Fricatives are made by creating turbulent air flow. They can be either compact or diffuse, but most of the time, they are some combination of both. In a spectrogram, they look like white noise, often with regions of higher intensity (**spectral peaks**).

Compact Fricatives

The turbulence in **compact fricatives** is created by focusing the airstream through a narrow channel, creating high intensity white noise with spectral peak frequencies that depend on the length of the resonance tube formed by the remaining portion of the mouth after the end of the fricative channel. Shorter resonance tubes result in higher frequency spectral peaks. This tube can be lengthened (and thus, causing the spectral peak frequencies to lower) by raising the front of the tongue to create a **sub-lingual cavity**, forcing the airstream to travel a longer distance before leaving the mouth.

Alveolar fricatives [s z] are mostly compact, with a very short resonance tube (alveolar ridge to the lips), resulting in high frequency spectral peaks.

Post-alevolar fricatives [ʃ ʒ] are mostly compact, with a longer resonance tube (behind the alveolar ridge to the lips), resulting in lower frequency spectral peaks than for alveolar fricatives. In addition, the raised tongue tip creates a sub-lingual cavity, so the spectral peaks are at even lower frequencies than expected for a post-alveolar place of articulation.

Retroflex fricatives [ʂ ʐ] are much like post-alveolar fricatives: mostly compact, with a longer resonance tube (behind the alveolar ridge to the lips), and a raised tongue tip creating a sub-lingual cavity. In addition, retroflex fricatives have a curled tongue, which lengthens the sub-lingual cavity even more, so the spectral peaks are at even lower frequencies than for post-alveolars.

Palatal fricatives [ç ʝ] are mostly compact, with a longer resonance tube (hard palate to the lips), resulting in lower frequency spectral peaks than for alveolar fricatives. However, palatal fricatives lack a sub-lingual cavity, so their spectral peak frequencies are higher than for post-alveolar fricatives, despite being formed farther back in the mouth.

Uvular fricatives [χ ʁ] are mostly compact, with a long resonance tube (uvula to the lips), resulting in lower frequency spectral peaks than even for retroflex fricatives. Somewhat more dampened than more forward fricatives because of energy loss in the airstream as it travels further.

Diffuse Fricatives

The turbulence in **diffuse fricatives** is made by focusing the airstream against a 'wall' that disperses the airstream, reducing its overall intensity, flattening the spectral peaks. In contrast with compact fricatives, spectral peak frequencies for diffuse fricatives depend largely on the length of the fricative channel, because there is little resonance due to the dampening effect of the wall.

Bilabial fricatives [β ɸ] are mostly diffuse, with the open air outside the mouth acting like a wall. The fricative channel formed by the lips creates mild spectral peaks across a range of frequencies.

Labiodental fricatives [f v] are mostly diffuse, with the teeth acting like a wall. The fricative channel formed by the teeth and lower lip is shorter than the bilabial channel because the teeth are thinner than the upper lips, resulting in higher frequency spectral peaks than for bilabial fricatives.

Interdental fricatives [θ ð] are mostly diffuse, with the teeth acting like a wall. The fricative channel formed by the tongue along the alveolar ridge is longer than the bilabial channel, resulting in lower frequency spectral peaks than for bilabial fricatives.

Other Fricatives

Velar fricatives [x ɣ] have both compact and diffuse properties. They have a long resonance tube (velum to the lips), resulting in lower frequency spectral peaks than even for retroflex fricatives, but higher than for uvular fricatives. In addition, the airstream flows directly to the back of the alveolar ridge, which acts like a wall and dampens the overall intensity. Because the airstream travels so far in comparison to fronter fricatives, it loses energy along the way, and the dampening effect on the non-peak frequencies is even greater.

Pharyngeal fricatives [ħ ʕ] also have both compact and diffuse properties. They have a very long resonance tube (pharynx to the lips), resulting in the lowest frequency spectral peaks of all fricatives. In addition, the airstream flows through at a right angle formed by the throat and mouth, with this right angle acting like a wall and dampening the overall intensity. As with velars, because the airstream travels so far in comparison to fronter fricatives, it loses energy along the way, and the dampening effect on the non-peak frequencies is even greater.

Glottal fricatives [h ɦ] aren't really like other fricatives (and in fact, some phoneticians do not even classify them as fricatives at all), because they have no inherent tongue position. Instead, the shape of the resonance tube depends on the adjacent sound, with the glottal fricatives just acting as an overlaid phonation. For example, [hɑ] is acoustically [ɑ̥ɑ], while [hi] is acoustically [i̥i].

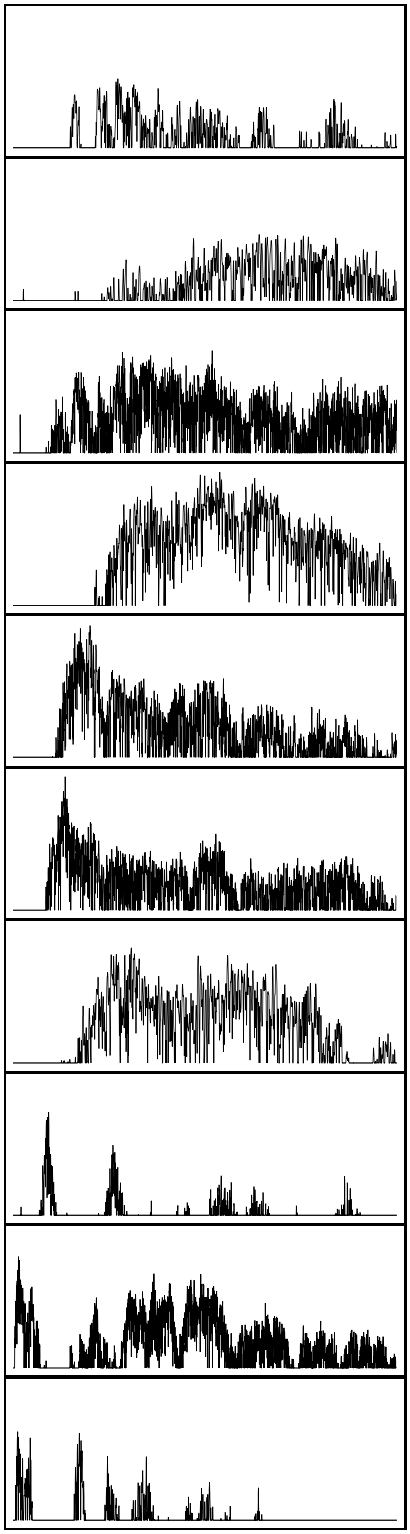
Summary

Compact fricatives: Location of the constriction generally determines the frequency of the spectral peaks. The farther back in the mouth, the lower the spectral peak frequencies are, because of a longer resonance tube. Exception: Fricatives with sub-lingual cavities lengthen the resonance tube slightly, making them sound a bit backer than their actual place of articulation, giving them lower frequency spectral peaks than expected.

Diffuse fricatives: Mostly flat due to airstream hitting a wall, with some spectral peaks dependent on the size of the fricative channel. The edge of the teeth are smaller than the lips, which are smaller than the alveolar ridge.

Combination fricatives: Resonance frequencies are like compact fricatives, but hitting a wall from very far away results in significant dampening, especially of the non-peak frequencies.

Note that these are general trends, and that for a given fricative in a given language, the acoustic properties may be somewhat different due to variation in the way it is articulated. For example, the English post-alveolars are often rounded, which lengthens the resonance tube and lowers the spectral peak frequencies below what would ordinarily be expected.



bilabial	ɸ	heavily diffused by outside air
labiodental	f	smaller channel than for bilabial; heavily diffused by teeth
interdental	θ	longer channel than for bilabial; heavily diffused by teeth
alveolar	s	small resonance tube
post-alveolar	ʃ	longer resonance tube, lengthened more by sub-lingual cavity
retroflex	ʂ	longer resonance tube, lengthened more by both sub-lingual cavity and tongue curling
palatal	ç	longer resonance tube, no sub-lingual cavity
velar	x	longer resonance tube; severely diffused by back of alveolar ridge
uvular	χ	longer resonance tube
pharyngeal	ħ	longest resonance tube; severely diffused by right angle at velum