

Acoustic phonetics is the study of sound waves, which are the variations in air pressure reaching our ear-drums. We use machines to analyze sound waves because we cannot hear everything: as language users, we tend to hear only what is linguistically significant in the language(s) we speak.

One of the main tools in acoustic phonetics is the spectrograph, with which we can make spectrograms of short samples of human language. This allows us to see the components of consonants and vowels.

Vowels are distinguished acoustically from one another by their formant structure. Formants are overtones of the fundamental frequency, which is the frequency at which our vocal cords are buzzing. This is known as F_0 [ɛ'fow]. Variations in F_0 are perceived as pitch changes—tone, intonation, or pitch accent.

The overtones of F_0 , the formants, are F_1 , F_2 , F_3 , and so on. Each vowel has characteristic frequencies for these formants, independent of F_0 and of the speaker. To understand this, consider wind instruments. No matter what pitch—what F_0 —a trumpet is playing, you can always tell it's a trumpet. If an oboe or a clarinet plays at that same F_0 , there are the same number of vibrations per second (called Hertz, abbreviated Hz.), but you can tell when the trumpet, the oboe, or the clarinet is playing. This is because each of these instruments has a characteristic shape which accentuates certain overtones but not others. In a sense, each different instrument plays a different “vowel”. You can vary the length of these instruments and thus their F_0 , but you can't change their shape, so you can't change their characteristic vowel (unless, in the case of a trumpet, you use a mute to change the shape of the tube as the air comes out)..

But we humans can change not only the F_0 , by causing our vocal cords to vibrate faster or slower, but also the shape of the vocal tract. We do this by bunching our tongues up in different parts of the mouth, by raising or lowering our jaws, by rounding or spreading our lips, and by raising or lowering our velums to block or increase nasal resonance. All of these movements change the formants which we hear.

Here are the main things to remember about acoustics for this course:

- “High” or “close” vowels have low first formants; “low” or “open” vowels have high F_1 s. So when a linguist talks about high vowels, he/she really means vowels with a low F_1 .
- “Front” vowels have F_2 s which are considerably higher than their F_1 s. In “back” vowels, the difference is smaller.
- We hear consonants by classifying them as to manner (stop, fricative, etc.) and phonation type (voiced, voiceless, ejective, implosive, etc.), and by place. Place is identifiable by what the consonant does to the surrounding vowels. The formants of vowels are influenced by the consonants next to them: labial consonants lower F_1 and F_2 , and velar consonants raise these formants. The characteristic formant height associated with a consonant is called its locus.
- Nasal and rhotic consonants also have characteristic effects on formants.
- Fricatives can be distinguished by the kind of aperiodic noise they produce. Say [ɸ f θ s ʃ ʒ ç x χ] and you will be able to hear this.

