

The Human Voice

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Anatomy: The Basics

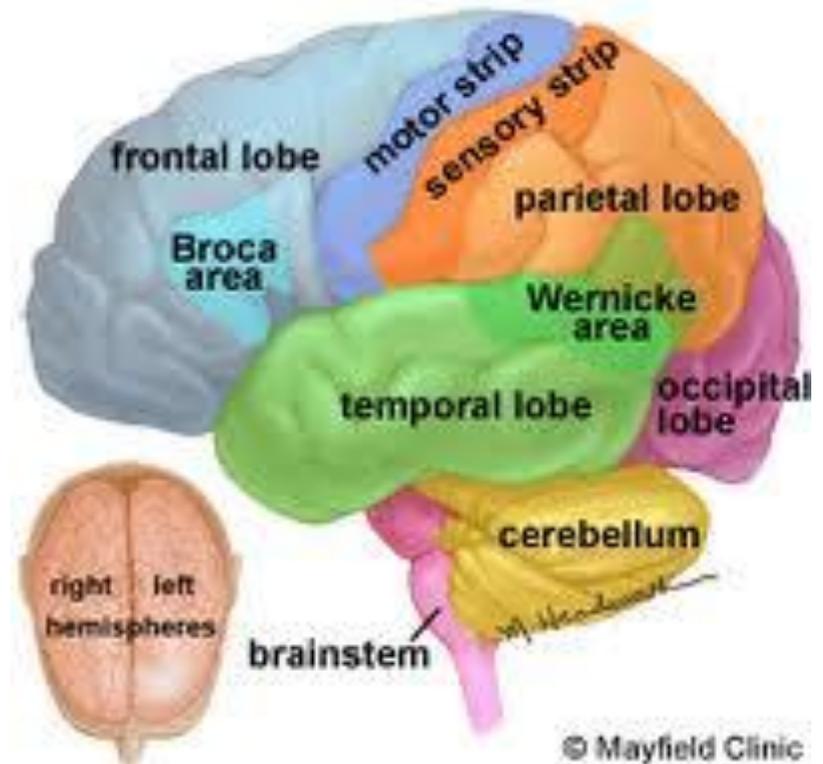
- 4 Body Systems in the Human Voice
 - 1) Muscular System
 - 2) Skeletal System
 - 3) Nervous System
 - 4) Respiratory System

Muscular System and Skeletal System

- Muscles of Inspiration
 - Expand ribcage up/down, side to side, front to back
 - Diaphragm: allows expansion of chest
 - Neck: stabilizes head, also lifts ribcage
- Expiratory Muscles
 - Abdominals
- Other Muscles
- Skull- protect the brain
- Spine- protect nervous system
- Bones in mouth- jaw
- Needed to support muscles

Nervous System

- Central Nervous System:
 - Brain and Spinal Cord
- Brain
 - Frontal-Motor Planning
 - Temporal- Auditory
 - Parietal- Sensory
 - Wernicke's Area- language
 - Broca's Area- speech motor planning



Respiratory System

- 2 Main Functions
 - To Breathe
 - Power source for the production of speech

Human Voice: A Musical Instrument

- Wind Instruments:
 - 1) Air Reservoir, maintains pressure above atmospheric
 - Lungs: 3- 6 liters of air (singing vs speech)
 - 2) An outlet channel with narrow constriction
 - Vocal Tract: changes shape, produce range of pitches
 - 3) Resonant Cavity
 - Throat, mouth, nasal cavities and bronchial tubes
- Conversion of moving air energy into sound energy through vibrations

How we speak:

- Step 1: Respiratory

- For Speech we need increased pressure and volume

- The louder = the more air

- Boyle's Law: $\text{Energy} = \text{Pressure} \times \text{Volume}$

- Because energy is constant in this closed system, pressure and volume are reciprocals

- We speak on exhalation

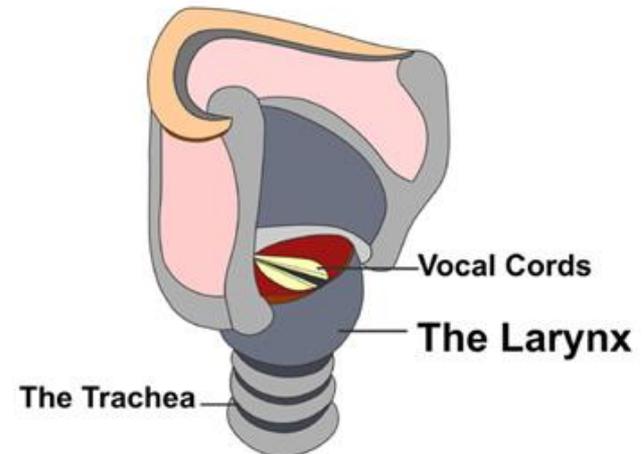
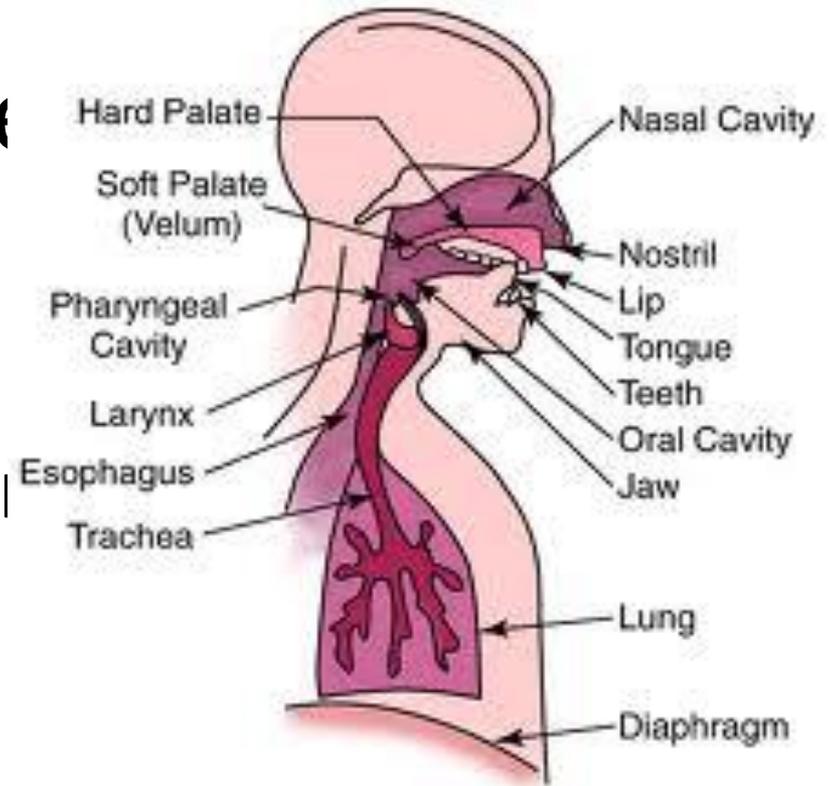
- The vocal folds are closed building up subglottic air pressure

- Changing our position changes strength of Phonation

- Phonation- The production of speech sounds

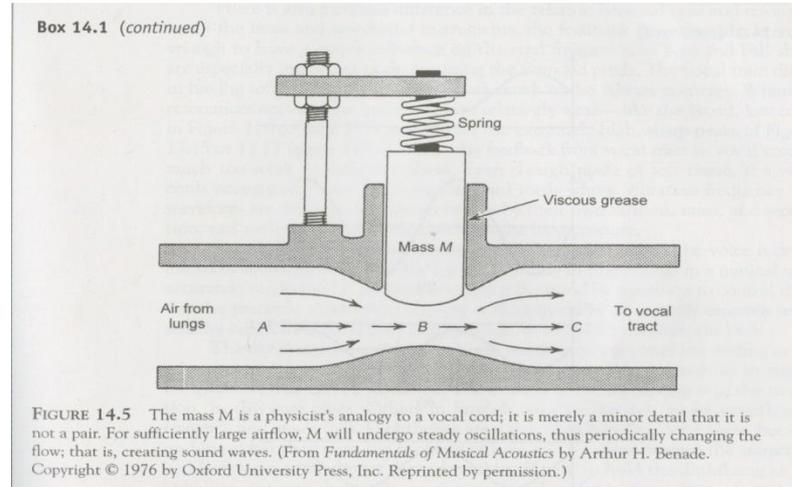
How we spe

- Step 2: Laryngeal
 - Structures: larynx, thyroid/cricoid cartilages, vocal folds
 - The air causes vibrations on the vocal folds
 - Bernoulli's Principle
 - This cycle occurs rapidly
 - 125 Hz Males
 - 225-250 Hz Females
 - 400 Hz Children
 - Change in length and thickness

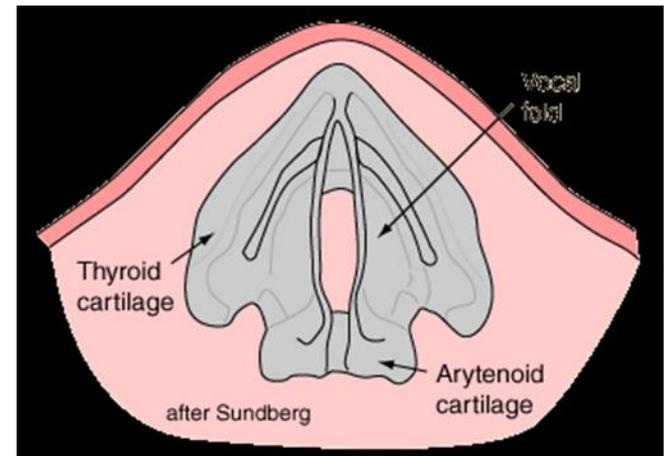


Bernoulli Principle

- The change in pressure at different points along a stream of flowing fluid
 - Decrease in pressure as the velocity of a fluid increases
- Ex: Shower Curtain



- 1) Vocal folds are closed during phonation and the airstream is momentarily stopped
- 2) Subglottic pressure builds up below vocal folds
- 3) Pressure causes vocal folds to open and air flows through
- 4) Airstream through vocal folds accelerates causing pressure to lower
- 5) Drop in pressure sucks the vocal folds back together
- 6) Cycle repeats creating air compressions and rarefactions that cause sound



How we speak con.

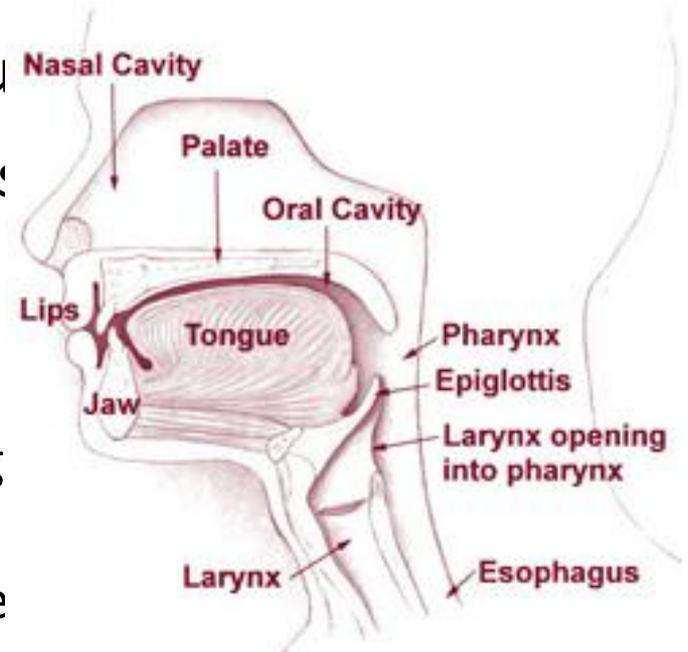
- Step 3: Articulatory

- Sound just above the vocal folds is a buzzing, need articulators

- Articulators- moveable structures

- Vocal Tract- 3 Air-filled Cavities:

- Pharyngeal Cavity
 - Oral Cavity
 - Nasal Cavity
 - Vibration and Resonance through these
 - Can change shape and therefore sound produced

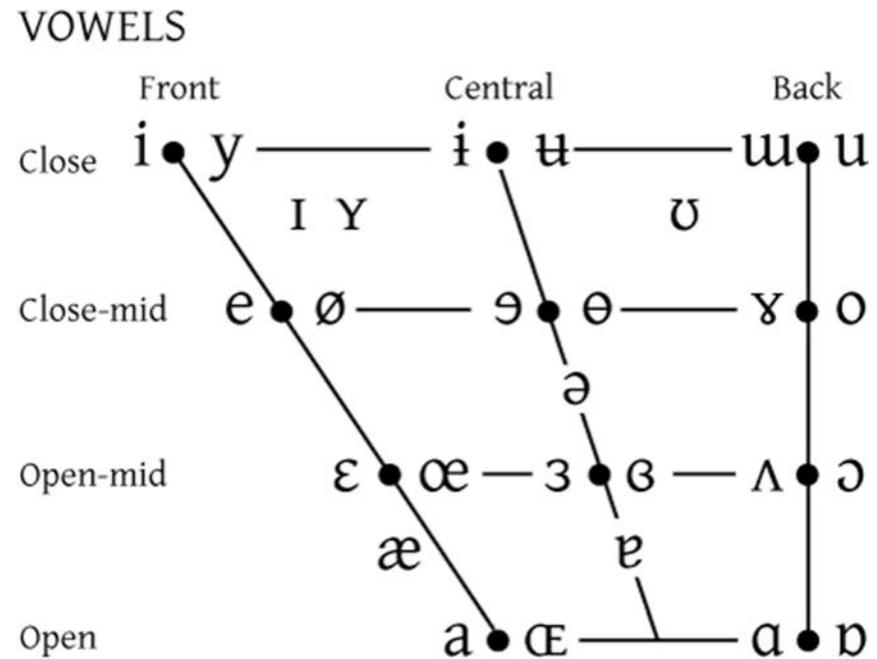


Speech Sounds

- Phonetic Descriptions determined through:
 - 1) Voicing: Presence or absence of simultaneous of vocal cords
 - Voiced (closed) vs voiceless (open)
 - 2) Manner: Type of constriction that the articulators produce.
 - 1. Stop-Plosives
 - 2. Fricatives
 - 3. Nasals
 - 4. Affricates
 - 5. Glides
 - 6. Laterals
 - 7. Rhotics
 - 3) Placement: Parts in the vocal tract that move and change shape causing restriction of air to create particular sound
 - Active Articulators- Parts that move
 - Passive Articulators- Motionless and active articulator moves towards it

Manner

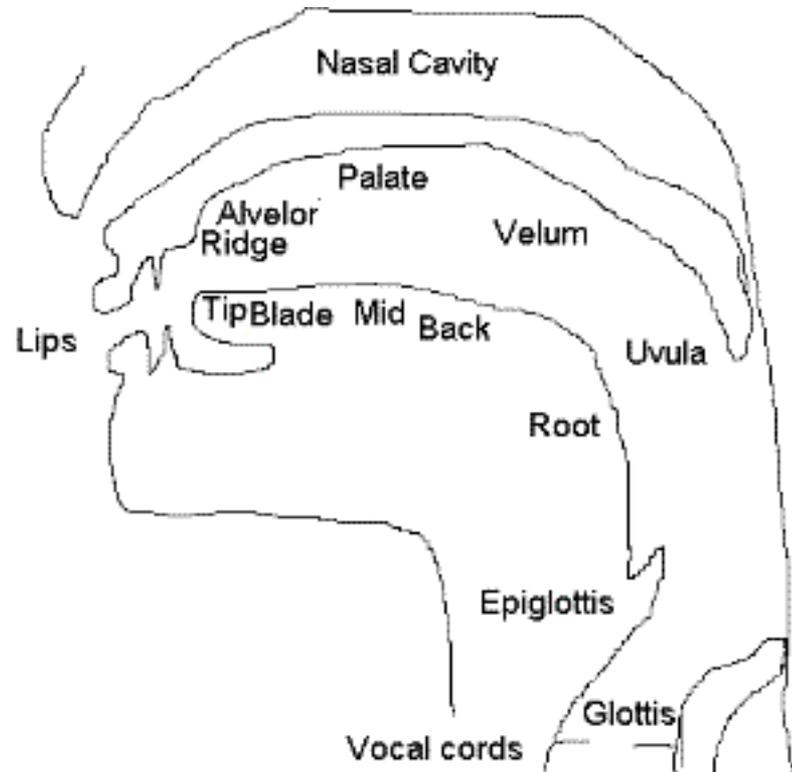
- 1) Plosives
 - Completely blocking vocal tract, then suddenly opening it
 - Transient and carry little total sound energy
- 2) Fricatives
 - Can be sustained for any length of time
 - Continuous range of frequencies, non periodic waveform
- 3) Other Consonants: glides, liquids, nasals
 - Fundamental properties similar to other groups
 - Nasals are practically vowels
- 4) Pure Vowels
 - All voiced sounds that have a definite pitch
 - Waveforms are periodic and harmonic frequencies
 - Vowels categorized by strength of harmonics (formants)
- 5) Diphthongs
 - These are quick transitions
 - Tongue changes shape- goes from one vowel to another
 - Ex: Mount (a-ou) or Moat (aw-oo)



Where symbols appear in pairs, the one to the right represents a rounded vowel

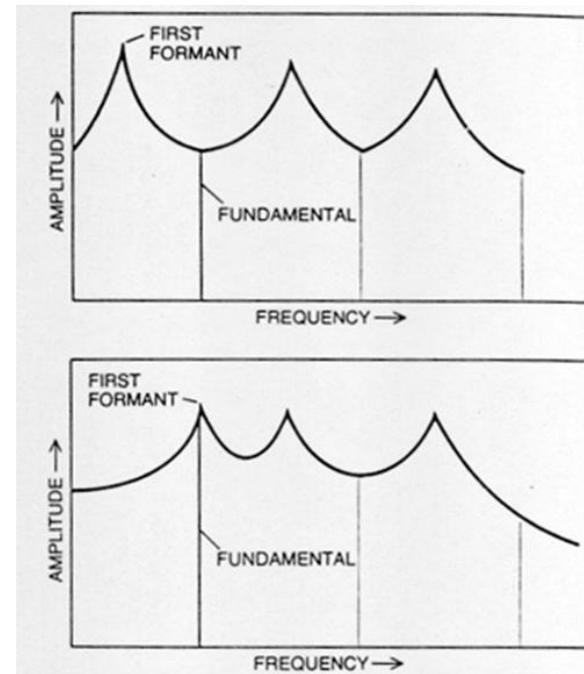
Placement

- Articulators:
 - Tongue
 - Hard Palate
 - Soft Palate (Velum)
 - Mandible (Jaw)
 - Teeth
 - Lips



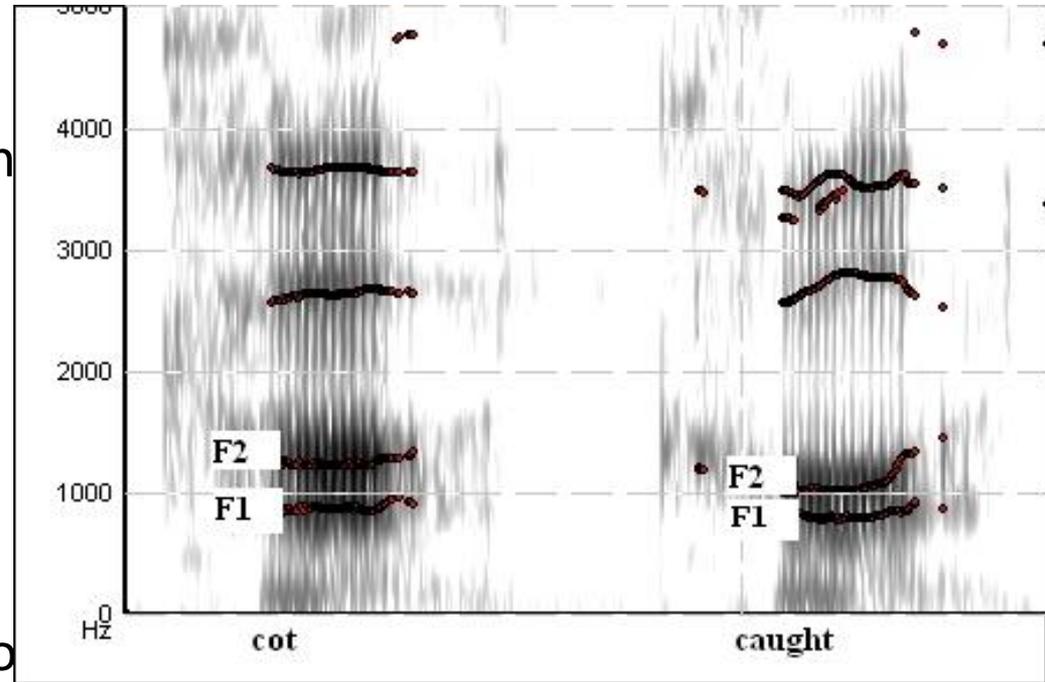
Formants

- Defined as a concentration of acoustic energy around a particular frequency in the speech wave
 - In other words, an acoustic resonance of the human vocal tract
 - The distinguishing or meaningful frequency components of human speech and of singing
- They occur at roughly 1000Hz intervals ($v/4L$)
- Measured as an amplitude peak in the frequency spectrum of the sound
- The frequency and waveform of the vocal cords vibration is determined by the larynx.
- Vocal cord opening/tension and tongue placement determines a vowel sound.
- The sound entering the vocal tract is a series of puffs of air, which changes based on the force of the air going through the larynx.
- For a given vowel sound, resonant formant regions sound identical if fundamental frequencies differ by an octave



Formants Con.

- Vowel sounds are distinguishable by the information found through the frequency content (which formants show)
- The formants with the two lowest frequencies (f_1 , f_2) are most important in distinguishing the vowel (open/close and front/back quality)
- The context of the sound also plays an integral role in the perception of the formants



Phonetics and Articulation

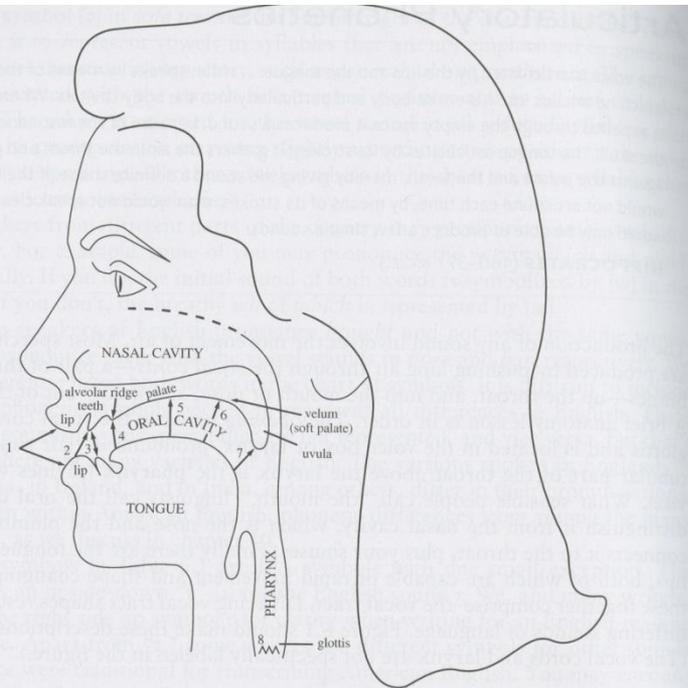


FIGURE 6.1 | The vocal tract. Places of articulation: 1. bilabial; 2. labiodental; 3. interdental; 4. alveolar; 5. (alveo)palatal; 6. velar; 7. uvular; 8. glottal.

TABLE 6.4 | Some Phonetic Symbols for American English Consonants

	Bilabial	Labiodental	Interdental	Alveolar	Palatal	Velar	Glottal
Stop (oral)							
voiceless				t		k	ʔ
voiced	p			d		g	
Nasal (voiced)	m			n		ŋ	
Fricative							
voiceless		f	θ	s	ʃ		h
voiced		v	ð	z	ʒ		
Affricate							
voiceless					tʃ		
voiced					dʒ		
Glide							
voiceless	w						
voiced					j		ɰ
Liquid (voiced)							
(central)				r			
(lateral)				l			

TABLE 6.5 | Examples of Consonants in English Words

	Bilabial	Labiodental	Interdental	Alveolar	Palatal	Velar	Glottal
Stop (oral)							
voiceless	pie			tie		kite	(ʔ)uh-(ʔ)oh
voiced	buy			die		guy	
Nasal (voiced)	my			night		sing	
Fricative							
voiceless		fine	thigh	sue	shoe		high
voiced		vine	thy	zoo	measure		
Affricate							
voiceless					cheese		
voiced					jump		
Glide							
voiceless	which						which
voiced	wipe				you		wipe
Liquid (voiced)							
(central)				rye			
(lateral)				lye			

Morphemes

- Anti-dis-establishment-ari-an-ism
=6 morphemes
- Gentle-man-li-ness=4 morphemes
- Desire-able=2 morphemes
- Morph=1 morpheme

Language

- Wherever humans exist, language exists.
- There are no “primitive languages—all languages are equally complex and equally capable of expressing any idea. The vocabulary of any language can be expanded to include new words for new concepts.
- All languages change through time.
- Speakers of all languages are capable of producing and comprehending an infinite set of sentences.

Discussion of Grammar, Standard Language and Accent

Table 1.1 Grammaticality judgment comparison

	<i>Grammaticality according to</i>		<i>Is the speaker's intent clear?</i>	
	<i>Linguist</i>	<i>Layperson</i>	<i>Linguist</i>	<i>Layperson</i>
Colorless green ideas sleep furiously	Yes	Yes	No	No
Furiously sleep ideas green colorless	No	No	No	No
That house needs painted	Yes	No	Yes	Yes
I seen it yesterday when I got home	Yes	No	Yes	Yes
My daughter is taller than me	Yes	No	Yes	Yes
Dr. Hallahan might could give you a call	Yes	No	Yes	Yes

Two Types of Grammar

- **Descriptive grammar:** Does not tell you how you *should* speak, but describes your basic linguistic knowledge. Explains how it is possible for you to speak and understand and make judgments about well-formedness.
- **Prescriptive grammar :** The belief that some versions of a language are better than others. Does not describe the words people know, but tells them what rules they should follow.

