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Airstream Mechanism

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Airstream Mechanisms

Air coming out of the lungs is the source of power in nearly all speech sounds. When lung air is pushed out, we say that there is a pulmonic airstream mechanism. The lungs are spongelike tissues within a cavity formed by the rib cage and the diaphragm (a dome-shaped muscle indicated by the curved line at the bottom of Figure 1.3). When the diaphragm contracts, it enlarges the lung cavity so that air flows into the lungs. The lung cavity can also be enlarged by raising the rib cage, a normal way of taking a deep breath in. Air can be pushed out of the lungs by pulling the rib cage down, or by pushing the diaphragm upward by contracting the abdominal muscles. In the description of most sounds, we take it for granted that the pulmonic airstream mechanism is the source of power. But in the case of obstruent consonants (stops and fricatives), other airstream mechanisms may be involved. Stops that use only an egressive, or outward-moving, pulmonic airstream are called plosives. Obstruents made with other airstream mechanisms will be specified by other terms. In some languages, speech sounds are produced by moving different bodies of air. If you make a glottal stop, so that the air in the lungs is contained below the glottis, then the air in the vocal tract itself will form a body of air that can be moved. An upward movement of the closed glottis will move this air out of the mouth. A downward movement of the closed glottis will cause air to be sucked into the mouth. When either of these actions occurs, there is said to be a glottalic

airstream mechanism. An egressive glottalic airstream mechanism occurs in about 18% of the languages of the world. Hausa, the principal language of northern Nigeria, uses this mechanism in the formation of a velar stop that contrasts with the voiceless and voiced velar stops [k, g]. The movements of the vocal organs are shown in Figure 6.1. These are estimated, not drawn on the basis of x-rays. In Hausa, the velar closure and the glottal closure are formed at about the same time. Then, when the vocal folds are tightly together, the larynx is pulled upward, about 1 cm. In this way it acts like a piston, compressing the air in the pharynx. The compressed air is released by lowering the back of the tongue while the glottal stop is maintained, producing a sound with a quality different from that in an English [k]. Very shortly after the release of the velar closure, the glottal stop is released and the voicing for the following vowel begins. Figure 6.1 The sequence of events that occurs in a glottalic egressive velar stop [k' Stops made with a glottalic egressive airstream mechanism are called ejectives. The diacritic indicating an ejective is an apostrophe ['] placed after a symbol. The Hausa sound we have just described is a velar ejective, symbolized [k'], as in the Hausa word for ‘increase’ [k'a…ra~], which, as you can hear at the website, contrasts with [ka…ra~…] ‘put near.’ (The symbol […] indicates that the vowels are long. The accents over the vowels indicate the pitch, a low tone. (We will discuss tones in Chapter 10.) The website also illustrates the contrasts between the Hausa words [kWa…ra~…] ‘pour’ and [kW'a…ra~…] ‘shea nut.’ It is possible to use an ejective mechanism to produce fricatives as well as stops, as Hausa does in the words [sa…ra~…] ‘cut’ and [s'a…ra~…] ‘arrange,’ which are also on the website. Of course, a fricative made in this way can continue only for a short length of time, as there is a comparatively small amount of air that can be moved by raising the closed glottis. Ejectives of different kinds occur in a wide variety of languages, including Native American languages, African languages, and languages spoken in the Caucasus. Table 6.1 gives examples of ejectives and

contrasting sounds made with a pulmonic airstream mechanism in Lakhota, a Native American language. The sounds of Lakhota differ from those of English in many ways, in addition to having contrastive ejectives. Later in this book, we will discuss the unfamiliar symbols in this table. You can probably hear the difference between the Lakhota syllables [t 1u] and [t 'u1] in the audio files that accompany Table 6.1, and these differences are also apparent in the acoustic waveforms and spectrograms of the syllables shown in Figure 6.2. Both of these syllables begin with a short burst of noise—the release burst of the stop. In the case of the pulmonic egressive stop [t 1], the vowel starts about 30 milliseconds later, while in the glottalic egressive stop [t 1'], there is a gap of over 120 milliseconds and then a second stop release burst (the second burst is marked by the double-headed arrow that points at the release burst in the waveform at the top of the figure and in the time-aligned spectrogram at the bottom of the figure). This second stop release is the release of the glottal closure. This is a clear acoustic cue telling us that the stop release burst in [t 'u1] was produced by a glottalic egressive airstream mechanism. Some people make ejectives at the ends of words in English, particularly in sentence final position. You might notice this in words such as bike with a glottal stop accompanying the final [k]. If the velar stop is released while the glottal stop is still being held, a weak ejective may be heard. See if you can superimpose a glottal stop on a final [k] and produce an ejective. Now try to make a slightly more forceful ejective stop. By now, you should be fully able to make a glottal stop in a sequence such as [a/a], so the next step is to learn to raise and lower the glottis. If you hold your breath and make [k] sounds while you keep holding your breath, you are probably making ejective stops. The glottis remains closed because you are holding your breath, and it moves up and down in the throat to produce the [k]. Feel your larynx and see if it moves up in the throat. Another way to learn to recognize what it feels like to raise the glottis is by singing a very low note and then moving to the position for singing the highest note

that you possibly can. Doing this silently makes it easier to concentrate on feeling the muscular sensations involved. Putting your fingers on your throat above the larynx is also a help in feeling the movements. Repeat (silently) this sequence—low note, very high note—until you have thoroughly experienced the sensation of raising your glottis. Now try to make this movement with a closed glottis. There will, of course, be no sounds produced by these movements alone. Practice superimposing larynx movement on a velar stop. Say the sequence [Ak]. Then say this sequence again, very slowly, holding your tongue in the position for the [k] closure at the end for a second or so. Now say it again, and while maintaining the [k] closure, do three things: (1) make a glottal stop; (2) if you can, raise your larynx; and (3) release the [k] closure while maintaining the glottal stop. Don't worry about step (2) too much. The important thing to concentrate on is having a glottal stop and a velar closure going on at the same time, and then releasing the velar closure before releasing the glottal stop. The release of the velar closure will produce only a very small noise, but it will be an ejective [k']. Next, try to produce a vowel after the ejective. This time start from the sequence [AkA]. Say this sequence slowly, with a long [k] closure. Then, during this closure, make a glottal stop and raise the larynx. Then release the [k] closure while still maintaining the glottal stop. Finally, release the glottal stop and follow it with a vowel. You should have produced something like [Ak'/A]. When this sequence becomes more fluent, so that there is very little pause between the release of the velar closure and the release of the glottal stop, it will be simply an ejective followed by a vowel: [Ak'A]. There is, of course, still a glottal stop after the release of the velar stop and before the vowel, but unless it is exceptionally long, we may consider it to be implied by the symbol for the ejective. Another way of learning to produce an ejective is to start from the usual American (and common British) pronunciation of button as ["bØ/nÆ]. Try starting to say button but finishing with another vowel [Ø] instead of the nasal [n]. If you make

sure you do include the glottal stop form of / t /, the result will probably be ["bØ/tØ]. If you say this slowly, you should be able to convert it, first into ["bØ/t'/Ø], then into ["bØt'Ø], and finally, altering the stress, into [bØ"t"Ø]. Eventually, you should be able to produce sequences such as [p'A, t'A, k'A] and perhaps [tS'A, s'A] as well. Practice producing ejectives before, after, and between a wide variety of vowels. You should also try to say the Lakhota words in Table 6.1. But if you find ejectives difficult to produce, don't worry. As you might gather from this discussion, many people aren't able to say ejectives right away. Just keep on practicing. It is also possible to use a downward movement of the larynx to suck air inward. Stops made with an ingressive glottalic airstream mechanism are called implosives. In the production of implosives, the downward-moving larynx is not usually completely closed. The air in the lungs is still being pushed out, and some of it passes between the vocal folds, keeping them in motion so that the sound is voiced. Figure 6.3 shows the movements in a voiced bilabial implosive of a kind that occurs in Sindhi (an Indo-Aryan language spoken in India and Pakistan). Implosives sometimes occur as allophones in English, particularly in emphatic articulations of bilabial stops, as in absolutely billions and billions.