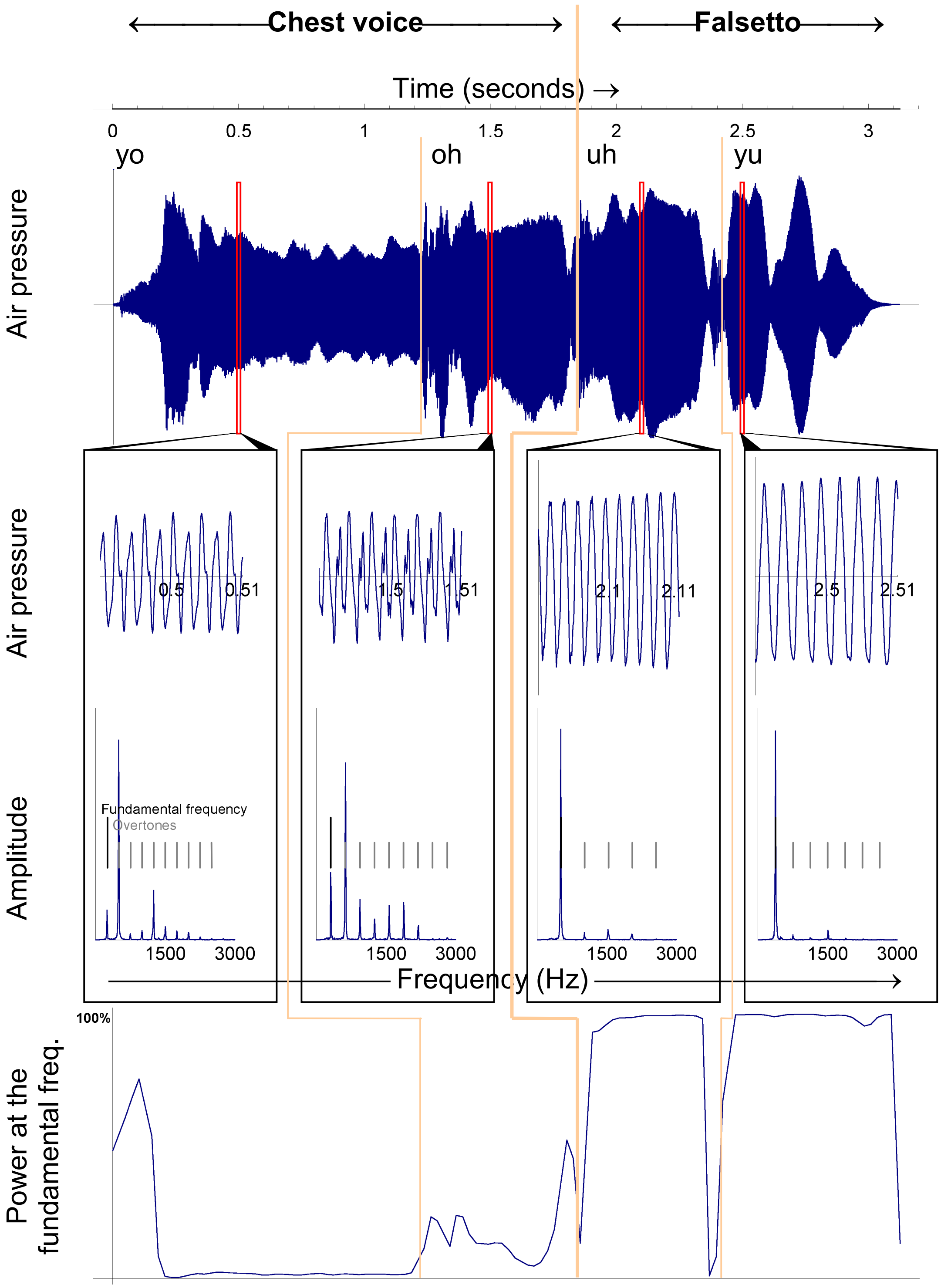

A yodeler alternates between chest voice and falsetto.

Notice that the falsetto has a more regular waveform than the chest voice.

The frequency spectrum confirms that the falsetto has fewer overtones.

Thus, the fraction of power at the fundamental frequency can be used to distinguish the falsetto voice.

Figure 1: Chest voice and falsetto waveforms

	Chest voice	Falsetto
Frequency	Low	High
Overtones	+	–
Glottis closure	+	–
Vocal cord motion	Different parts move separately	Vocal cord moves as a unit
Thyroarytenoid tension	+	–
Cricothyroid tension	–	+

Table 1: Summary of difference between chest voice and falsetto. + and – indicate relative values and not absolute amounts.

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The Mechanics of Yodeling

The human voice undergoes an abrupt transition from chest voice to falsetto at a critical frequency. With training, singers can learn to create a smoother transition between these two vocal registers. Yodelers, on the other hand, exploit this transition by rapidly alternating between chest voice and falsetto. What is the difference between these two registers, and why is there an abrupt transition?

Figure 1 shows a yodeler singing two notes in a chest voice, then two notes in falsetto. In a falsetto voice, the air pressure oscillates smoothly, whereas the chest voice has a more complex waveform. This gives us some valuable clues on the mechanism by which the larynx generates each sound. The sinusoidal variation in pressure and the lack of overtones in the falsetto voice indicates that the vocal cords are vibrating smoothly, and there is no abrupt closure or opening of the glottis. By contrast, the rich spectrum of the chest voice suggests that different parts of the vocal cords are vibrating separately, or that abrupt movements, such as closure of the glottis, are contributing to the spectral richness.

Several lines of evidence support this hypothesis. Video images of the vocal cords in action (Fletcher 1965) show that chest voice involves complete closure of the glottis and complex vocal cord movements. In particular, the flap of tissue at the top surface of the vocal cord can move independently from the rest of the vocal cord. During a falsetto voice, the glottis vibrates but does not completely close, and the vocal cords can be seen to move as a single unit.

What laryngeal muscles are important for distinguishing falsetto and chest voice? A mathematical model of the vocal cords (Lucero 1996) shows that the behavior of the vocal cords undergoes a discrete transition from chest voice to falsetto as the tension in the upper portion of vocal cord increases. The interpretation of this result is as follows: In the chest voice, the thyroarytenoid (TA) and vocalis muscles contract to increase pitch, while the cricothyroid (CT) muscle remains relatively relaxed. Because CT is relaxed, the tissue covering TA relaxes as TA contracts. This difference in tension means that the flap of tissue above the vocal cord muscles can vibrate separately, contributing to the rich overtones of the chest voice. In the falsetto voice, CT contracts to increase pitch. The CT stretches both the vocal cord muscle and the tissue overlaying it, so the whole vocal cord can vibrate more as a unit.

Recent experimental evidence (Švec 1999) supports these conclusions on the differential contraction of CT and TA. Using excised human larynges, the experimenters created an abrupt transition to falsetto simply by smoothly increasing the tension of the vocal cords (similar to the action of CT).

Decreased tension of the transverse arytenoid muscle and increased tension in the posterior cricoarytenoid muscles may aid in the production of falsetto by preventing glottis closure. However, the experiments with the excised human larynges indicate that CT tension may be the primary determinant of falsetto.

Table 1 summarizes the difference between falsetto and chest voice.

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