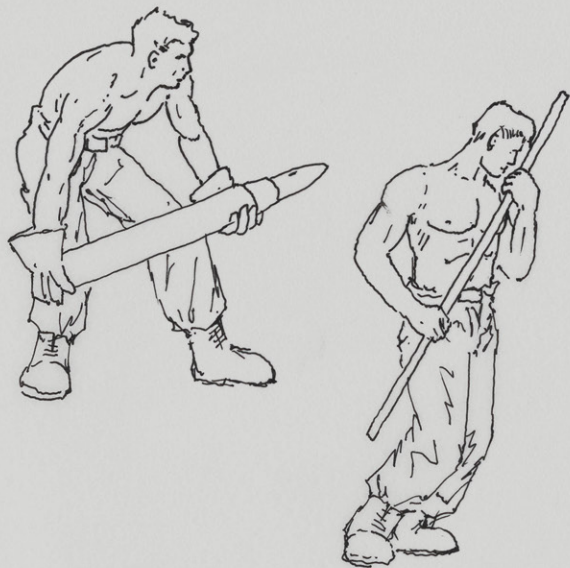
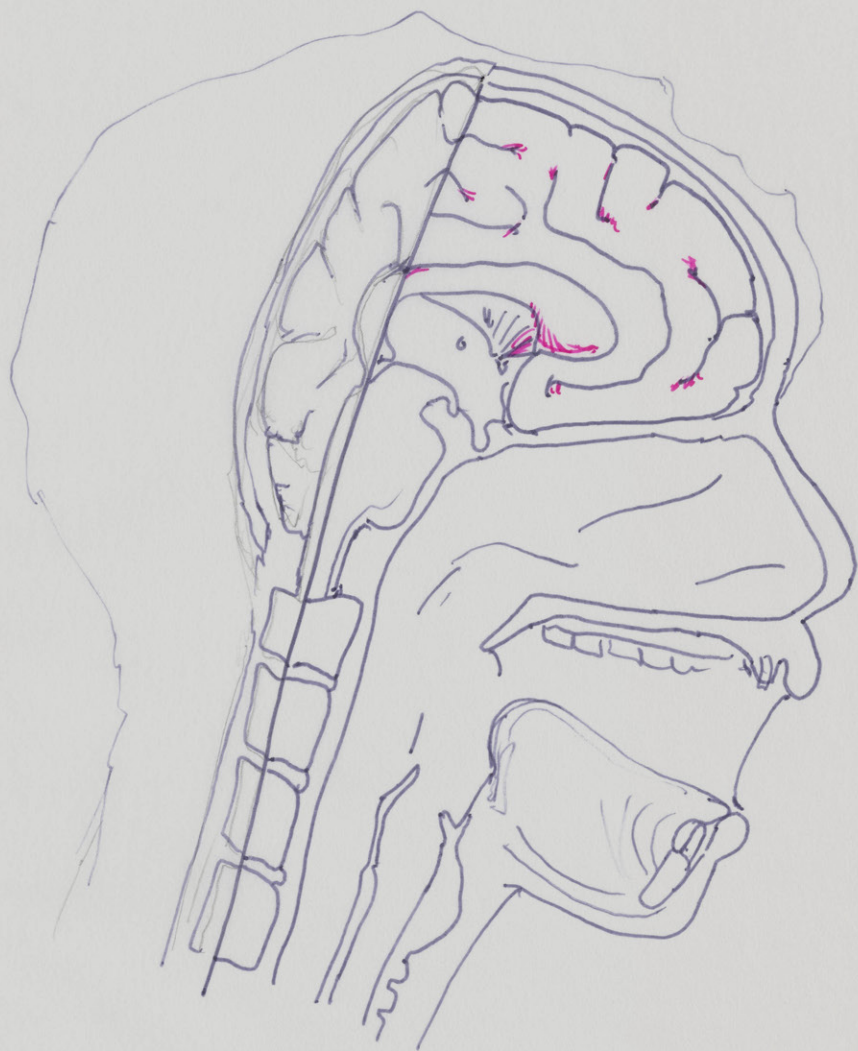
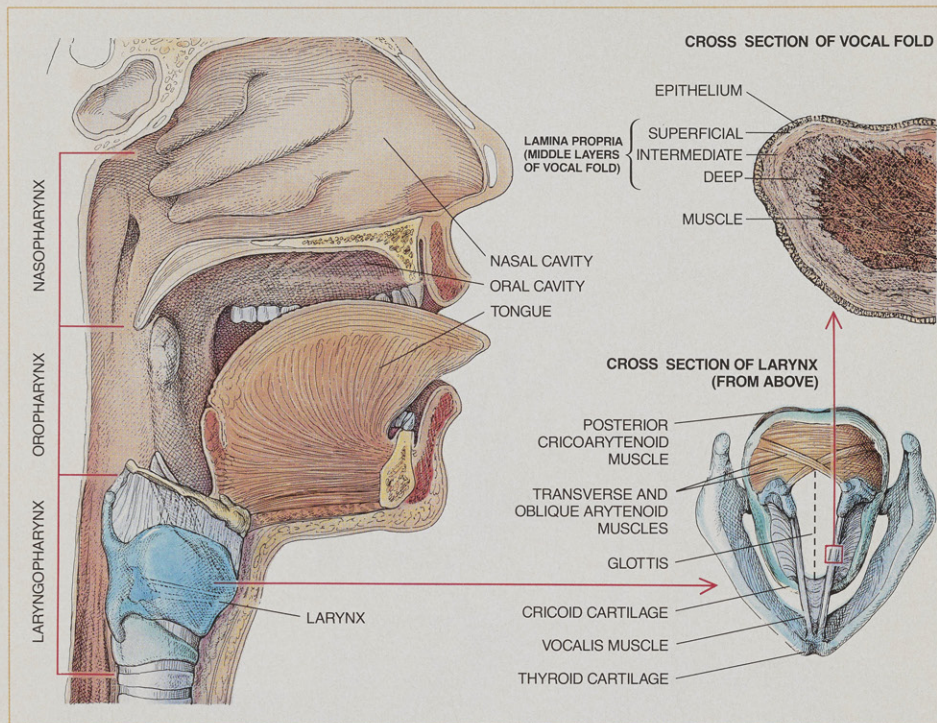










structure. Beneath the thin, lubricated epithelium on the surface lie the superficial, intermediate and deep layers of tissue called the lamina propria. Underlying the lamina propria is the thyroarytenoid (or vocalis) muscle itself. The five layers have different mechanical properties that produce the smooth shearing motions essential to healthy vocal-fold vibrations.

When the vocal folds vibrate, they produce only a buzzing sound. That sound resonates, however, throughout the supraglottic vocal tract, which includes the pharynx, the tongue, the palate, the oral cavity and the nose. That added resonance produces much of the perceived character and timbre, or vocal quality, of all sounds in speech and song.

The power source for the voice is the infraglottic vocal tract—the lungs, rib cage and abdominal, back and chest muscles that generate and direct a controlled airstream between the vocal folds. As the glottis closes, opens and alters shape, its air resistance changes almost continuously. The power source must therefore make rapid, complex adjustments to maintain a steady vocal

quality. Singers and actors refer generally to the entire power complex as their “support” or “diaphragm.” Actually, the anatomy of the power complex is complicated and not completely understood, and performers who use such terms do not always mean the same thing.

The principal muscles of inspiration, or inhalation, are the diaphragm (a dome-shaped muscle that extends along the bottom of the rib cage) and the external intercostal (rib) muscles. Expiration, or exhalation, is largely passive during quiet respiration: the mechanical properties of the lungs and rib cage typically force air out of the lungs effortlessly after a full breath. Of course, active expiration is also possible, and many of the muscles involved in this process are also used to support voice production, or phonation.

During active expiration, muscles may raise the pressure within the abdomen and thereby force the diaphragm upward. Alternatively, they may lower the ribs and sternum to decrease the dimensions of the thorax. The primary

muscles of expiration are the abdominal muscles, but internal intercostals and other chest and back muscles also contribute.

Trauma or surgery that alters the structure or function of these muscles undermines the power source of the voice, as do asthma and other diseases that impair expiration. People often compensate for deficiencies in their support mechanism by overworking their laryngeal muscles, which are not designed to serve as a vocal power source. Such behavior can result in decreased function, rapid fatigue, pain and even structural problems, such as vocal-fold nodules.

Like the muscular and skeletal systems, the nervous system also contributes to voice production. The “idea” for a voice sound originates in the cerebral cortex and travels to motor nuclei in the brain stem and spinal cord. These areas send out complicated messages for coordinating the activities of the larynx, the thoracic and abdominal musculature and the vocal-tract articulators. Signals from certain divisions in the nervous system, called the extrapyramidal