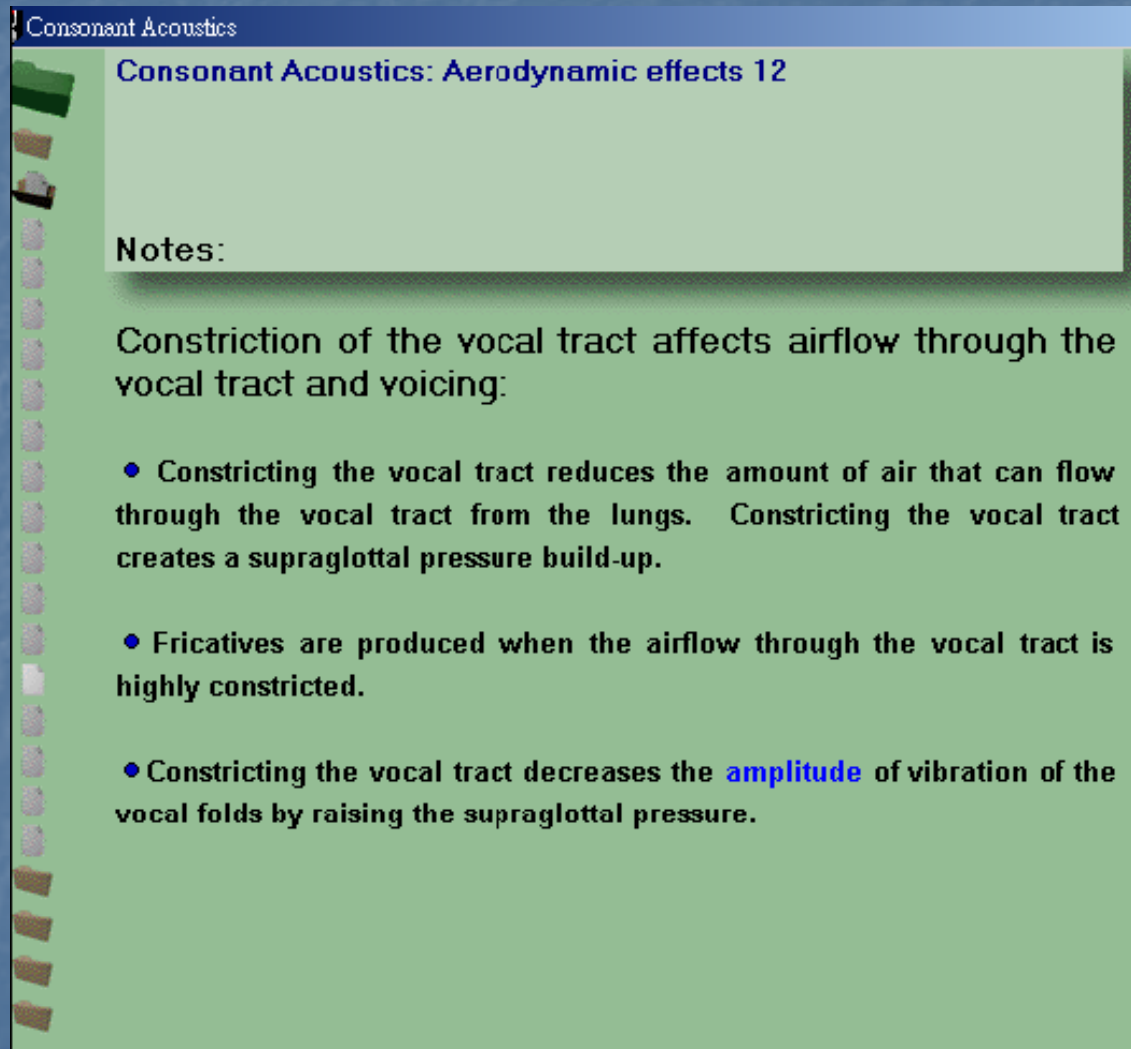
10

Subglottal pressure:
about 10 cm H₂O above
atmospheric pressure.

ATMOSPHERIC PRESSURE

What about the
voiceless
consonants?

The general concept

The image is a screenshot of a presentation slide. The title bar at the top is blue and contains the text 'Consonant Acoustics'. The slide itself has a light green background. On the left side, there is a vertical toolbar with various icons, including a green folder icon at the top, followed by several small icons of papers and folders. The main content area of the slide is titled 'Consonant Acoustics: Aerodynamic effects 12' in a dark blue font. Below the title, the word 'Notes:' is written in a bold black font. The notes consist of a paragraph and three bullet points. The paragraph states: 'Constriction of the vocal tract affects airflow through the vocal tract and voicing:'. The three bullet points are: 1. 'Constricting the vocal tract reduces the amount of air that can flow through the vocal tract from the lungs. Constricting the vocal tract creates a supraglottal pressure build-up.' 2. 'Fricatives are produced when the airflow through the vocal tract is highly constricted.' 3. 'Constricting the vocal tract decreases the amplitude of vibration of the vocal folds by raising the supraglottal pressure.' The word 'amplitude' in the third bullet point is highlighted in blue. The overall background of the entire image is a textured blue gradient.

What about the voiceless consonants?

The general concept

Consonant Acoustics

Consonant Acoustics: Aerodynamic effects 13

When the stop articulation in a voiced oral stop is released, the high-pressure air in the oral and pharyngeal cavities is released, producing a **burst**. As the high supraglottal pressure drops, voicing begins again since the vocal folds are in the adducted position.



3

Supraglottal pressure:
increases during vocal tract closure,
then decreases when the
articulators release the stop closure.

ATMOSPHERIC
PRESSURE

10

Subglottal pressure:
about 10 cm H₂O above
atmospheric pressure.

ATMOSPHERIC
PRESSURE



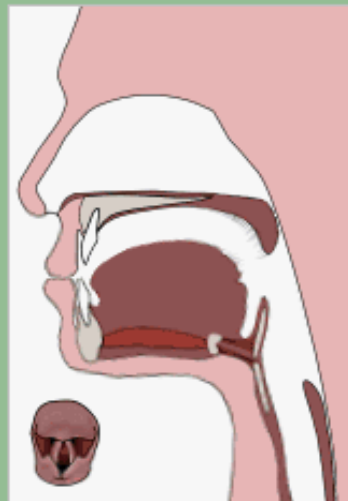
What about the
stop
consonants?

The general concept

Consonant Acoustics

Consonant Acoustics: Aerodynamic effects 14

In a voiceless stop, the glottis is generally fully open, since the vocal folds are abducted. Although the supraglottal pressure drops (producing a burst) as soon as the articulators release the closure, voicing does not resume until the vocal folds return to their adducted position.



10

Supraglottal pressure:
about equal to subglottal pressure during
the articulatory closure, then drops
rapidly when the closure is released.

ATMOSPHERIC
PRESSURE

10

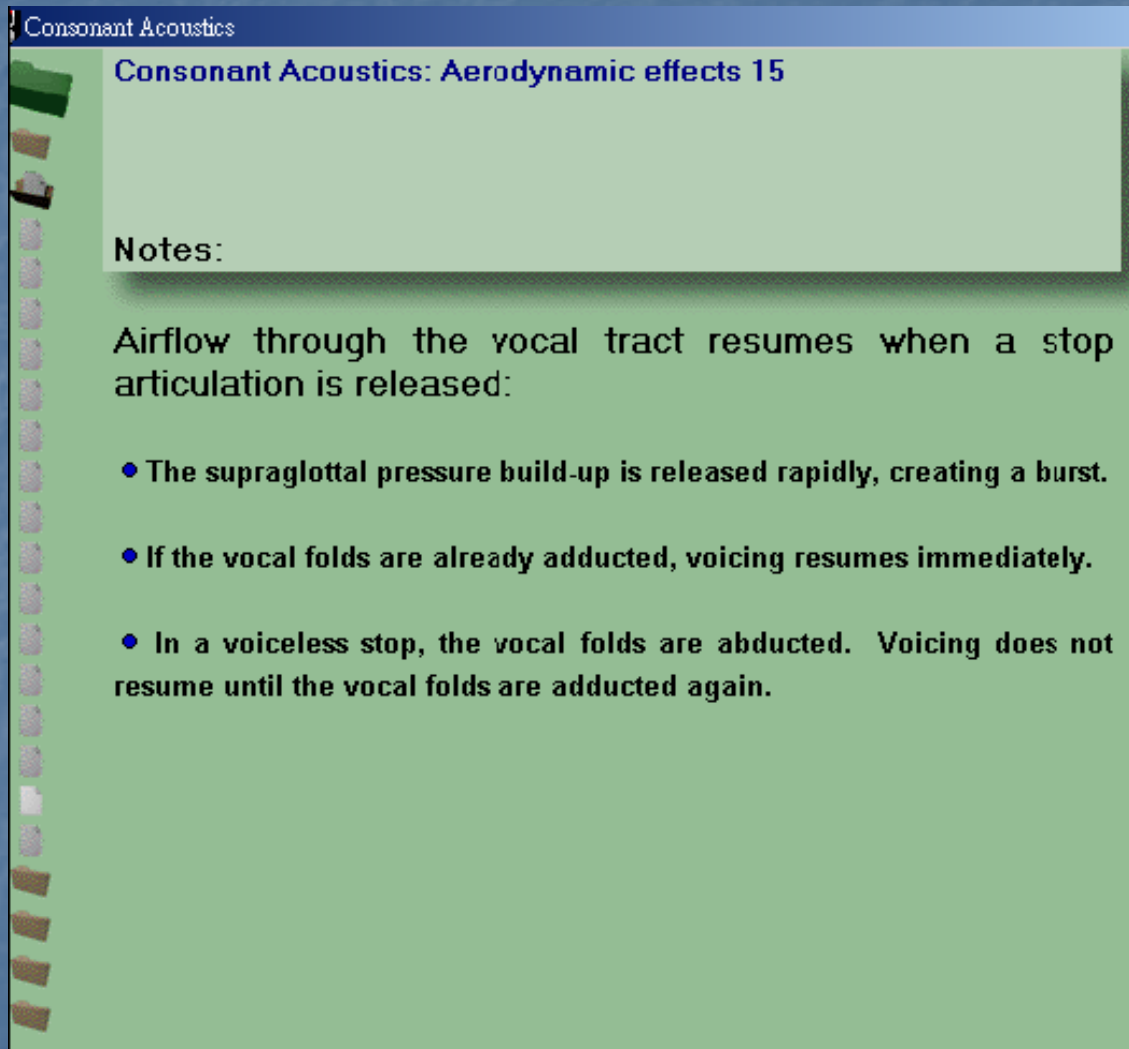
Subglottal pressure:
about 10 cm H₂O above
atmospheric pressure.

ATMOSPHERIC
PRESSURE



What about the
voiceless stop
consonants?

The general concept

The image is a screenshot of a presentation slide. The title bar at the top is blue and contains the text 'Consonant Acoustics'. The slide itself has a light green background. On the left side, there is a vertical strip of icons representing different file types. The main content area of the slide is titled 'Consonant Acoustics: Aerodynamic effects 15' in a dark blue font. Below this title, the word 'Notes:' is written in a bold black font. The main body of the slide contains three bullet points, each preceded by a blue diamond icon. The text of the bullet points describes the aerodynamic effects of stop consonants, specifically focusing on the release of supraglottal pressure and the state of the vocal folds during voiceless stops.

Consonant Acoustics

Consonant Acoustics: Aerodynamic effects 15

Notes:

Airflow through the vocal tract resumes when a stop articulation is released:

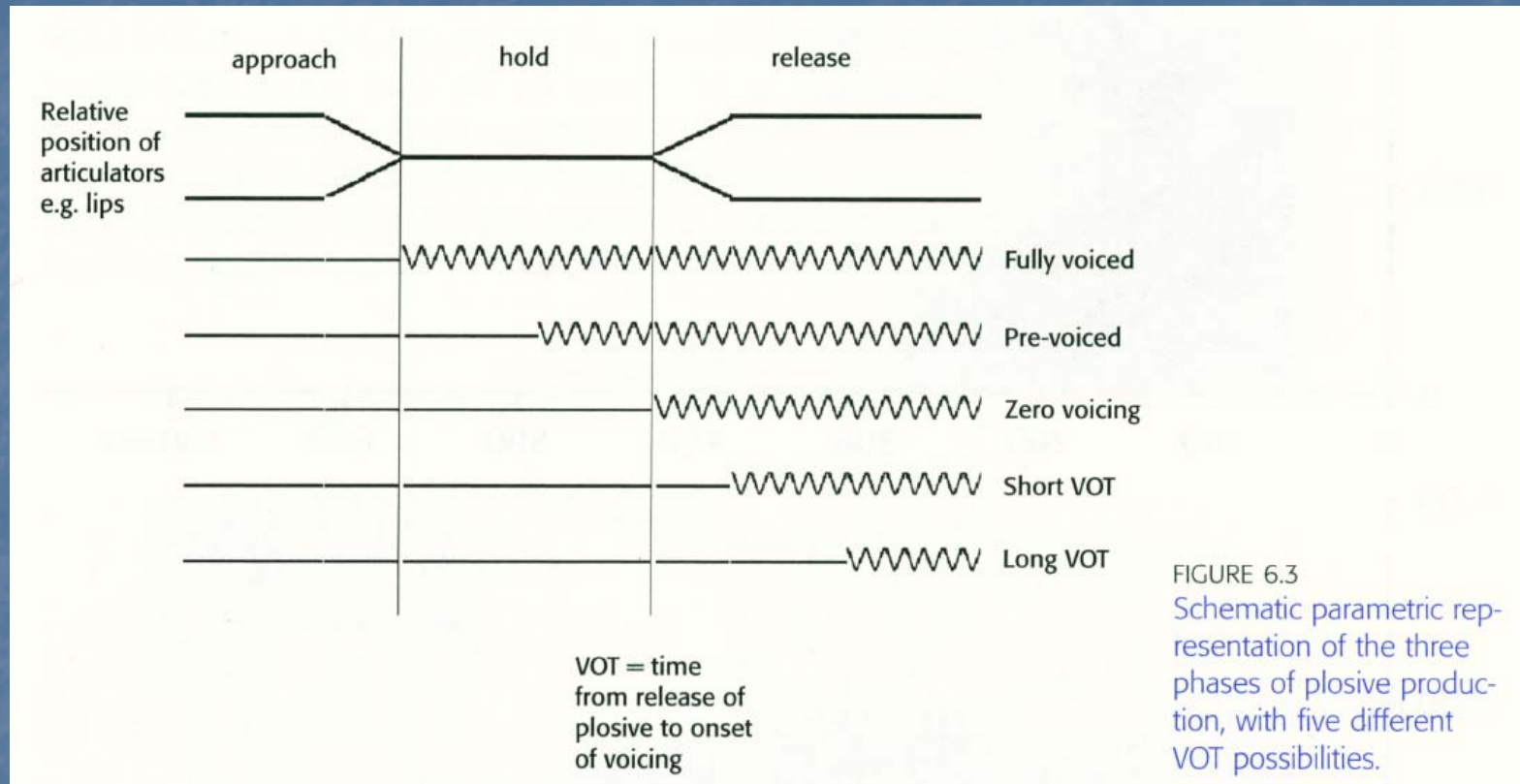
- The supraglottal pressure build-up is released rapidly, creating a burst.
- If the vocal folds are already adducted, voicing resumes immediately.
- In a voiceless stop, the vocal folds are abducted. Voicing does not resume until the vocal folds are adducted again.

What about the voiceless stop consonants?

Voice onset time (VOT)

1. For voiceless plosive consonants, vocal vibration is stopped for a period that is a little longer than the hold phase, so that there is still no vocal fold vibration around the moment of release and possibly for a further brief time afterwards. This delay, measured from the start of the explosion to the point where vocal fold vibration begins, is called the **Voice Onset Time (VOT)**.
2. The VOT is expressed in milliseconds ($1 \text{ ms} = 1,000^{\text{th}}$ of a second). The listener use the **VOT** to categorize the plosive they are hearing as **voiceless** or **voiced**.

Examples on Thai



Fully voiced

Short VOT (10 ms or so: voiceless unaspirated)

Long VOT (very long VOT: 50 ms or more – strongly aspirated)

[ba] (crazy) [pa] (aunt) [p^ha] (cloth)

[d^{ɛ̃}a] (to curse) [t^{ɛ̃}a] (eye) [t^{ɛ̃}^ha] (landing place) (Thai)

Examples on French and English

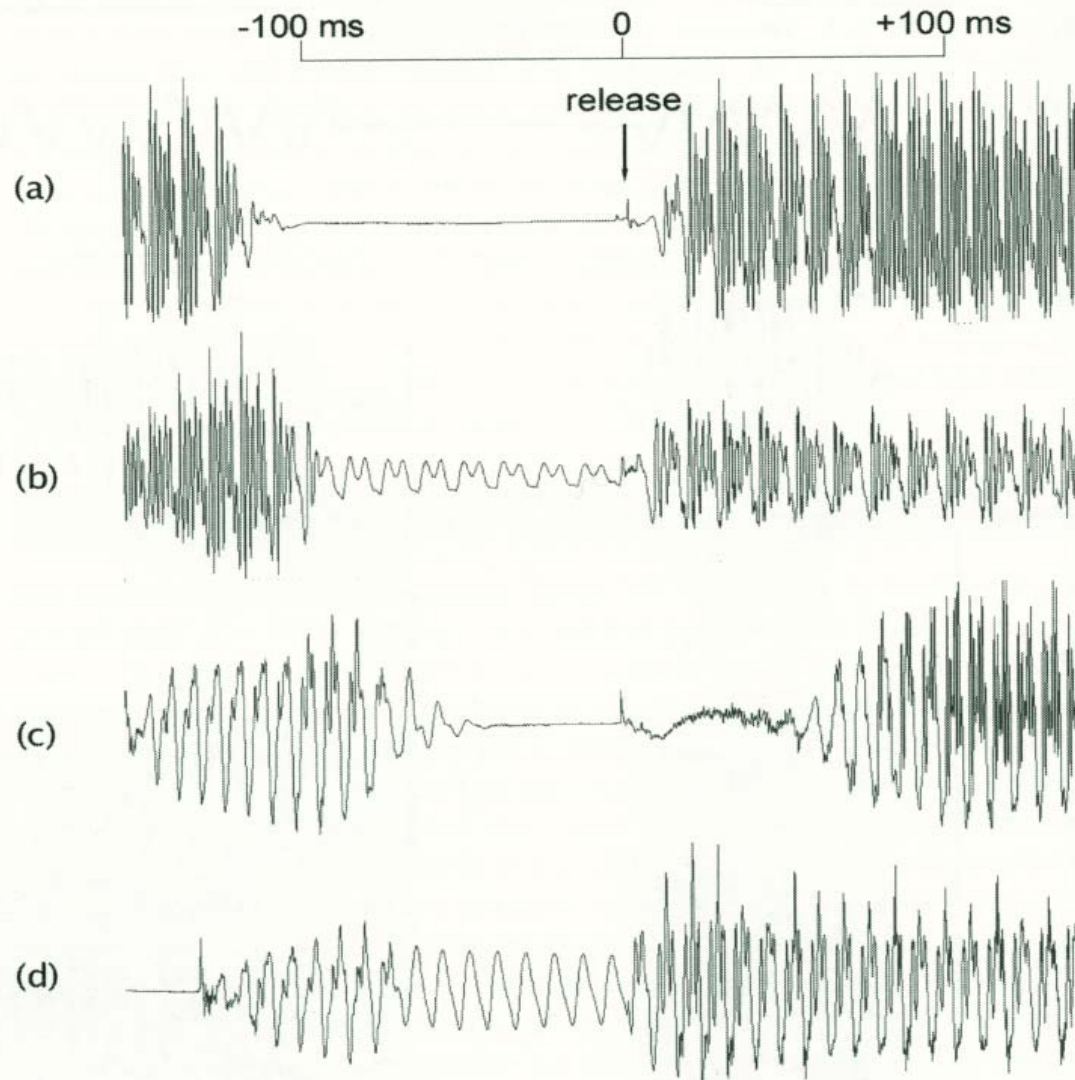
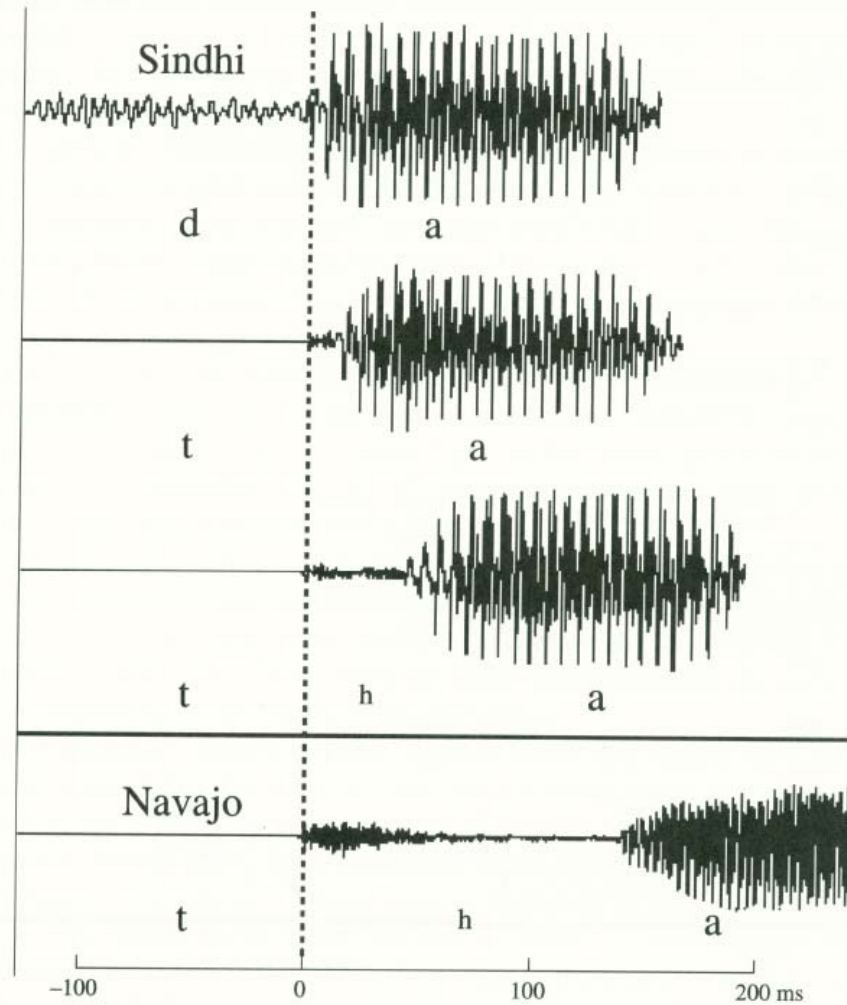


FIGURE 6.2
Waveforms showing
intervocalic plosives in
French and English,
aligned by moment of
release. The words are
French (a) *apart*,
(b) *abeille*, and English
(c) *apart*, (d) *obey*. In
this context the voiced
plosives show voicing
throughout the hold
phase in both languages.




Examples on Sindhi




FIGURE 6.5 Waveforms showing stops with different degrees of voicing and aspiration.






Examples on English

Performance Exercises Chapter 6 M

Bilabial  [ba]  [pa]  [p^ha]

Alveolar  [da]  [ta]  [t^ha]

Velar  [ga]  [ka]  [k^ha]