Syllabus

September 9, 2015 1:43 PM

 LIN 4325syllabus2015

LIN 4325-6301 Speech Production

September-December 2015
Professor: Ian MacKay
Email concerning the course: profmac@uottawa.ca
Office: ART411
TA and Discussion Group Leader: Sameer Ratti
Email: sratt013@uottawa.ca
Office Hours: Mondays, 9 - 10:30 am
Textbook: *The Speech Sciences* by Raymond Kent. *Other readings will be assigned as the semester progresses.*
Room: SMD227

Prerequisite for undergraduate students: LIN3325 or equivalent. Graduate students are expected to have taken a phonetics course of some description.

Official course description for LIN4325: Anatomical, physiological, and neurological substrates of speech production and of hearing. Phonetics in the light of these substrates. Ontogeny and phylogeny of speech. Applied speech sciences.

Learning Objectives: This course examines the substrates of speech and hearing with considerable attention to anatomical and physiological components. Specifically:

- Human anatomy and physiology as it relates to speech sound production and hearing;
- Principles involved in creating some sounds of speech through physical action;
- Functioning of the peripheral hearing mechanism;
- Research techniques and methodologies in the discipline;
- Theoretical issues in perception and production of speech;
- Practical applications and technologies;
- Evolutionary differences between humans and other great apes and other hominids, required for speech;
- Embryology as it relates to speech and physical anomalies affecting speech
- A number of other topics as outlined in the textbook table of contents.
- NOTE: There is a lot of information (for example, the anatomy) which will need to be learned (at least in part) in a rote manner; however, as much as possible for each topic, a strong emphasis will be placed on ***understanding*** the concepts. Again, while some exam questions will certainly test knowledge of facts (e.g., anatomical structures), many questions (even objective questions) will be directed at testing the *understanding* of concepts. Be sure you can *explain* the material we've covered, not simply repeat it.

Topics: We will follow the textbook in order. The prof may not make announcements about starting upcoming readings, so whatever chapter we are currently working on, the next topic will be that of the next chapter in Kent (exception: we will largely skip chapter 9). Be sure to read before class discussion of a chapter begins. Our depth of study will vary among the chapters; this table shows how detailed our study will be of each chapter:

detailed coverage	medium	light to medium	light	mostly skip
Ch 4, 5, 6, 8, 11, 12. Ch 7 (limited topics, mainly cranial nerves)	Ch 1, 3	Ch 13, 14	Ch 2, 10	Ch 9

impediments to learning

Do I need to know this? The textbook covers a great number of topics in very fine detail. It is not possible or reasonable to expect to know it all by heart, nor is that the objective of the course. As noted above, in many cases there will be emphasis on understanding the principles. Additionally, as noted in the table immediately above, it is understood from the start that some chapters or sections will be covered superficially or lightly. As the class lectures proceed, the professor will often comment on the importance of material, which can be interpreted as a comment about the depth of knowledge that is expected of students taking the course. In some cases the professor will verbally dismiss certain sections of the chapter, and that can be taken as instructions for what you need to know.

Peanuts: If you have peanuts on your person when you arrive at the class (whether raw nuts or in a chocolate bar, etc), leave them in a sealed container out of reach until you leave the room. Thank you.

Contacting the Professor: For topics relating to a course *that you are currently enrolled in*, email **profmac@uottawa.ca**
I will not answer emails that ask me to repeat material from this syllabus; likewise, if you send an email asking for a repetition of material that I have already sent out in a class email, I will not answer. (Of course, you may ask for clarification on either of these, but if so, the question must make reference to what is in this document or in other documents the prof has sent to you).
Office Hours: Most days, I can meet with you shortly before, or immediately after, class. To meet me before, please contact me by email — if you show up 5 or 10 minutes before class and/or need more than a minute of my time, you may find me too busy. However, if you arrange even an hour ahead by email, I will usually be able to see you before class.
You may contact me by email to arrange to meet with me at other times. If you do, please suggest several different times that would be convenient for you to meet, so as to reduce the number of back-and-forth messages.

Email: your full name should appear on all emails sent. Send only from your @uottawa address. ***A search of my inbox should allow me to find all messages you've sent me if I use your name as the search term.*** That means setting your account so your name appears as sender and/or writing your name and student number on the first line of the content of every email. You must receive emails sent to your @uottawa address in a timely manner. The professor and the university expect that messages sent to your @uottawa address will be received quickly, so please ensure you check your uottawa email at least daily. If you don't want to use that address, set up your account so that all @uottawa emails are forwarded to an address you do use, and make sure you set up said account so that emails can be sent from your @uottawa address. You can also set up a forward to an app that notifies you when an email comes in. This can be accomplished quite easily in Gmail for instance, and if you need assistance remember that you have Google at your fingertips to ask for help.
Subject line: every email sent to the prof must have a subject line that reflects the content of the message. Not "Question" but "Vocal Fold Vibration".

Attendance: Attendance is required and will be monitored for all or part of the semester. Points will be deducted for absence above 15% of class sessions. (This is not intended to force you to come to class if you are sick, particularly with a communicable disorder – especially the flu. Email me before class starts if you're missing a class due to illness and the absence will be excused. Naturally, extended or frequent absences require a medical

Lin 4325-6301

Quite a large number of students have taken this course and have faced the same academic challenges, some more successfully than others. Over time I have come to perceive where the greatest challenges lie, not for everyone, of course, but for the great majority. You can improve your own chances of success (however you define it) by paying special attention to these areas.

The subject of this page is topics and concepts that are especially challenging to a large number of students in this course. This page is *not* about study techniques in general, but in part about how to overcome the challenges presented by the material.

Basic phonetics. Basic phonetics is a prerequisite to this course. This course is about the production of speech in greater physiological detail than seen in basic phonetics. It is essential to review phonetics and to keep its concepts in mind. When we are discussing speech musculature, for example, it is important to constantly make comparisons with the details of the articulation of specific speech segments: if you find yourself considering the muscles that control the velum (soft palate) without thinking about the role played in the articulation of entire classes of phonemes, then you're not thinking in an integrated way about the material.

When the course turns its attention to the production of specific sounds or classes of sounds, is not reasonable for the student to claim unfamiliarity with the IPA symbols for the basic sounds of English or French, or to claim unfamiliarity with basic classes of speech sounds (such as plosives, nasals, fricatives, vowels, etc.). The specifics named here are *examples* of the sorts of things you should know from your phonetics course, not an exhaustive list. Review as you need to. [Do not interpret this paragraph to mean that you are "not allowed" to ask about basic phonetic issues. You may ask such questions, of course — there may be excellent reasons for a misunderstanding or a difference of opinion or terminology. However, the point of this section is that you need to assume that the material is cumulative and that you need therefore to bring with you the knowledge acquired in introductory phonetics, and that it is *the student's* responsibility to review those basics.]

Three-dimensional space. Much of this course is about anatomy and physiology. The body is a three-dimensional object, as are its components. Generally, you will see those structures depicted in two-dimensional pictures in the book. It is absolutely essential to your understanding to succeed in imagining the objects in three-dimensional space and "viewing" them mentally from all angles. Some people find this easy to do, and others find it hard. *Especially* those people who find it difficult must strive to conceptualize the structures in space, in order to understand the relationships among the structures and *their potential for movement*. Here are some methods used in the course material to assist you: drawings from additional sources are provided (so you can see a variety of views); three-dimensional models are made available of some structures (and these must be studied in detail, not simply glanced at).

If you still find the material difficult to conceptualize, you can seek additional pictures on the web. You can make models for yourself in three dimensions with plasticine: even if you have little talent for this and your models turn out to be embarrassingly crude, the exercise will have forced you to try to conceptualize in three dimensions, and *that* will be helpful to

certificate.) A sign-up list will be distributed each class; if your signature is not on it, then officially, you were not there.

Personal electronic devices (PEDs): Phones must be on silent mode and stored out of site throughout the class session. Phones may not be consulted during class. Computers and tablets may be used for note-taking but for no other purpose. This course isn't just about you; it's about those with whom you share a space. If you're writing messages and watching YouTube, you are distracting those around you from the course material, and those individuals have a right not to be distracted by you. The room will be close to full for this course, so other students cannot escape your self-indulgent activities.
True anecdote: a few years ago, I did an informal survey in a class. Of the 5 students using laptops, 4 were among the very bottom of the class in final grades. One was using her laptop to take notes, and she did very well, among the top 10% of students in the class.. Great! Perfect use of the device! The other four were off in cyberspace and some flunked the course. None achieved more than a C grade.

More on distractions: It is normal to occasionally whisper to the person sitting next to you "What was that term he used?" or suchlike. However, more than the very occasional whispered word to one's neighbour is a distraction to other students, and often a distraction to the professor. If you distract me, I cannot pay full attention to the message I'm delivering to others, and those others are doing what we're here for: learning this material. If you are engaging in conversations or activities with your device that distract me, you will be asked to leave.

DGD (Discussion group)
Meets Wednesday at 4:00 pm. Attendance is optional. The DGD instructor, Sameer Ratti, will go over material with you to help your understanding. New material will not be introduced in the DGD, though Sameer may give a different perspective on the same material to aid in learning. The professor *may* attend DGD sessions preceding exams for the purpose of answering review questions, but this depends upon the timing.
In general, it is very helpful to email the DGD instructor with questions *before* the session so he can prepare material to help you. (Of course, the professor also welcomes questions asking for clarification.)

Keep up: Keep up with the material. There is far too much to successfully cram in a few days. Always read the chapter before we begin to study it in class.

Impediments to learning: The material of this course is quite different from the material that most linguistics students see in other courses. There are particular ways of thinking about the material that help understanding; on the other hand, some ways of approaching it are unhelpful. A document with the same title as this section will be distributed and the prof will discuss it in class. It may not seem like it, but this guide to approaching the material is very important, and if you ignore it you do so at your peril. Follow the instructions in it, and you'll be far ahead.

Repetition of Topics: Many of the topics in the course are ones you will have seen in phonetics. A common mistake is to assume that since you've seen the topic before, the knowledge you already possess is sufficient. In almost all instances, the depth and detail of the knowledge base for this course is more advanced (sometimes far more advanced) than in previous courses. It is important to attend to the ways in which the material in this

course goes beyond what you've previously seen and not to assume you're up to speed, and not to turn off your attention because you think you know it already.

Graduate Students: You will have an additional assignment involving primary source material. I would like to meet with all grad students (either individually or in a group or groups) within the first 5 days of classes to discuss your goals, course requirements and related materials. Please set up an appointment with me by email ASAP. I will communicate more specific details about the way that your requirements differ from what is outlined here.

Grading:
There will be two midterm exams, plus a small number of exercises. The grade breakdown is as follows *for undergraduate students* (grad students: talk to me):

First midterm	25%
Second midterm	25%
Assignments	10%
Final exam	40%

Exams: *read this carefully, and don't ask me to repeat this in class!* ☺ There are two midterms and a final, and you can think of the course as being divided into thirds Nearer the time of each exam, I will be able to give you a little more detail about content. However, the principles stated in this section about the purpose of each of the three exams will not change.

- **First midterm**: Tests material from the first third of the course.
- **Second midterm**: Focus on material from the second third of the course, with possibly some small reference to the first part.
- **Final exam**: this exam is intended to be **two things**:
  - This is the **midterm** for the last one-third of the course
  - This is a **cumulative exam** for the entire course.

Exam Dates:

First Midterm: Wed, October 7
Second Midterm: Wed, November 11
Final: as officially scheduled during the exam period.
Note: the professor has no control or influence over the date of the final exam. You should not make travel plans until you know your final exam schedule.

We will go over the exams together in class. If there is a question or questions on the first or second midterm where many students made important errors, this question or a similar one may show up on the next midterm or the final. So treat going over the exam as a learning opportunity that may earn you points on the next exam.

Plagiarism:
Don't even contemplate it. Any type of academic fraud will be considered a serious infraction and will be dealt with under formal Faculty and University rules. I'd be happy to clarify what constitutes plagiarism if you care to ask. The university has material online. I'd remind you that handing in the same material for more than one course is also a form of academic fraud.
Read the following:
http://www.uottawa.ca/administration-and-governance/academic-regulation-14-other-important-information

Language: This course is taught in English. *Néanmoins, les étudiant.e.s francophones ont le droit de répondre aux examens et de soumettre leurs TP en français. Vous pouvez également poser des questions en classe en français. Si vous en posez une en français j'y répondrai en classe en anglais, tout en faisant une interprétation de la question en anglais pour vos paires. Je préfère de beaucoup que vous posiez votre question en français en classe que de se décider de ne pas poser la question. Même si vous êtes mal à l'aise à parler en classe en anglais, vous avez le même droit de poser vos questions.*
De plus, je distribuerai des listes de terminologie technique française. (si j'oublie de le faire, rappelle-moi. ☺) Je ne prétends pas que ces listes soient exhaustives, mais elles peuvent s'avérer utile quand même.

Website and emails: Blackboard Learn (Virtual Campus) will be used to post grades. It may or may not be used to post other material, as announced in class. From the start of the semester, the professor will make some announcements and distribute some material by means of a bulk email from the professor to your UOttawa email account. You must set things up so you will receive this material in a timely manner (see **Email**, above). If there is a change to posting material on a website, an email will be sent the first time to notify you of the change.
Note that most announcements will be made live voice in the classroom, and typically these will *not* be repeated electronically. However, if an intended announcement is forgotten, it may then be circulated electronically.

Study buddy: Make the acquaintance of another diligent, reliable student in the class and consider that person your "buddy" for the purpose of providing detailed information if you miss a class. You are responsible for material covered in class, and if it took me 80 minutes to say it, I cannot give a useful summary in a short email.

Additional reading. As noted at the top of the syllabus, there will be some additional reading material from other sources, mostly online. This raises a couple of points:
Download when the reading assignment is given. Sometimes, online material changes. My expectation is that you will read the assigned site at the time it was assigned. I have no idea what might be at that address two months later, and while it's unlikely, it is possible that it will be different from what I assigned. So download the page or article promptly, use that as your reading, and re-read the same version when studying for the final.
Wiki-type sites are acceptable for assigned readings. Some assigned readings may be from Wiki-type sites. The question may arise in your head "If I can't use Wikipedia (or similar) for my research paper, why can the professor use it?"

The simple answer is that a reading assignment is not a research assignment. Textbooks are secondary sources, not primary research sources, but it is normal to use textbooks as reading material – the textbook is deemed by the professor to be of sufficient detail and sufficient accuracy to help fulfill the learning objectives of the course.

If I assign an online reading, I will have determined that, for the purpose of the learning objectives in this course, it is sufficiently accurate and detailed. In essence, I am saying that if that article were in the textbook, I'd be happy with it as a learning tool. I am *not* saying it is a research source (it is NOT!), and I'm not necessarily endorsing other material on the same site.

your understanding (and understanding is the point, isn't it? — having a nice pretty model isn't).

Muscles, mechanics. It is important always to think of the "machinery" of the body in mechanical terms: that is, to consider the mechanical potential of the structures in an anatomical drawing. What is meant by this? Mentally, contract each of the muscles in the drawing and consider the consequences: what structure moves in what direction? In what direction can the bone(s) move? In which direction do joints flex? How far? If the structure is pulled in a certain direction, what forces will it in turn place on other structures? In general, while a picture in the textbook is a static object, you must use your brain to make it dynamic. A picture does not need a glance, it needs in-depth study, and that study involves animating the picture with your mind. This is essential to understanding what you are looking at.

Drawings and coding of elements. Something else about the drawings, especially the anatomical ones: Drawings are not exactly like the reality they represent. (For one thing, pictures in the book are in black and white.) There are widely-used conventions in drawings to represent different kinds of material and the relationships among objects. In anatomical drawings, the following kinds of tissue are generally represented in a standard way that you should recognize at a glance: muscle, bone, cut-away bone (to reveal what is behind it), nerve pathways, and others. Be sure you learn to identify all the different kinds of tissue represented in a standard manner in such drawings; once this is accomplished the drawings should be almost instantly interpretable.

Scientific methodology. Be sure to conceptualize the subject matter of the course within the context of rigorous scientific methodology. This includes the nature of inference, rigour in measurement, and the ability to detect cause and effect.

If you find some material more difficult, avoid the temptation of ignoring that material. If it is difficult, that is all the *more* reason to apply yourself to understanding it!

Lecture 1: Intro/Chapter 1

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4 kinds of info contained in the speech signal

1. Phonetic quality: **linguistic** content of speech message. Phonetic aspects most challenging when acquiring a second language.
   *specific to humans
2. Affective quality: **paralinguistic** (meaning that accompanies linguistic message or influences interpretation; emotional quality) ex. Irony, sarcasm
   *not specific to humans (nonhuman vocalizations)
   - Stressing factors: physical, chemical, physiological domains
3. Personal Quality: extralinguistic (outside of speech) informative about the speaker not the language. ex. Age, gender, health, **vocal individuality.**
4. Transmittal quality: talker's location (distance, orientation in speech, background noise)

Physics and Biology of Speech Communication

- Sound used for: direction, recognition of young, mating
- Visemes: sounds with the same visual appearance (lip reading)
- Tadoma: understanding speech from putting hand on mouth

Phonetics: the way in which speech sounds are produced
Phonology: Way in which speech sounds are put together, sound patterns

- 40-50 phonemes in English- 60,000 words
- 50% of speech can be deleted and still know what people are saying

Biological Differences In Speakers

- Gender differences:
  - Girls faster to acquire language than boys, better chance of recovery, maintain lanuagage competence longer
  - Boys most likely to have disorders/delays
  - Women more spontaneous speech than men
- Age differences
  - Prenatal period: swallows and hears
  - Infancy (0-2): babbling (universal and language specific to parental). Comprehension vocab larger than production vocab
  - Childhood (2-10): learns 21 new words a day
    - Critical period or sensitivity
    - Mastery of sounds
  - Adolescence (10-18): emergence of sex differences

Different models of speech

- Neural
- Articulatory
- Vocal tract
- Functional
- Motor control

Lecture 2: Chapter 2/3

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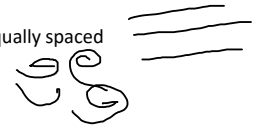
Hydrodynamics- study of flow of fluids (gases that are non-compressible)
Liquid and gases are fluids

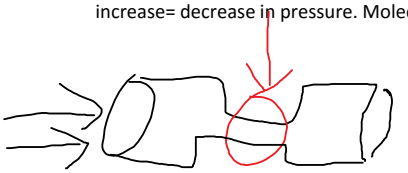
Langrangea method: focus on behavior of molecule in motion in a particular region
Ellerian Method: focus on characteristics of particles as they pass in a neighborhood at a given point

- Flow
  - Laminar flow: equally spaced
  - Turbulent flow
    Ex. Fricatives



- Bernoulli's principle: pressure is lower at a constricted point in the tube. Velocity of flow increase= decrease in pressure. Molecules spread apart at constriction but move faster

*cant stay close together and move faster



Sound: variations in pressure
20-2000 hertz

- Eardrum pushed towards low pressure
- Propagates
- Signal/noise ratio
- Decibels: used to measure strength of a sound logarithmic, different dB scales (hearing level dB HL)

Acoustics: physics of sound
Psychoacoustics: loudness, pitch, timbre
Sound waves= longitudinal (energy propagated)
Resonance: depends on frequency

Anatomy of Speech Apparatus

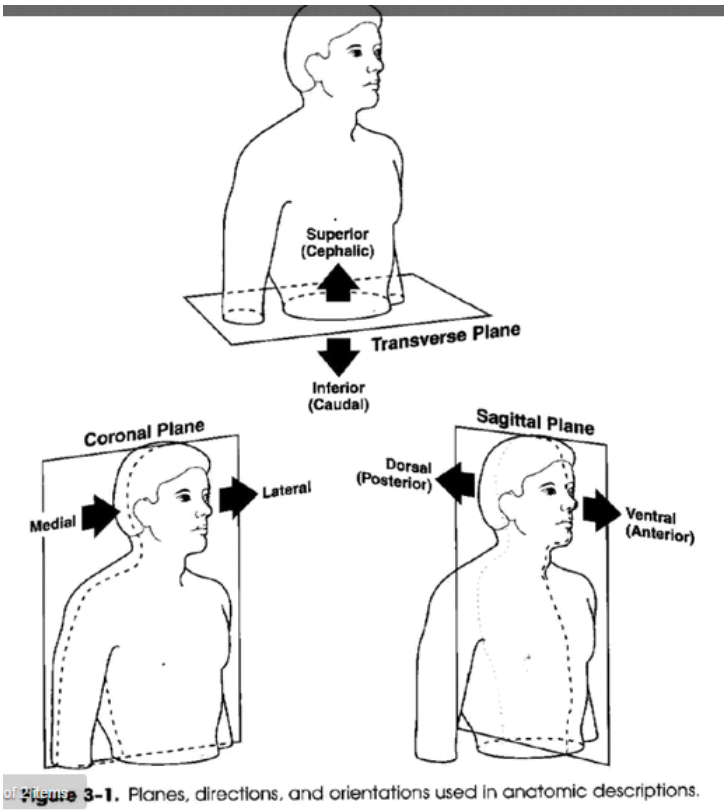


Figure 3-1. Planes, directions, and orientations used in anatomic descriptions.

Bone: remodelled as we grow (jaw). More use= stronger bones,
Cartilage: elastic (protective, cushion) vs. hyaline (dense can ossify)

- Some cartilage stiffens with age (arthritis) and some becomes more elastic (ear canal cartilage collapses)

Connective Tissue: tensile strength (resistance to being pulled part)

- Ligaments: bones to joint (elastic)
- Tendons: don't move. Muscle to bone

Muscles: striated (skeletal muscles- larynx, tongue), smooth (slow involuntary), cardiac
diagrams of muscles have lines representing the orientation/direction)*
Muscles pull not push**
Agonist vs antagonist (opposite effect of agonist)
Glands: produces chemical excretions
Membranes: high tensile strength. Encases something
Neural Tissue: neurons
Lymphoid tissue: creates antibodies to fight infections. Includes tonsils, spleen, thymus, adenoids

Body Systems related to Speech Production

- Respiratory system: lungs, chest wall, abdomen, air way.
  - Pulmonary= oxygen and carbon dioxide exchanged in lungs
  - ingressive vs egressive (speech produced on egressive - outgoing- air)
- Laryngeal System "voice box": cartilages and muscle tissue- primary biological function- keep things out of the lungs
  - Secondary biological function- speaking
    - Ontogenetic: development differences in anatomy
    - Sexual dimorphism: differences in sex
    - Human larynx more complex than mammals (Birds- syrinx 'y' shaped)
- Supra Laryngeal System-everything above larynx (Pharynx- upper airway, nasal passage, oral passage)
  - Upper airway sight of speech production- different sounds produced
  - Uses resonance and articulation
  - If paralyzed, speech is impossible, even if the person could phonate (produce voice)

Four basic functions of vocal folds: complete opening, closure (physically demanding activities), vibration, and narrow opening (whispering)

Neural Basis of Speech

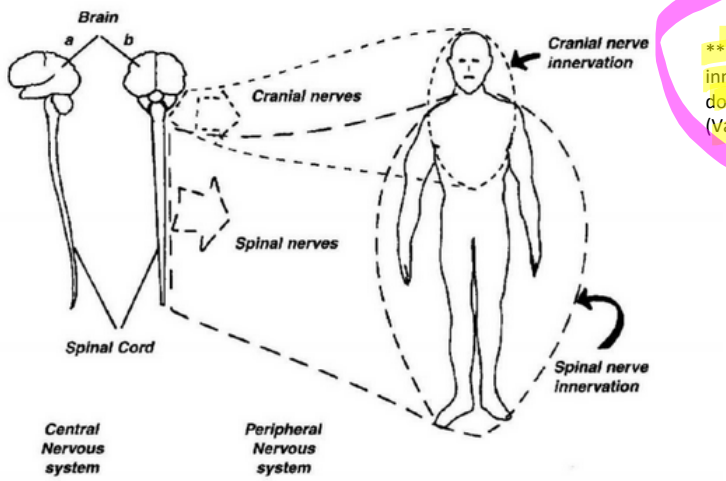
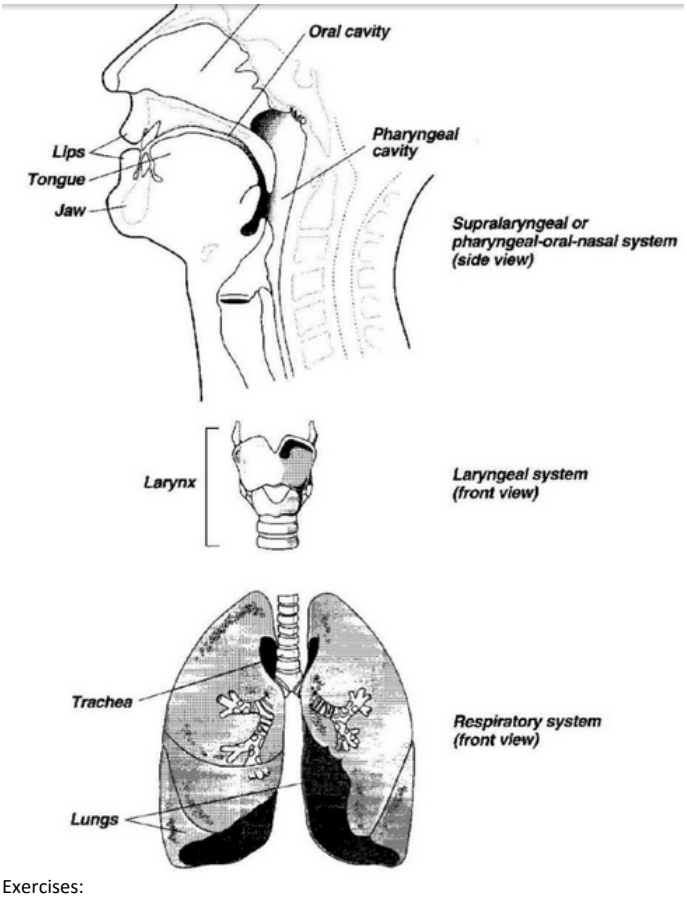


Figure 3-6. A simplified drawing of the major structures of the nervous system divided into the central nervous system and the peripheral nervous system. General innervation regions are shown for the cranial and spinal nerves.

**Cranial nerve that innervates all the way down to the intestines (Vagus- guts to larynx)

- Most languages are pulmonary, very few are inspiratory
- Articulation and resonance are related- articulation gives rise to characteristic resonator shapes of the vocal tract



Exercises:

Match the terms in the left column with the corresponding definition in the right column.

anterior	away from midline
caudal	toward the front
cephalad	below
distal	above
dorsal	toward the tail
inferior	toward the midline
lateral	toward the rear
medial	toward the periphery
posterior	toward the belly
proximal	toward the center
superior	toward the head
ventral	toward the back

Lecture 3: Chapter 4

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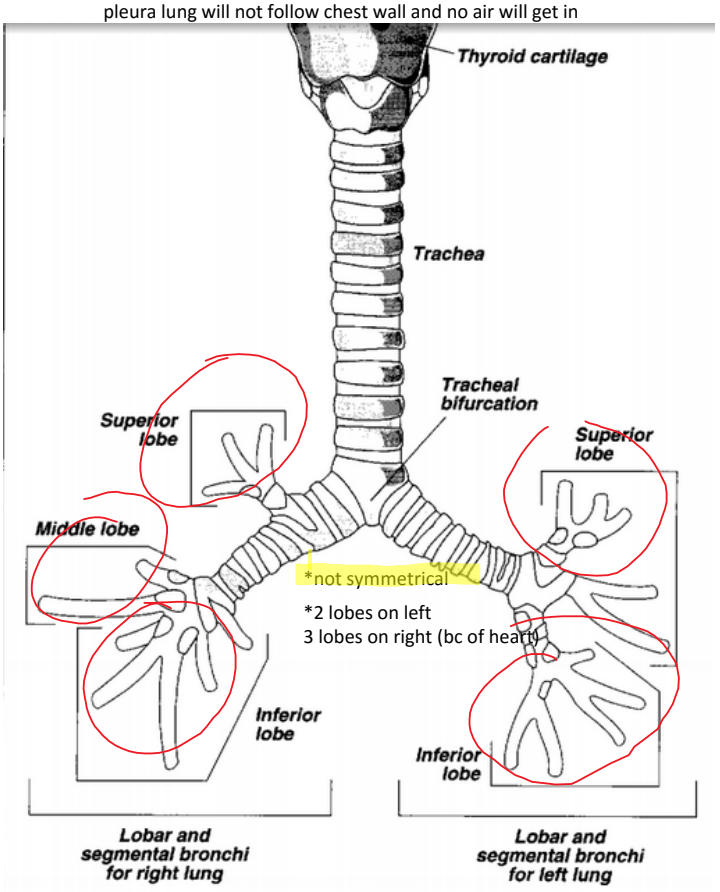
Office Hours: 1.5 hrs before or after each class
UNIBET- normal keyboard symbols as phonetic symbols (IPA symbols hard to find)
Tracheal bronchiole tree

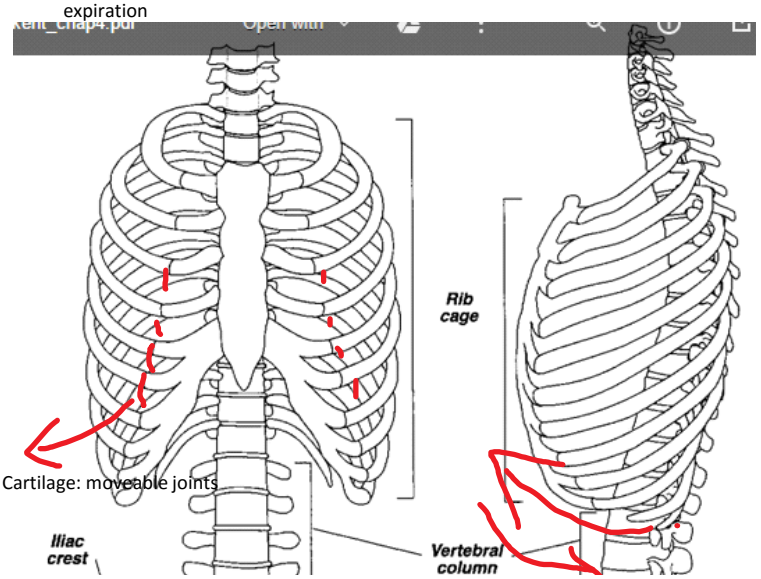
- Tracheal Bifurcation= splitting in two
- Fractal design= divides into branches (same in structure but not size)
- Lungs encased in membranes: pleura
  - **Visceral pleura** (around lungs) vs **parietal pleura** (around rib cage)
    *not attached to each other (**Intra pleural space**) Collapsed lungs= air between 2 pleura lung will not follow chest wall and no air will get in



- Lungs and heart in thoratic cavity
- Abdomen- protected by some ribs in the back, but nothing in the front
- cavities separated by diaphragm (openings for esophagus, aorta, blood vessels)= ab muscle
  - Moves about 2 ribs in distance (major m. in sneeze and hiccups)
- Gas exchange in aveoli (300 million)- combined with highly vascularized lungs

Diaphragm (muscles separating thoracic and abdominal cavity)

- Attached to the lowest rib
- Diaphragm contracts= increases lung capacity (diaphragm moves down) [primary muscle of inspiration] not identical curverature
- Diaphragm is 'recoiled' (back to normal) by the abdomen pressure below pushing up- expiration



Costal Cartilage: moveable joints

Normal conversation using moderate loudness requires same **volume** of air required for normal rest breathing (for adults)
Breath group: number of syllables produced on one expiration

- Dictated by temporal boundaries of exhalation/inspiration. Interrupted by inhalation

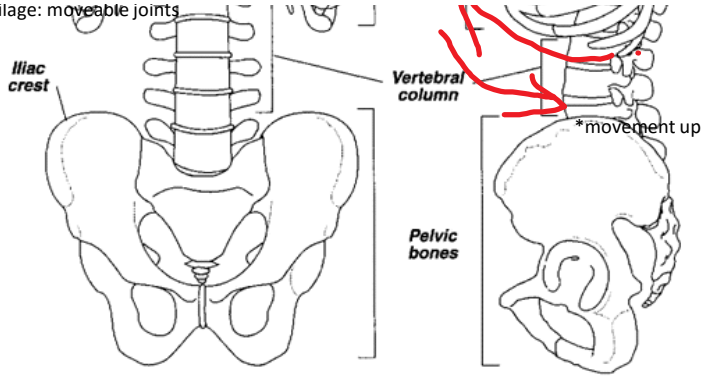
Negative air pressure between membranes causes them to stick together
Allows lungs and rib cage to work in sync "GLUE"

Bifurcation: each branch subdividing into two branches. 20+ generations
(largest to smallest)
narrow bronchioles are viscous/frictional- resist air flow. Therefore they are shorter
Narrow passages to alveolar ducts to alveolar sacs

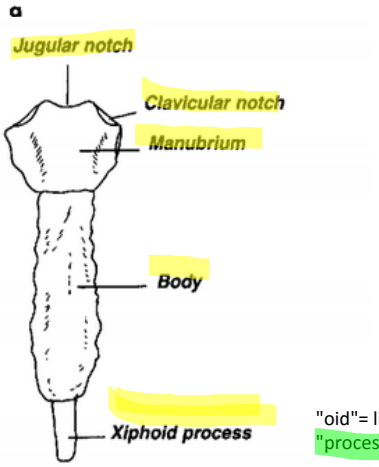
Sex differences in lung capacity 1.25:1
Mediastium- cavity between the lungs encasing the heart trachea esophagus and blood vessels

*first 7 ribs= true
next 3= false (more mobility)
Lowest 2=2 floating
Tension caused by 1. twisted along axis 2. bent (costal angle)
*all mammals have the same # of cervical vertebrae

Costal Cartilage: moveable joints



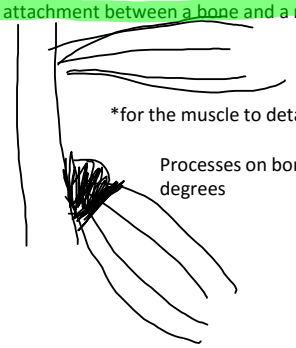
*movement up and down



"oid"= like in greek
"process"= area on bone or cartilage that 'stick out'

Figure 4–8. The sternum or breastbone.

- Stongest attachment between a bone and a muscle is at 90 degrees

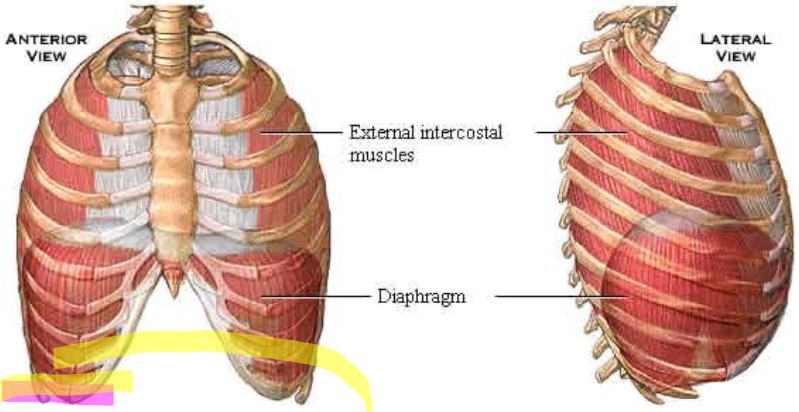


*for the muscle to detach, the entire attachment must come off a once

Processes on bones make it so that muscle can be attached at 90 degrees

★ Muscle Activation During Inhalation and Exhalation

- Rib goes up, lungs bigger, same # of molecules but bigger space= low pressure therefore air will equalize by flowing **inwards**
- Mechanism: a process by which something occurs
- Breathing occurs using 2 different mechanisms
  - Abdominal mechanism- diaphragm contracts (elastic recoil- air flows out)
  - Thoracic mechanism- external intercostal muscles contract (moves ribs up- pale)
    *typically occur together
    Ex. Yoga breathing- mostly abdominal breathing

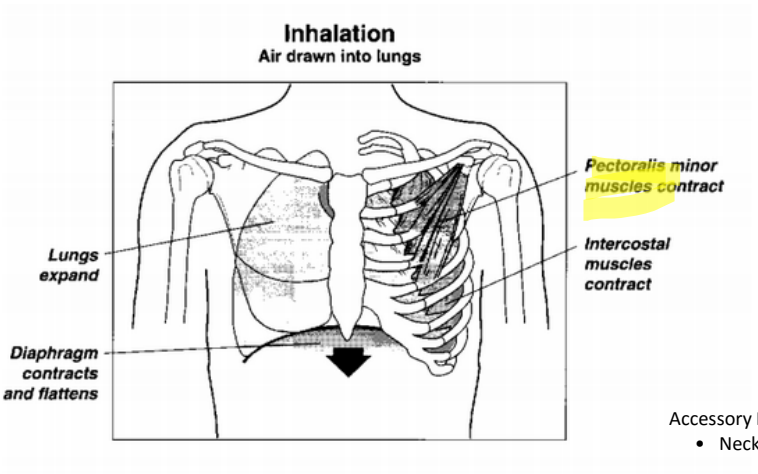


If ask what muscle.... Say name and m.
Ex. Thyroid m.

If ask what muscle…. Say name and m.
Ex. Thyroid m.

Intercostal muscles

- Internal- exhaling (origin lower margin of each rib insertion- upper part of each rib)
  Ascending orientation. From sternum to almost vertebrae column.
  Part between bones acts for depression (exhalation)
- External- inspiration (elevates ribs)- lower rib to insert on upper margin of rib below
  Descending orientation. From vertebrae column to costal cartilage



Accessory Muscles

- Neck muscles, anterior/posterior thoracic and abdominal

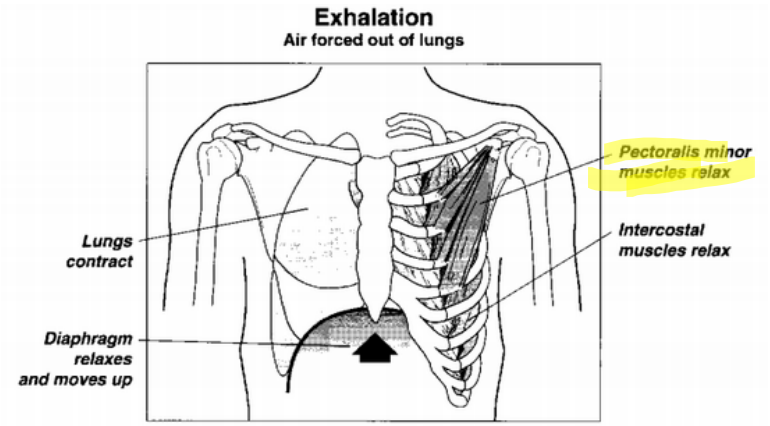


Figure 4–12. Simplified patterns of muscular action in respiration. The diagram shows the action of the intercostal muscles, diaphragm, and one accessory muscle, the pectoralis.

Respiratory Cycle

- spirometry: measurement of air volumes and capacities

*Postural muscles in trunk have a respirator effect (pectoral muscles)- accessory muscles
*more muscles used in heavy breathing/ loud speech

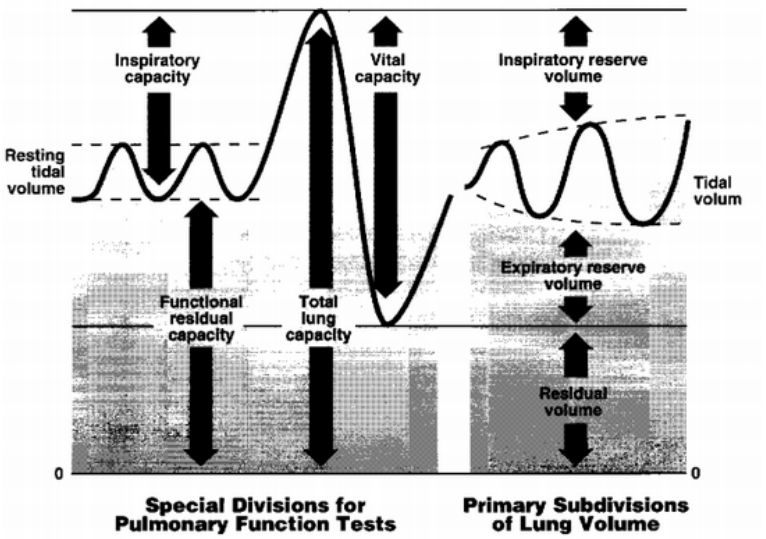


Figure 4–20. Patterns of respiration shown on a spirogram. See text for definition of volumes and capacities.

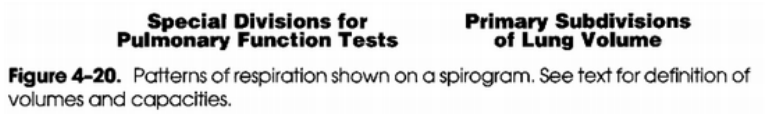


Figure 4–20. Patterns of respiration shown on a spirogram. See text for definition of volumes and capacities.

- Tindal volume: amount of air exchanged in a certain period
  - resting tidal volume: obtained for at-rest breathing
- Inspiratory reserve volume: amount of air above and beyond the inspiratory peak of tidal volume
- Expiratory reserve volume: max amount of air that can be expired below the low phase of tidal breathing
- Inspiratory capacity: the amount of air you can possibly breath in until full starting at the expiratory phase of tidal volume. Sum of tidal and inspiratory reserve volume.
- Functional residual capacity: the rest of the air in the lungs not being exchanged. Sum of residual volume + Expiratory reserve volume.
- Total lung capacity: the max amount of air you can exchange- completely full to completely empty. Sum of IRV, ERV and RV
- Residual volume: not possible to push out. Volume of air that remains after forceful expiration. Cannot be measured directly
- Vital capacity: the max amount of air you can exchange in a single breath (marathon runner, not sprinter). **sum of tidal volume, inspiratory+ expiratory reserve volumes**
  - Related to sex and body size
- Breath group: number of syllables produced on one expiration

Age differences in lung volume

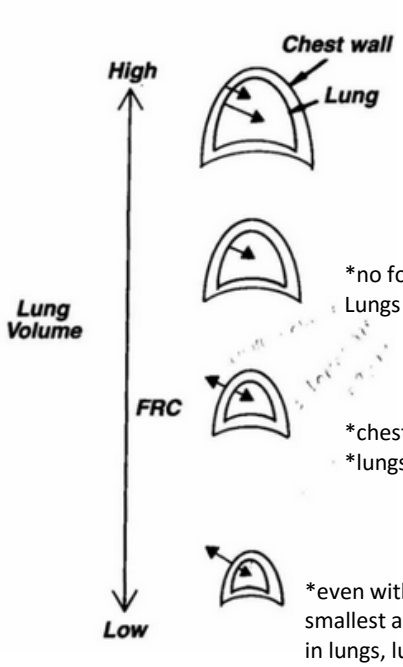
- Vital capacity, Inspiratory capacity, Expiratory Reserve volume decreases with age.
- (Functional) Residual volume increases with age
- Due to decrease in elastic recoil and muscle strength/mass

Lecture 4: Chapter 4

September 21, 2015 1:05 PM

Movement of ribs
- Bucket handle
- Pump handle

Passive and Active Forces in respiration
- Active forces: inhalation: contract external intercostal muscles, contract diaphragm, and abdomen
- Passive forces: elastic recoil of diaphragm, and thorasic wall and lung membranes
  - Elastic forces of chest wall and lungs are different



*length of arrow represents how much force

*no force from chest wall
Lungs still feel stretch= pulling to get smaller

*chest wall wants to get bigger
*lungs want to get smaller

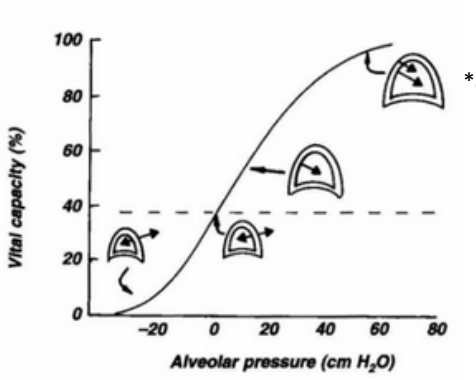
equilibrium:
wont get bigger or smaller (only passive forces)

End of expiration of normal rest breathing

*even with the smallest amount of air in lungs, lungs still feel stretched

- Quite breathing- almost no expiratory muscles used (elastic recoil- still using inhaling muscles to resist elastic recoil)
  - Checking action- inhaling muscles keep recoiling in "check" (not letting it go to fast)
  - Uses inspiratory muscles to control rate of lung deflation
- Yelling- lots of expiratory muscles

Relaxation Pressure Curve



*80cm above normal pressure

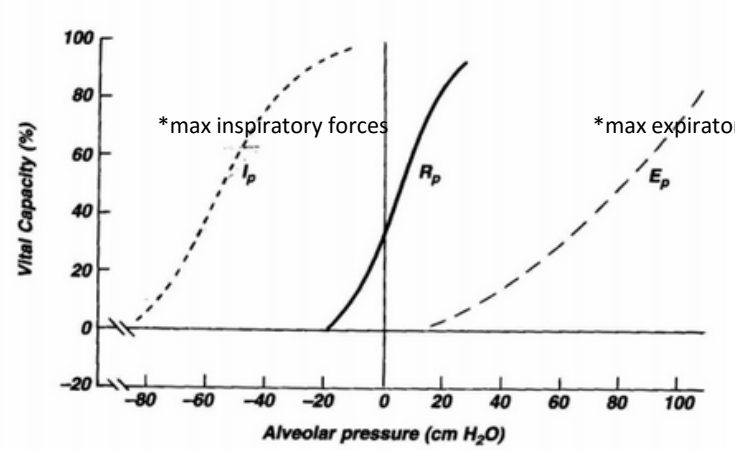


Figure 4–23. The pressure-volume diagram with curves to represent the relaxation pressure, R_p (from Figure 4–22), maximal inspiratory pressure, I_p, and maximal expiratory pressure, E_p.

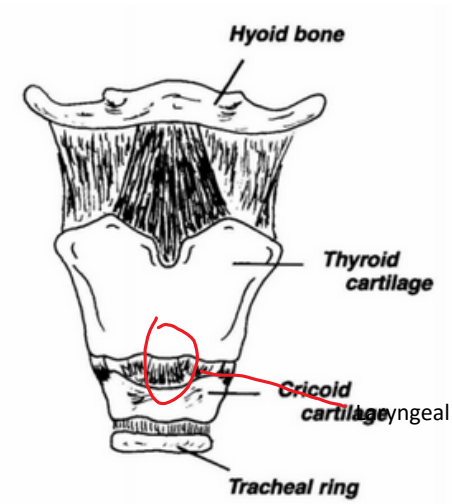
Breathing for speech and song

- Speaking modifies the way we breathe
- Inhaling cycle faster, breathing out slowly
- Learned efficient breathing through experience of talking for long periods of time
- Plan the inhale in a point in syntactic structure (clause boundaries) where it was efficient
- Internal intercostal muscles and abdominal muscles both active throughout expiration- regulate subglottal pressure for speech/song
- Both inspiratory muscles and expiratory muscles are involved in expiration

Life-course Issues

- Apgar scale used to assess neonate health at birth
  - Alveoli developed by 8 (300,000)
- Childrens respiratory systems work harder than adults: shorter max phonation time (max phonation of a vowel after max inhalation), take more breaths, larger subglottal pressures
  - Adult like by 10
- Quality of vocal fold vibration deteriorates with age, so does max respiratory volumes/capacities
  - Max phonation factors: amount of air in lung and efficiency of vocal fold vibration
  - Not reflection of lung capacity alone

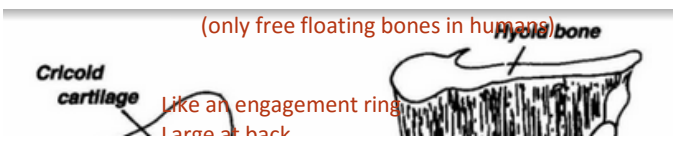
Laryngeal Anatomy and Speech

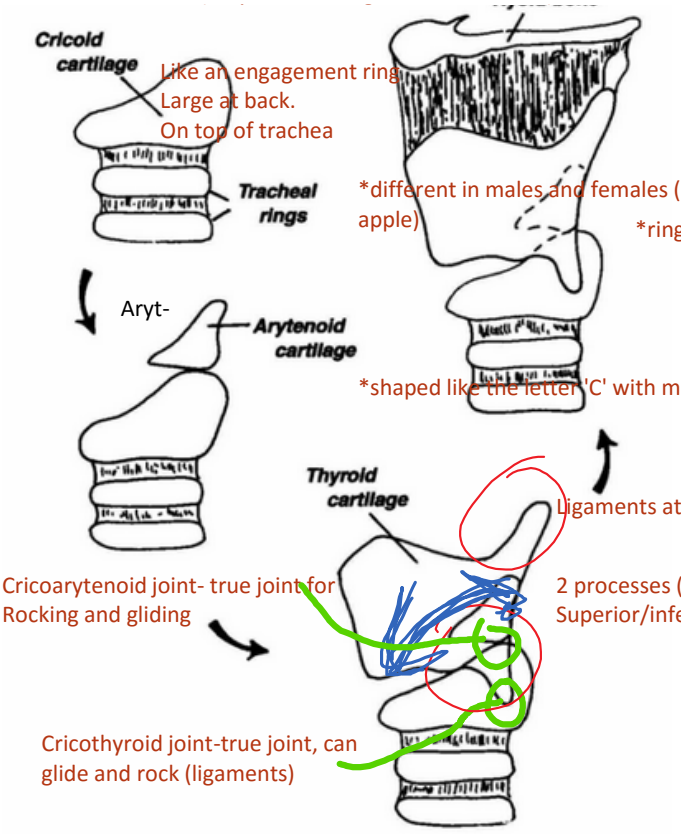


Cartilages
Unpaired bones: thyroid, cricoid and epiglottis
Thyroid cartilage- 'v' larger degree angle in women
Paired: arytenoids
*larger in men by 40%

laryngeal prominence/thyroid notch - bigger in males (adam's apple)

Figure 4–27. Anterior aspect of the lar-




Cricoid cartilage
Like an engagement ring
Large at back.
On top of trachea
Tracheal rings
*different in males and females (adams apple)
*ring around trachea- wider at posterior end
Aryt-
Arytenoid cartilage
*shaped like the letter 'C' with membranes in between
Thyroid cartilage
Ligaments attach to hyoid bone
Cricoarytenoid joint- true joint for Rocking and gliding
2 processes (horns)
Superior/inferior cornua
Cricothyroid joint-true joint, can glide and rock (ligaments)

Lecture 5: Chapter 4

September 23, 2015 11:23 AM

Laryngeal Anatomy and Physiology

- Maximum phonation time: max amount of time you can make your vocal folds vibrate continuously
  Affected by 2 factors:
  - Amount of air in lungs
  - efficiency of vocal fold vibration (how much you put in vs. how much you get out)
    Ex. Inefficient- breathy voice: lots of air out, not very loud

Assignment: measure sound you can create with one breath (to nearest second)
3 times
Email: Phonation Time
Include: gender, smoker, respiratory issue (ex. cold)
Due: Midnight Saturday

Cartilage of Larynx

- Vocal folds attach to process on arytenoid cartilage, and 'v' in thyroid cartilage
- arytenoid cartilage: sliding, pivoting, tilting (less important)

Thyroid cartilage

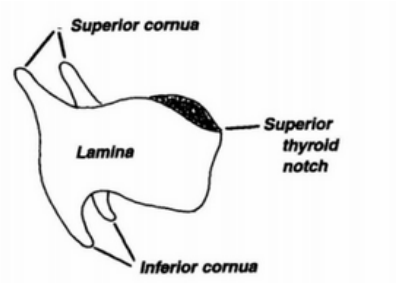


Figure 4–29. The thyroid cartilage in oblique anterolateral perspective. The two lamina that form its sides come together in a V-plow shape.

Sex differences in thyroid angle

- Significance: puberty (both in male and female)
- Males get longer

Inferior corua attach

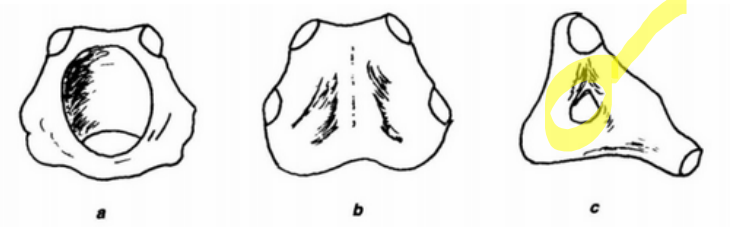
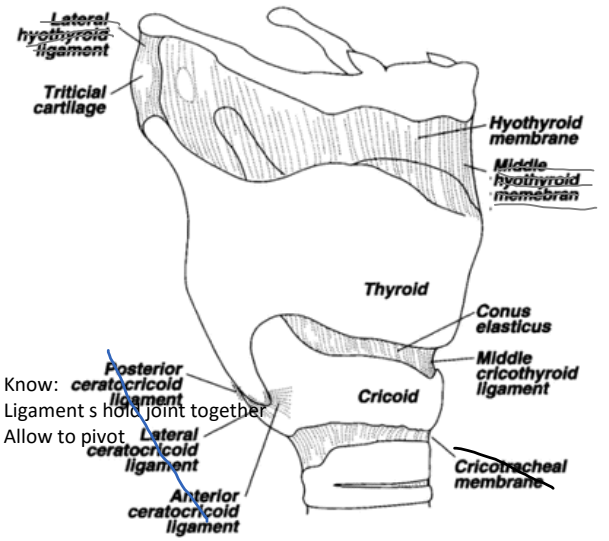
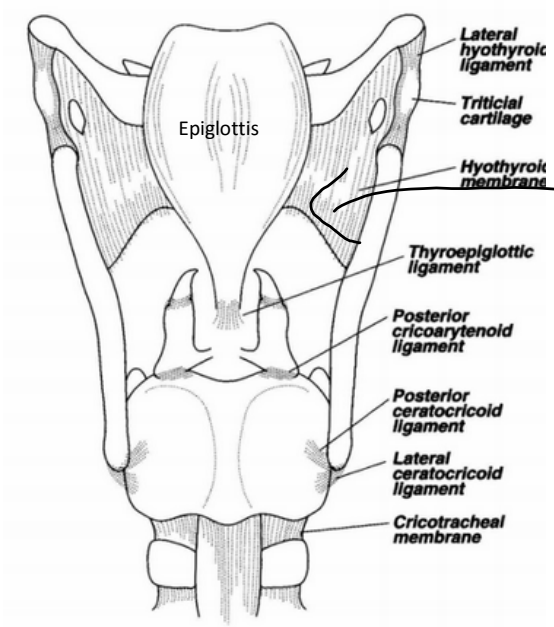


Figure 4–31. The cricoid cartilage: **a.** Anterior aspect, **b.** Posterior aspect, and **c.** Lateral aspect.



Know: Ligament s hold joint together
Allow to pivot



Laryngeal vestibule: transition btwn throat and larynx. Space in front of epiglottis

Conus elasticus: intrinsic membrane connecting thryoid, cricoid, and 2 arytenoid

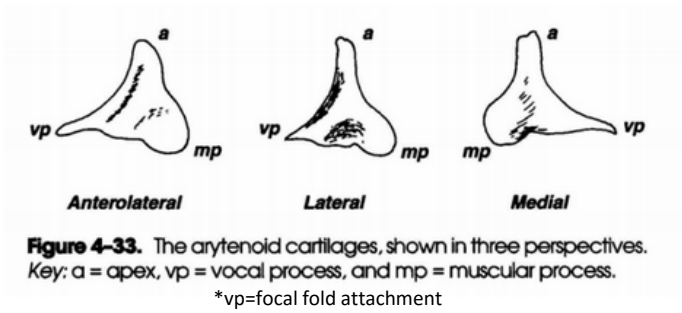
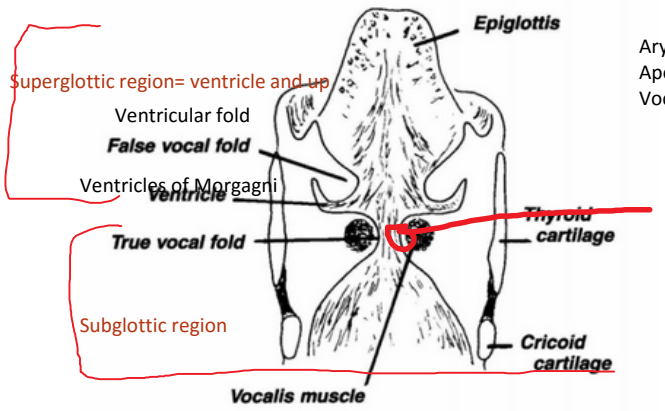


Figure 4–33. The arytenoid cartilages, shown in three perspectives. *Key:* a = apex, vp = vocal process, and mp = muscular process.

*vp=focal fold attachment
Mp= attaches to laryngeal muscles



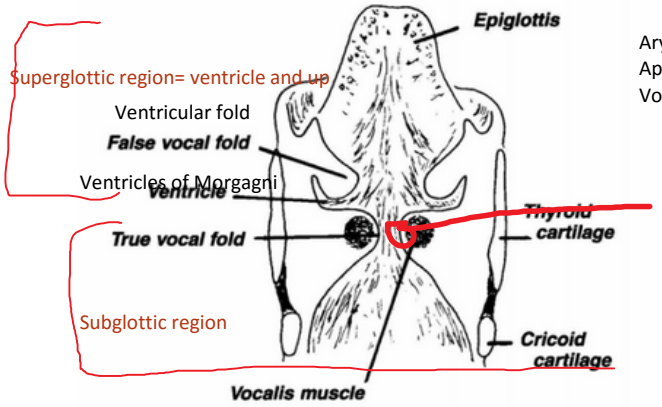
Superglottic region= ventricle and up

Glottic region=true focal fold

Subglottic region

Arytenoid cartilage spans from true to false vocal folds
Apex= false vocal fold
Vocal process=true vocal fold

Figure 4–34. Coronal section of the larynx, showing



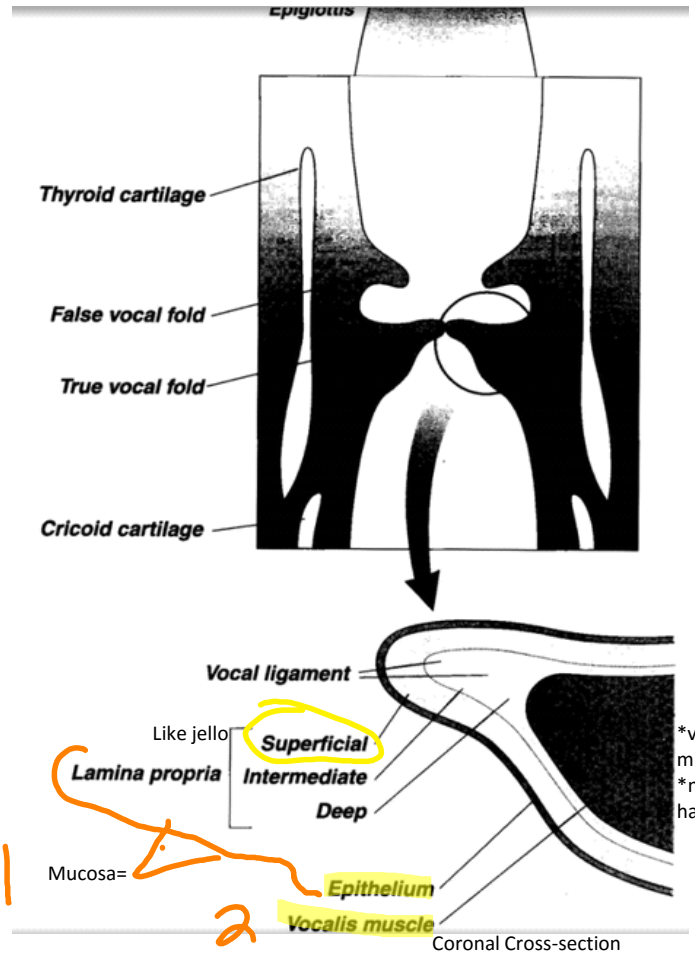
Superglottic region= ventricle and up

Subglottic region

Glottic region=true focal fold

Arytenoid cartilage spans from true to false vocal folds
Apex= false vocal fold
Vocal process=true vocal fold

Figure 4–34. Coronal section of the larynx, showing true and false vocal folds separated by the ventricle of Morgagni. Vocalis muscle is the bulk of the true folds.



Like jello

Mucosa=

1

2

*voice depends greatly on micro tissue
*more flexible= more harmonics

Coronal Cross-section

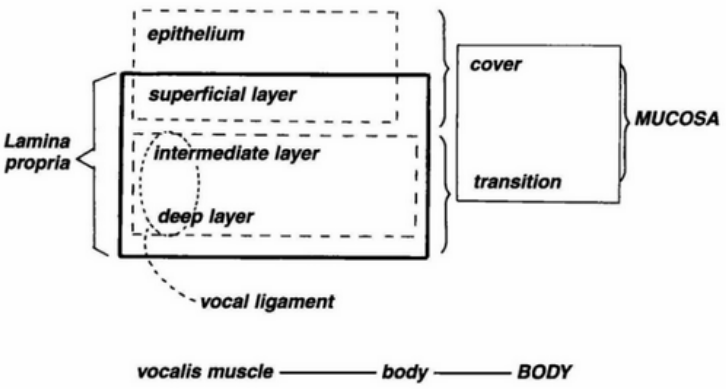


Figure 4–36. A schematic representation of the layered structure of the vocal folds.

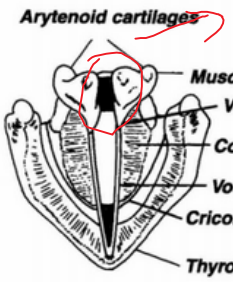


Figure 4–37. Superior view of the larynx illustrating relation of vocal ligament to arytenoid, cricoid, and thyroid cartilages.

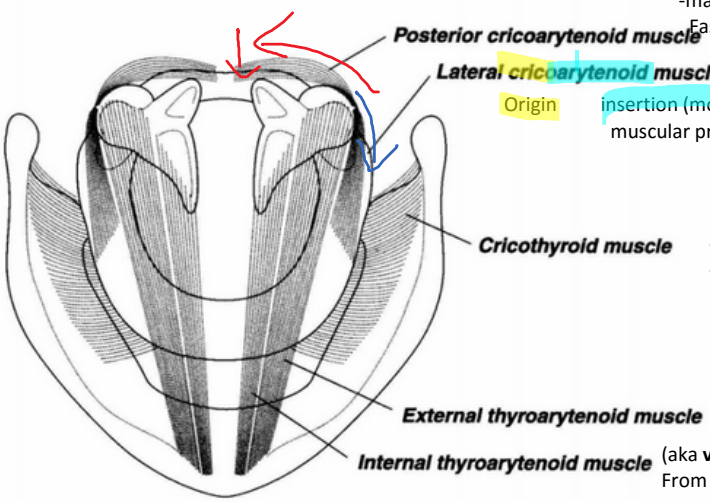
Posterior glottal gap (can be closed by arytenoid cartilages) Whispering, consonant /h/ most common in women but not men- more breathy voice

Muscles between and on side

From cricoid cartilage to vocal folds

-Runs from vocal process of arytenoid cartilage to inner aspect of thyroid angle

Intrinsic Muscles of the Larynx (origin and insertion within the larynx)



-main abductor, innervated by cranial nerve (superior laryngeal nerve)
Fast contraction. Originates on cricoid and inserts on muscular process of arytenoid

-main adductor and creates medial compression force

Origin insertion (moves)
muscular proccess

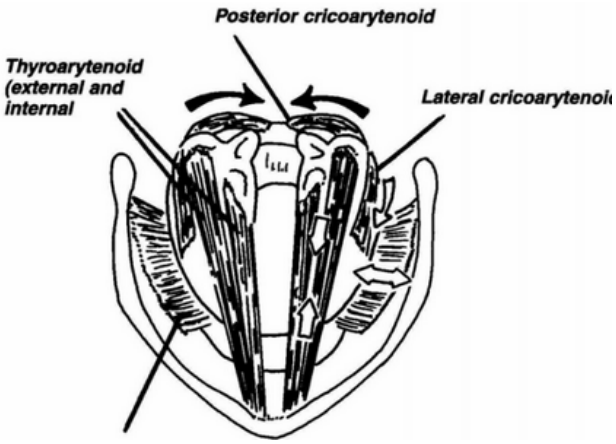
- Moves thyroid cartilage Down= lengthening/tensing Vocal folds (higher pitch)
- Attaches to cricothyroid joint

(aka **vocalis muscle**- majority of vocal folds)
From thyroid angle to arytenoid vocal process

Figure 4–39. Intrinsic muscles of the larynx visible in a superior view.

Intrinsic muscles- Function in respiration, swallowing, and vocalization- made for quick action (highly vascularized)

Arytenoid cartilage: pulled in all direction by various muscles (no antagonist or agonist)



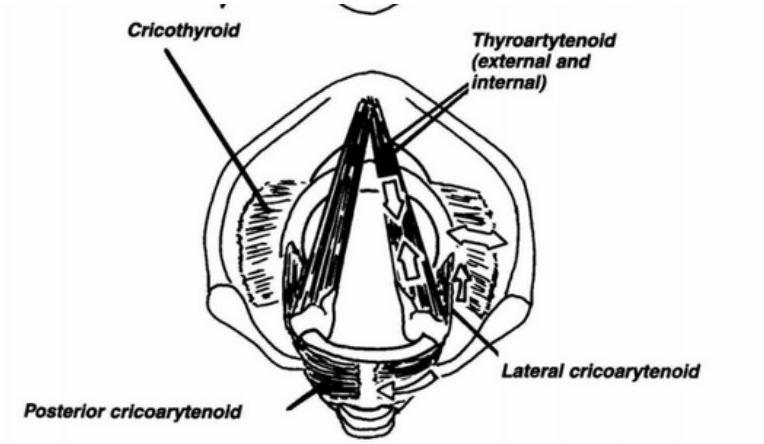


Figure 4–40. The actions of selected intrinsic muscles of the larynx. The arrows indicate muscle actions.

Posterior cricoid muscle

Muscle	Origin	Insertion	Action
Cricothyroid	Arch of cricoid (antero-lateral aspect)	Inferior cornu and caudal margin of thyroid	Pulls thyroid forward and elevates arch of cricoid; regulates vocal pitch by tensing or lengthening vocal folds
Thyroarytenoid	Angle of thyroid	Vocal processes of arytenoid	Pulls arytenoid forward and rotates it
Vocalis	Angle of thyroid	Vocal processes of arytenoid	Regulates contraction of vocal folds; tensor of folds
Thyroepiglottic	Angle of thyroid	Aryepiglottic fold	Depresses epiglottis and closes entrance to larynx
Posterior cricoarytenoid	Posterior surface of cricoid	Muscular process of arytenoid	Opens and tenses vocal folds; only abductor in larynx
Lateral cricoarytenoid	Superior border of arch of cricoid	Muscular process of arytenoid	Closes, tenses vocal folds; adductor
Transverse arytenoid	Postero-lateral margin of arytenoid	Same region on contralateral member	Approximates arytenoids; adductor
Oblique arytenoid	Posterior surface and lateral margin of arytenoid	Apex of contra-lateral member	Draws apices of arytenoids together; adductor
Aryepiglottic	Apex of arytenoid	Aryepiglottic fold	Assists in closure of epiglottis
Superior thyroarytenoid	Angle of thyroid	Vocal process of arytenoid	Assists in shortening and reducing tension on vocal folds

*know some action of the main muscles

Extrinsic: actually moves larynx - attached from something outside to the larynx

- Suprahyoid- origin: superior to hyoid Insertion: hyoid bone (pulls larynx up/forward)
- Infrahyoid muscle- origin: inferior to hyoid insertion: hyoid bone (pulls down)

Vocal Fold Vibration

- Longitudinal affect F0

- Abductors/Adductors affect regulation of voicing

- Vibration depends on:
  - **Surface wave** along the vocal fold mucosa
    - Vertical phase difference- superior and inferior parts of the vocal folds do not move in-sync
    - Vocal folds blown apart=inferior margins separate before superior
  - **Self-sustaining oscillation:**
    1. Phonatory threshold pressure needed to set vocal folds in motion (varies with F0). Increase in frequency= increase in tension. Ranges from 3-6 cm H20
    2. Vocal folds placed in appropriate position with medial compression force achieved
    3. Subglottal air pressure pushes vocal folds laterally and superiorly- initiates first cycle
    4. Continuing cycles maintained by recoil forces of vocal folds and **bernoillis principle**

    *energy transfer between airflow and focal folds contributes to self-sustainment

Lecture 6: Chapter 4

September 28, 2015 1:03 PM

Cheat card:

- Hand draw images
- Name student number on opposite size

Phonation assignment

- 27.3 mean
  - 26.6 women
  - 32.4 men

  Gender difference- physical size of lungs, males have more efficient vibration, women have more breathy voices than males

Vocal nodules= calluses on the vocal folds
Vocal fold video- vocal folds vibrate incredibly fast. Video camera does not capture every cycle of vocal fold vibration, in order to visualize the vibration, camera takes snap shot every few cycles or so

- Vocal folds opposite to piano (short strings=high notes)
  - Vocal folds- longer vocal folds= high pitch
    - Because: **Cross-sectional mass**: vocal folds are thinner when they're stretched (smaller cross-section)

- cross-section (heavier it is= slower it reacts to changes in motion. More energy needed, resists slowing down)

Cross section (1mm of this will weigh less than the short one)

Cover-Body Theory of Phonation

- Subtle vocal adjustments are made by the mechanical properties of the different vocal fold layers
- mechanical properties depend on the interaction of both layers- nature of flexibility of vocal folds ex. Jello in middle and balloon on the outside compared to just jello (simple model-but more on the inside to contribute)
- Two mass model: upper and lower edges of vocal folds- ungelatory (don't move in synchrony)
  - Connected by spring- one is always slightly behind another in its movement
  - The body: lateral movement
  - Cover: surface wave behavior (vertical phase difference)

Lecture 7: Chapter 4

September 30, 2015 11:33 AM

Vocal fold vibration

- Harmonics: supple(flexible) object vibrates- generates harmonics
  - Ex. Vibrates at 100Hz
    2oo, 300, 400, - 5000Hz frequencies generated
  - Rigid vocal folds will reduce harmonics
  - The higher the harmonic- the less energy it will have
    drop off= 6-12 dB/octave

Phonation

- Exert pressure on the vocal folds
- 3 factors: tension of the vocal folds and pressure of air pushing up on them (sub glottal pressure)
  - Learned behavior- boys at puberty have to relearn
- Bernoulli principle- if you have a fluid (gas or liquid), going through a restriction
  - Air molecules at restriction travel faster to go through (LOWER PRESSURE)
  - Before vocal folds open- static pressure (no aerodynamics)
  - When vocal folds open-aerodynamics, lowers pressure at the vocal folds, not enough pressure to keep vocal folds apart= come back together bc of elasticity
  - 120-180 times/second
  - No muscle movement- more like flag flapping in the wind
    - Use the muscles to set up unstable situation for vocal folds to vibrate

- Stressed languages use respiratory muscles to alter the pressure in order to create different stress for speech
- Muscles involved in low and high pitch?--- more energy required?
- Vocal intensity a function of subglottal pressure
- Voiceless consonants- vocal folds disrupted by **laryngeal devoicing gesture** (pause in vocal fold vibration and vocal folds abduct)

Voice Qualities

- No language uses but
- Some types of phonation are distinguished in some languages
  - Modal phonation- used in every language, max efficient, ordinary phonating
  - Breathy voice (murmur- when it has linguistic distinguish, aka phonemic)
  - Creaky phonation (phonemic)
    - Paralinguistic form in English accent- discriminates social classes
    - Each cycle is different from another
  - Falsetto- not phonemic in any language- tense folds and raises pitch (man imitating women)
    - Less rich in harmonics- tense vocal folds, more rigid
  - Whisper- does not involve phonation, no vibration of vocal folds. Make fricative with vocal folds

*how did these voices become phonemic if they are not the most efficient lets make it harder to speak. More effortful to learn a certain language with tone (learned skill).

Tone (pitch)

- Phonemic in some languages, done with modal voice
- Ex. Swedish
- Very common

Glottogram

- Graph of laryngeal (voice source) waveform, record of the time varying area of the glottis

  Cinemetography
  - Measuring area of glottis- difficult to measure with camera
  - Electroglottogram- movement of the vocal folds and larynx

  stroboscopy
  - Allows you to see something at different intervals of time
  - Used diagnostically to see cycles of vocal fold vibration- rigid scope
  - What appears to be one cycle is many cycles taken at different points
  - Ex. Strobe light

  Electroglottography (EEG)
  - Electrodes placed on both sides of neck
  - As vocal folds contract, signal to electrode changes
- Serves to distinguish different voice types

History of Voice Science

- First theory was myoelastic aerodynamic theory- air from lungs was the active element in voice production, caused vibration of passive vocal folds
- Second theory- rochronaxic theory- nerve impulses from brain initiated each cycle of vocal fold vibration (WRONG)

Lifecourse Issues

- Length of the vocal folds
  - Adult life women- stability in growth
  - Adult life in males- continued growth (cartilage of males continue to grow- big ears etc)
- Sex differences narrow with older age in F0

Lecture 8: Review

October 5, 2015 12:58 PM

Myoelastic aerodynamic theory:

- In opposition to previous view: believed that vocal fold vibrating was caused by muscle contraction. Separate nerves signals from the brain- beyond ability of human muscle.
    - Crying baby- 500-600 cycles per second
- Aeoro- air
- Dynamic- moving fluid, static to movement
- Myo- muscles
- Muscular forces, elastic tissues, principles of flow of fluid
- Muscular- tension of the muscles to position vocal folds- right amount of resistance force
- Elasticity of vocal folds
  4 aspects explain

Graph of change of fundamental frequency for men in women as a function of age

- Young age- both high F0 (300Hz)
- Puberty- bigger drop in males (one octave- biggest difference in all mammals)
    - Sexual dimorphism. Plays a role in identification of sex and sexual attraction
- Change in voice frequency is a secondary sexual characteristic (appear at puberty)
    - Primary sexual differences are present at birth

Review Questions

Chapter 2?

- No chaos, no phonetics, no

Muscles

- Understanding the naming process- origin
- Strap muscles of neck- no individualality
- Accessory muscles of respiration- group don't have to know individual
- Ligaments- holds things together, but don't have to know their names
    - Cricoid cartilage inferior artynoid joint-flexible joint, held ogeter by attachments

Passive and Active Forces

- Active force-
- Passive force-relaxation of stretched tissue will
    - Elastic recoil of lungs- always a passive force to get smaller
    - Elastic recoil of thoracic-
- Alveolar pressure- pressure in sacs in lungs
- No pushing of the air

Cover-body theory- mechanical properties depend on the interaction of both layers- nature of flexibility of vocal folds ex. Jello in middle and balloon on the outside compared to just jello (simple model-but more on the inside to contribute)
Laryngeal vestibule- area of air pipe below thyroid cartilage and above vocal folds. Area of space. Can adjust the walls to affect voice (subtle properties of phonetics)

Cross-sectional theory

- Ex. Resistance to movement with more mass. Shaking gallon of paint can vs. pint of paint can

Cricoidthyroid muscle- on top of conus elasticus

Mechanisms of breathing

- 2 types of breathing

Internal intercostals- exhalation
External intercostal muscles- inhalation

Diaphragm

- Pushed back up by
    - quite breathing: elastic forces of gut
    - Forced exhalation: using abdominal muscles
      *elasticity is always there

Lecture 9: Chapter 5

October 14, 2015 11:36 AM

Take-up Midterm:

- Vagus nerve goes down to chest then back up to larynx (not to gut)

Chapter 5:
Anatomy of upper airway

- Men 17cm vocal tract (larger pharynx), women 15cm
- Monkey anatomy: larynx higher up, oral cavity longer (mussel), soft palate (velum) can contact epiglottis,
  - More similar to new born than adult
  - **Remodelling**- bones grow/change shape, soft tissue develops (almost every structure in tract undergoes developmental change)
- Oral cavity: anterior lips to anterior/posterior faucial pillars
  - Saliva essential for swallowing bolus and moistening
  - Dry mouth when talking: atmosphere evaporates and saliva is spewed out in speech (harder to articulate)
  - 2 layers of mucosa- line mouth and throat:
    - Outer epithelium
    - Lamina propria
    - Different functional mucosa: lining mucosa (all soft tissue except gingiva), masticatory mucosa (on gingiva and hard palate), and specialized mucosa (covers superior part of tongue, papillae)
- Nasal cavity: nares to velopharynx
  - Humidifies air before reaching the lungs
  - Nose runs in cold bc its trying to secrete more moisture to heat cold air
  - Mucociliary transport- mucus lining renewed, contaminated lining gets transferred to nasopharynx and down to stomach

  2 cavities joined at velopharynx
- Figure 5.5- **faucial pillar**- muscles inside pillars to make mouth narrow.

Cranial Bones

- Brain and cranium reach adult size by 6-8
  - Lower face adult size by 16-18
- temporal bone, parietal bone, nasal bone, maxillary bone, mandible
- alveolar process= small hole/cavity, alveolar ridge, alveolar sounds,
- sphenoid bone, palatine bone (hard palate)
- zygomatic bones (zygomatic arch-muscles of mastication), important bc of origins: mastoid process, soft palate, cranial nerve
- **Determinate Bone** Growth- growth of bone stops at maturity
  - curves: 100 line=adult size
  - Rapid up to 2 year (general)
  - **Brain and head increase very rapidly (just focus on this)**
- Structures involved in speech are shaped by forces developed when feeding

Functional matrix theory: muscular shapes bone growth

- Cranial bones- gaps not fused in new borns (fit through birth canal)
  - 45 cranial bones in new borns, 22 in adulthood
  - **Fontanelles-** large opening where bones have not fused yet
- To allow for different rates of development for the skull and face bones- base of cranium allows face too grow downward and forwards
  - **Cranial base**-site for craniofacial growth. Ethmoid, sphenoid, occipital bones
  - **Spheno-occipital synchondrosis**: sphenoid and ethmoid connected by cartilage (growth center for base)
- Mental foreman
- Harder the muscle pulls- bigger effect on bone (more mylohiod lines)
- Digastric muscle/glenoid spine
- **Bone remodelling** in mandible. 2 ways it grows:
  1. **Gnomic**- changes in size not shape. bones don't grow they remodel. Reabsorption of bone in **mandible**
  2. Cartilage to bone
  - Slow steady growth for females, rapid growth for males at puberty
- Mandible only moving bone in craniofacial skeleton
  - **Tempomandibular joint (TMJ) wrote down on his paper**
    - no details on things in joint, but relationship btwn arch and hinging, sliding and lateral motion of jaw
    - Inserts onto mandibular fossa of temporal bone
    - Insertion of condyloid process into mandibular fossa of temporal bone

- Hyoid bone: supports tongue and larynx
    - Located higher in infant

Lecture 10: Chapter 5

October 19, 2015 1:06 PM

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Absorption and growth of bone

Dentition

- Teeth insert on maxillary and mandible bones
- 1st set at 6 months, second permanent set at 4 years
- Low correlation btwn Dental maturation and skeletal maturation
- Adult jaw longer
- Chewing teeth= molars
  - Teeth linked by periodontal ligament
- No names of teeth
- sutures in maxillary bone- bind together in prenatal
- Incisive foreman- hole in maxillary bone
- Cleft palate- suture hasn't come together. Hole from mouth to nose (cant suck)- immediate issue
  - Sub-mucous palate- bones not together but mucous covers it
- No structure of teeth
- **Occlusion**- bottom and top teeth come together- different patterns of bite, some can affect speech production if huge difference btwn maxilla and mandible

Sinuses

- Hollow space within bone
- **Paranasal sinuses**- around nasal structures, contribute to resonance and make head lighter
- Sinusitis- infection/inflammation of sinus
- Grow in size- after eruption of permanent teeth and puberty
- Don't have to know individual sinuses

Different sections of pharynx

- Oropharynx- middle portion, posterior to oral cavity
  - Salivary glands to make saliva (lubricates food and movements for speech)
- Laryngealpharynx (food goes through)
  - below oropharynx and above entrance to larynx and esophagus (epiglottis)
  - not the same as laryngeal vestibule
- Blade labelled wrong on diagram
  - Place of articulation of alveolars. Front vowels

- Alveolar ridge is where blade touches
- Tongue dorsum is middle of tongue-divided into front and back
  *only oropharynx is visible from looking in mouth (other parts need a mirror)

Glands

- No names
- Just know saliva made in glands

Muscles
Mandibular muscles- origin on skull, insert on mandible (deep muscles of face)

- We do not have powerful jaw muscles compared to other species
  - Predators have huge jaw muscles
- Mandibular elevators:

- We do not have powerful jaw muscles compared to other species
    - Predators have huge jaw muscles
- Mandibular elevators:
    - Temporalis: elevate and retract mandible (fan-like from temporal bone)
        - Attaches underneath zygomatic arch
        - Gorilla has crest so temporalis muscles can attach
        - Human males have tiny crest on back of head which is "left over" from ancestors crest
    - Masseter: elevate and closes mouth opening
        - Origin along zygomatic arch
    - Internal (medial) pterygoid: elevates, and with masseter forms the **mandibular sling**
- Mandibular depressors
    - External pterygoid: lowers, alternating contractions can cause lateral movement
        - 2 insertions on sphenoid bone
        - Fibers run laterally
    - Digastric muscle- passes though loop on hyoid bone (doesn't pull hyoid bone up- hyoid=fixed)
        - Contraction will pull down on mandible (jaw opening)
    - Mylohyoid-muscular floor of mouth, lowers if hyoid is stabilized. Horizontally to geniohyoid
    - Geniohyoid- paired, from mandible to mandibular symphysis

  *Geniohyoid/myohyoid- bottom of mouth mandibular symphysis- attached to hyoid (genio= chin)
- Oblique jaw muscle
    - Jaw opening and closing
    - Holding jaw closed- cant open mouth with much force (alligator)
    - Platysma- superficial- little pulling muscle (degrades with age)
- For speech: lower and raise jaw- sideways movements irrelevant pterygoid

Tongue

- Elephants trunk and human tongue similar
- Doesn't have skeletal framework. Changeable in shape
- Muscular hydrostat- no skeleton, cartilage or bone
    - Support through muscular contraction and incompressibility
    - Hydro: Tissue is Water cannot compress
    - Stat: static volume, no bigger or smaller
    - Ex. Water filled balloon- can change shape but cant make it smaller
    - Tongue changes shape by contracting muscles from the inside

      *muscles+ water tissue+ static volume
- Parts of the tongue
    1. Body
    2. Root- extends along pharynx, forms anterior wall of pharyngeal tube
    3. Dorsum
    4. Blade
    5. tip
- Intrinsic muscles- inside, **change shape**
    - Longitudinal muscles- superior (tip up), inferior (pulls tip down)
        - Both contract= shortening tongue
    - transverse muscles (side to side)- narrows tongue "L"
    - Vertical muscles- make tongue thinner
        - Gets shorter along the path of fibers
- Extrinsic- attach to something outside, **puling tongue in different directions**. All insert by interwoven fibers
    - All end in -glossus (tongue)
    - Genioglossus- run down midline of tongue. Makes up bulk of tongue. Origin- midline of mandible
        - Contraction= protrude tongue tip, depress, form midline groove
    - Hyoglossus-hyoid bone to tongue, blends with fibers of tongue. Origin- greater cornua of hyoid bone
        - Contraction= depress, pull backwards
    - Styloglossus- pair of muscles on 2 sides. Origin- spike projections of styloid process of temporal bone
        - Contraction= upward and backwards (runs along syloglossus- Posterior Pillars)
    - Palatalglossus- pair of muscles on 2 sides. **Both tongue and palate muscle.** Origin and insertion can switch depending on which structure is more mobile (Anterior Pillars)
        - Contraction=elevate the tongue

look at all muscles and say what happens when they contract

Lecture 11: Chapter 5/6

October 21, 2015 11:32 AM

Assignment: due at the end of first week back from break

- Tongue is highly vascularized- so rapid movement and turnover of surface cells
- Tongue growth- posterior part of tongue descends during first few years of life. Adult size by 16
- Muscles in tongue insert by connecting fibers of other muscles
- No tonsils/papillae

Muscles of facial expression (superficial facial muscles)

- Points of attachment in the epidermal layers (not bone, cartilage)
- Muscles changing shape of oral opening
- **Obbicularis oris**- fibers have different innervation (different points behave differently) ORAL SPHINCTER
  - Extrinsic muscles- attach to obicularis oris but origin is elsewhere
- Pull back on corners of mouth (oral comissour)- **risoreous** (laughing muscle), **buccinator**
  - Platysma- from pect's to corner of mouth. Contraction= corner downward and laterally
  - Depressor anguli oris: mandible to obicularis oris corners. Contraction= depress lip angle and pull upper lip to lower lip
    - Levator anguli oris- maxilla to same insertions. Elevates angle, pulling lower lip upwards
  - Mentalis- pulls down in center. Contraction= curls lip and crinkles chin
  - Zygomatic muscle: pulls corners up and back. Smile muscle
- Growth of lips
  - 2 growth periods;
    - Infant (birth-2): double in width
    - 10-17: coincides with mandible growth

- Pharyngeal muscles
  - Styloglossus- pulls up and back on tongue
  - Stylopharyngeous- not important
  - Pharyngeal constrictors (superior, middle, inferior)- contract= makes pharynx smaller moves backwards
  - Cricopharyngeus-arises from cricoid cartilage, encircles superior esophagus.
    - Contraction= muscular valve at esophagus opening
- Nasopharynx
  - Velopharynx and larynx connectedness in infants, so they can breathe while feeding, minimizes risk of choking
  - Volume increases by 80% btwn infancy and adulthood- grows long not wide
  - Torus tubarius- medial part of eustachian tube (connects middle ear with pharynx)
  - Snoring= soft palate falling against pharyngeal wall

- Soft palate- velum (valve)
  - Extension of hard palate
  - Nasals= lowered velum, oral= raised
  - Soft palate closed during swallowing
  - Swallowing with open- food can go through nose
    - Need to close nasal in order to suck- feeding crisis if baby cant suck
  - Speech and survival: trade-off for speech and choking
  - VPI- velopharyngeal insufficiency/incompetence. Velum can't close= hypernasality
    - Incompetence: muscles not using full function (birth defect, paralysis). Insufficient musculature
    - Insufficiency: velum not big enough. Tissue to small
    - Cannot close off nasal from oral passage (could be cleft palate or VPI)
    - velum not functioning properly
    - Swallowing liquid so tissue shows on x-ray

    Is there a critical period for learning the velum closing? Get it fixed at an older age, wold they have hypernasalized speech
  - Cleft palate in hard palate
  - Velum muscles- learned movement VELOPHARYNGEAL SPHINCTER
    - Closure= raise velum and pharyngeal walls squeeze around it
    - #2- levator palati- raises velum. Temporal bone to medial soft palate
    - #1- tensor palati- pulls wider, dilate the Eustachian tube
    - #5 superior pharyngeal constrictor- pull back, seal (hugs)
    - #3, #4 open passage
      - Palatoglossus- origin tongue, fibers run upwards to insert on soft palate
        - Make up the **anterior pillars**
        - Contraction= depress sides of soft palate, OR pull sides of tongue upwards and backwards
      - Palatopharyngeus- run upwards to form **posterior pillars**
        - Contraction= depress soft palate, or elevate pharynx/larynx
    - Uvular- only intrinsic muscle- others have attachment outside palate
      - 2 bands of muscles
      - Can reflect palatal dysfunction- **bifid uvula-** spit down middle indicated cleft palate
    - Lowering velum includes: muscles contraction, gravity, and tissue elasticity
- Cleft palate/ VPI Susceptible to teratogens- prenatal birth defect
- Swallowing- dumb job for speech paths
- Velum closure patterns different bc of differences in anatomy of nasopharyngeal
- Velopharyngeal patterns change with age; growth of nasopharyngeal faster in early years than boney structures. Therefore, nasal airway narrow, nasal resistance valves greatest?????

Chapter 6
Auditory System

- Hair cells are mechanoreceptors: mechanical to electrical energy
  - Encased in temporal bone- **otic capsule**
- **Inner ear=cochlea**
- Cavity within middle ear should have same pressure as auditory ear canal
- Muscles in inner ear- protective mechanism, reflex
  - Tympani and stapedious muscles
  - Reduces amplitude (loudness) of sound
- Outer ear
  - Pinna/auricle
  - Auditory canal/external auditory meatus
  - 1/3 cartilage bound- hair and cerumen
  - 2/3 temporal bone
  - Function- protect middle ear, warms air
- Tympanic membrane

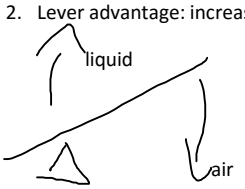
Lecture 12: Chapter 6

November 2, 2015 1:03 PM

Middle ear- impedance matching device

Impendance mismathcing- transferring energy is hard to do

- Very sensitive, lined with mucus overlying cilia to get rid of foreign bodies
- Reduce amplitude increase force
- Ossicles- smallest bones in body. **Malleus, incus, stapes**
  - Connects tympanic membrane with cochlea (sound energy → mechanical energy)
  - **Function:** amplifies sound because (impedance match)
    1. Typmanic membrane larger than oval window (up 15dB). CONCENTRATING
    2. Lever advantage: increase force at the stapes



    3. Buckling of tympanic membrane, doubling force between ear drum and malleus

    Total increase: 33dB 44:1.
    Good for transfer from air (low density, high compressibility) to inner liquid (high density and low compressibility)
    Reflection would occur without middle ear
  - **stapedius muscle**- contraction= reduction in amplitude (**acoustic reflex)**
  - **Tensor tympani muscle**
  - Birds/mammals have single ear bone
- Eustachian tube: ventilates middle ear and discards mucus
  - Always open at middle ear by cartilage always open, connected to nasopharynx open and closed by tensor palatini (when chewing, swallowing, or yawning) to equalize pressure between middle and outer ear
  - Children= horizontal (more easily get infections)
  - Adults= more vertical
  - Mastoid air cells, eustachian tube and middle- ventilator complex; resist mucus blocking and infection
  - **Function:** mucus eliminator and air ventilator
- Otitis Media- inflammation of the middle ear
  - Body temp rises
  - Fluid in middle ear causes resistance to vibration of tympanic membrane (normal air inside can be compressed, fluid can't)
  - If fluid causes joints to become fixed- becomes more like vertibraian (permanent reduction in transmission)
  - **If child has infection for an extended period of time, impacts language/phono development**
- Otitis externa- infection in ear canal (swimmers ear)

Inner ear= organ of hearing

- Semicircular canals (vestibular)- balance
- Cochlea and semicircular canal= hydrodynamic systems
  - Less stiffness from base to apex (apex loose), speed of wave decreases
  - Sounds of different frequencies= location of max displacement
- **Principle of lever** and **concentrating large area on small area**
- Pressing on oval window, bulges round window
  - Membrane between windows vibrates (cells fire- transduction)
- scala vestibuli and scala tympani connected at apex. Filled with perilymph
  - Cochlear partition (scala media): **reissner's membrane, basilar membrane** filled with endolymph
- **Organ of Corti:** faces scala media, reticular lamina= roof, basilar= floor
  - Tectorial membrane attached to basilar membrane- pushes hair cells back and forth. Diagram of organ of corti on card
    - Inner (3,500)- inside tectorial
    - vs. outer hair cells (12,000)- outside tectorial membrane
    - Generation of neural impulses by inner hair cells stereocilia (horse shoe shaped) (tip links) - activated by bundle deformation
      - **Transduction:** mechanical energy to electrical energy
    - Greater movement of longer cilia affects short cilia (higher amplitude of sound)
- Fluid in cochlea from ancestor who migrated from water
- Swimming in pool sound wave from above is 99% reflected off the medium
- Land animals have cochlea originally designed for water but now use it for air
- Impedance mismatch-physical qualities of the "stuff"
- 2 substances of air and water have different levels of force needed to vibrate something IMPEDENCE MISMATCH

Vibration of basilar membrane

- **Place Principle-** envelope function of basilar membrane- maximum displacement at different places, depends on freq of sound
- Tonotopicity- different frequencies at different place
- 3 mechanisms to which inner ear converts stimuli into perception of different frequencies
  - Most detected by tonotopicity
  - low freq detected by different mechanisms **Volley Principle-** frequency theory, no cell can fire 150 cycles/second. Cells grouped can fire together to make it seem like a continuous fire (Gettysburg analogy)
- High freq= base end on cochlea

    - Every sound heard vibrates the base (therefore damage of hearing here in old age)
- Low freq- apex end of cochlea
    - Only low freq sounds vibrate this end of basilar membrane

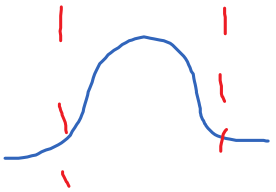
Lecture 13: Chapter 6

November 4, 2015 11:34 AM

Tonotopicity

- High freq= max displacement near base
- Low freq= max displacement near apex

Max displacement is a range of frequencies



How are we able to distinguish btwn frequencies for speech?

- 20-20,000Hz
- Historical thinking that nerve is activated each cycle (Direct response- frequency principle)

1. Frequency: below 1000 (volley + direct). The lower the frequency the more is direct response to brain. Higher needs volley
2. Frequency (volley)+ Place-1000-5000
3. Place- above 5000

- Lower the frequency, easier to find distinction
- Higher, harder to find distinction
- Cochlear implant- microelectrodes put on basilar in different places. Mechanism divides sound into different frequencies

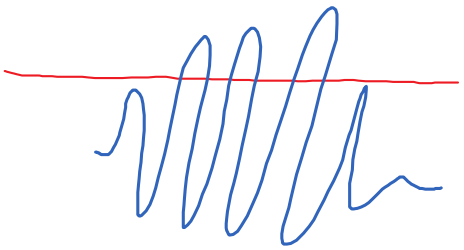
*double frequency coding?

Pathway of sound

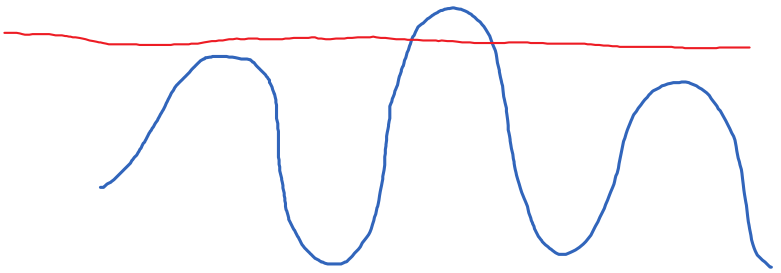
- Arrows forward and back
  - **Otoacoustic emissions**- sound waves being produces by the ear. Reflects activity of outer hairs cells (damaging and diseases). Asses auditory function, person doesn't have to be
  - Outer hair cells- feedback system: refines detection of frequency.(**Electromotility)** Inhibits cell firing of peripheral. Inhibits cells around desired frequency. Control flow of fluids between tectoral and organ of corti
    - Basic concept: info comes back to hair cells telling them not to respond
  - Acoustic reflex-muscles of ossicles contract

Videos

- Stirrup has a pivoting motion
- Tectorial membrane causes inner hair cells to move when it moves up and down
- Loudness
  - louder sounds stimulate a larger number of frequencies (harder to distinguish sounds) - use more of feedback loop to inhibit
  - Softer sounds stimulate fewer cells



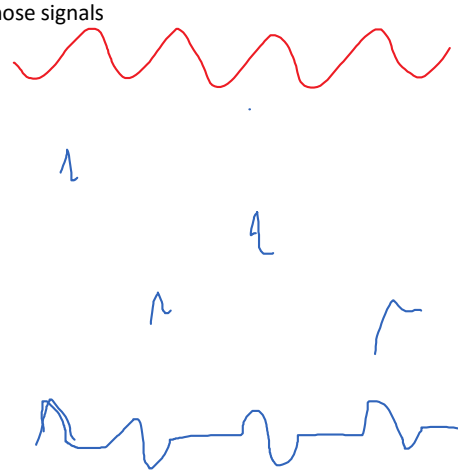
High freq= stimulate many cells
More freq stimulated more inhibitory feedback



Low freq= stimulate one cell
Easy to distinguish frequency

Volley principle

- Frequency is shared among cells- each cell fires at different times but the actual signal sent to the brain is the sum of those signals



Suddenly deaf or blind

- Deaf person has harder time, all form of communication is cut off

Life Course

- Hearing begins 5 1/2 months after conception
- Aging itself does not impair hearing- environment, behaviors and gender
    - Occupation, city lived in, exposure to loud sounds, toxins
- High frequency hearing declines after 20yrs old
- After 30, aging declines twice as fast as in women
- Older women have more sensitive ears than men

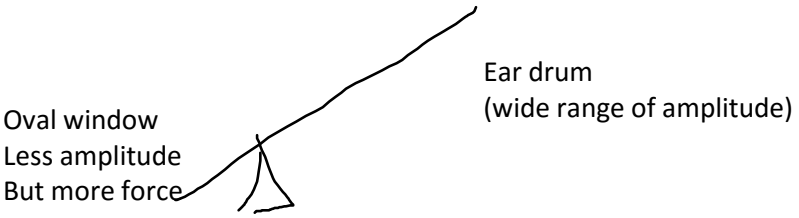
Lecture 14: Questions

November 9, 2015 1:08 PM

- Velum raised and tightened= plosives and fricative (high pressure sounds)
    - Cannot have air escape through nasal passage

Review

- Impedance of air and perilymph: reflection is the problem (shouting into pool)
    - Middle ear
        1. Captures energy on large area and compresses it onto small oval window (like a magnifying glass)
        2. Lever principle: trading amplitude for force. Oval window doesn't go back and



- Dentition: teeth use in articulation to extent with speech sounds
- You don't hear a symphony when its one note
    - Inner hair cells- detecting
    - Outer hair cells- refining frequency
    - But they do both
-

Lecture 15: Chapter 7

November 16, 2015 1:44 PM

- Look at email with pages relevant to exam- sent before midterm
- Figure 7.7

- Peripheral NS- efferent and afferent (muscle and sensory nerves)
  - 31 pairs of spinal nerves in PNS
  - 12 cranial nerves (origin in brainstem), short pathways
    - Special senses- hearing, taste
- Feedback loop of nerves (sense of touch in mouth)
  - CN VII-7 (stapedius, facial muscles)
  - Something about symmetrical/bilateral
- Neuro axis- telen, dien, mesencephalons
- Grey matter= cell bodies of interneurons
- White matter= myelinated interneuron axons
- Connection fibers in cortex (fasciculi)
  - Association fibres: same hemisphere connection fibers
  - Commissural fibers: one hemisphere to another
  - Corpus callosum

Cranial nerves

- Speech production nerves:
  - V trigeminal (mandibular muscles)- 3 branches
    - Sensory:somatosensation from the face, cornea, nose sinuses, teeth, mouth, meninges, eardrum, and tempomandibular joint
    - Motor: muscles of mastication (masseter, temporalis, pterygiods), extrinsic larynx (digastric, mylohyoid), middle ear (tensor tympani), velopharynx (tensor veli palatine)
  - VII facial (lip and other facial muscles)
    - Sensory: taste of anterior 2/3's of tongue
    - Motor: muscles of facial expression (obicularis oris/oculi, buccinator, platysma
  - VIII Vestibular and acoustic nerve
    - Sensory: auditory and balance
    - Motor: feedback loop
  - IX glossopharyngeal
    - Sensory: taste posterior 1/3 of tongue
    - Motor: stylopharyngeus and pharyngeal constrictors (along with CN X)
  - X Vagus (laryngeal muscles)
    - Sensory: somatosensation from larynx, pharynx, thoracic and abdominal viscera
    - Motor: muscles of larynx- all intrinsic laryngeal muscles, muscles of pharynx [except stylopharyngeus], and velopharynx, (pharygeal constrictors, palatoglossus, palatopharyngeus, uvular, and levator veli palatine). Thorsic and abdominal viscera
    - "wonderer" down to gut
      - Branch that only goes to larynx then back up
  - XI accessory
    - Motor: sternocledomastoid and trapezius muscles and velum
  - XII hypoglossal (lingual muscles)
    - Motor: muscles of tongue (intrinsic lingual muscles plus styloglossus, hyoglossus, geneioglossus) and strap muscles of neck
- The reason the brain is in the head: needs to be close to the special senses it innervates. Sensory fibers for vision, olfactory, taste, audition, and equilibrium, minimize length of neural connection and require HUGE number of sensory fibers to the brain. Safe wire

V+X= palatal muscles
IX+X= pharyngeal muscles

Spinal Nerves

- 31 pairs of nerves emerge from
- Bell's Law- dorsal=sensory, ventral=motor
- Dermatomes= segment of spinal cord representative of body sensation
- Spinal cord largest in cervical and lumbar regions because they supply nerves the limbs
- Thinnest where is supplies axial musculature

*don't have to know where cranial nerves emerge

Neural Control of speech

- Primary auditory cortex (heschl's gyrus): located on lateral fissure, receives info from thalamus
- Wernickes area: superior part of temporal lobe, involved I auditory comprehension of language
  - Aphasia= fluent incomprehensible speech
- Broca's area: inferior frontal gyrus, motor aspects of speech
  - Tan, one of first brain regions to specified by behavior
  - Tan: limited spoken language
- Angular gyrus: posterior to supramarginal gyrus (reading difficulty)
- Supramarginal gyrus: around of lateral fissure, acoustic stimulation and language processing (writing difficulty)
- Supplementary (pre) motor area: internal planning of sequential movement
- Cortical representation:
  - Females more bilateral representation, language processing activates both hemispheres more than men

Lecture 16: Chapter 8

November 18, 2015 11:33 AM

Chapter 8: physiological phonetics

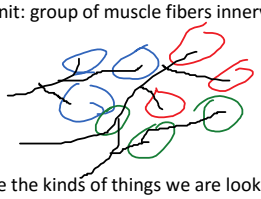
- Delicacy of throat anatomy- difficult to gather voice data
- Hard to get in and look whats going on
- Discomfort and danger
- Ultrasound in medical diagnosis 40ish years old
- How can aerodynamic forces (volume, pressure, flow) be used to study speech production?
  - Movements of speaking result in aerodynamic events (expiration of volume of air, air pressure beneath vocal folds, regulation of airflow through articulators)
  - If aerodynamic variables can be recorded than info on how speech sounds are formed

Physiological/ Experimental Phonetics: research for facts about speech production.

- Difficult to gather info because of delicate vocal tract and not many tools to investigate
- Vital for life (small injuries have large consequences)
- Human subject hard to get- small # of subjects (control of emotionallity)
- More detail in lexicon
- Syllable= basic unit of articulation
- What is the unit of speech? How do you measure it?
- Sounds are articulated differently when next to different consonants/ vowels

Methods

- Neural impulses (brain imaging)- EEG, ERP's fMRI
  - Motor commands: neural impulses to muscle
  - Motor neuron pool: reserve of neurons controlling single muscle
  - Motor control system must activate appropriate motor unit in a sequenced manner
- Motor commands
  - Controls respiratory, laryngeal, and upper airway muscles
  - Can generate air pressures or change vocal tract shape
  - Motor unit: group of muscle fibers innervated by the same nerve



- Table 8-1
  - What are the kinds of things we are looking at= "level of observation"
  - Neural= CNS
    - What pathway is used to speak, decode
    - ERP's
  - Motor= specific muscles
    - Electrical activity- electrodes placed on muscles directly
  - Structural movement
    - Directly measure- visualize or
    - Indirect- infer movement from something else (using light detector on velum)
  - Aerodynamic events- airflow
- Motor Commands
  - Electromyography (EMG)- electrode on muscle to study contractions
    - Surface electrode- coin size (smaller for smaller muscles), pick up activity of numerous muscle fibers. OVERALL muscle a activity
    - Microelectrode: smallest, record activity from single motor unit
    - Needle electrode: insulated only at tip, usually a number of motor units
      Micro and needle inserted into muscle
    - Use differential electrode- composed of 2 wires (insulated and finer than hair), tip has no insulation, system does not amplify ONE electric signal. Detects DIFFERENCE between 2 points (very localized)
      - Can detect difference between transverse and vertical muscles
    - Hooked-wire electrode: strips insulation from thin flexible wire
    - EMG good for looking at bundles of muscle
- Structural Movement
  - Duration between formant frequencies of sounds is constant (50ms)
  - How do we account for this constant transition time but different distances to go?
  - How do we account for accuracy of articulation? (ex. Tongue touching alveolar ridge)
    - Solutions:
    - Strain gauges: direct measure of lips and jaw movement, cause electrical signals when plate is deformed by movement
      - muscles cell all or nothing. More force= recruit more muscle cells. Nerves connected to each cell. Fibers act together
      - Would be nice for research to only get one muscle unit
    - Research- implanted electrodes to investigate speech errors- claim that speech produced was NOT phonologically correct in English
      - Does this disproved the claim of switching/assimilation in phonology
      - Blake black broke block
    - Pandendoscopy/ photoelectric- light source to detect velum opening
    - Electropalatography (EPG)
      - Pseudo palate covers hard palate with electrodes
      - Can see pattern of tongue contact with hard palate
      - Coarticulation, not good for velar sounds
      - Palatal sounds and forward
    - Laryngograph
      - Movement of vocal folds

Do all of them detect the difference in electrical transmission????

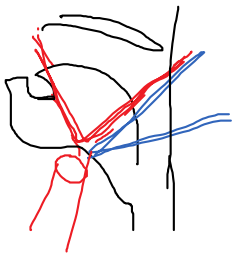
- Sophisticated ones- Measures the height of the larynx in the vocal tract
- Surface electrodes on sides of the thyroid cartilage
- Electrical transmission detected

Lecture 17: Chapter 8/10

November 23, 2015 1:01 PM

How to measure where articulators are when people talk

- Ultrasounds: sends and receives ultra sounds (frequencies higher than human hearing) above MHz
  - Hard to elicit normal speech
  - Sound waves propagate
  - Partial transmission and reflection of borders of different kinds of tissue **(impedance matching**)
  - Image determined by distance away from point on skin
  - Jelly fills gaps (no reflection along with water)
  - Bone reflects all of sound energy that hits it, or absorbs it (ex. Won't see anything if hyoid bone in way)
  - Can't see gap between tongue and hard palate- relevant for speech. Tongue reflects a lot of sound waves
    - Need to have probe set in place and water in mouth (sound wave go through water easily)
    - Hard to have probe stay in place, articulators move
  - Field of view of probe



Hard to see bc of hyoid bone

  - Have to coordinate image with the sound
- X-rays
  - x-ray microbeam technique (Cinefluorography)
    - Glue spots of metal things on articulators
    - Take x-ray video to record articulator movement
    - Solves high dosage x-ray problem: only beam on a pencil goes through spots glued in mouth

Look over impedance matching in hearing

Measuring Aerodynamics

- Measuring fluid mechanics
- Can measure alveolar (lung) pressure, subglottal pressure, intraoral (oral cavity) air pressure, and nasal airpressure
- Also measures airflows through: glottis, oral and nasal cavities
- Resistant measures: opposition of airflow at some region of speech: laryngeal resistance and velopharyngeal resistance. Measures efficiency of vocal fold vibration+ velopharyngeal function
  - Phonatory airflow: airflow during vowel production- measures efficiency of phonation
    - Uses mask over mouth to measure
  - Phonation air volume: total volume of air used in a specified speech task)
    - Assesses respiratory capacity
  - Intraoral pressure - pressure in mouth, behind articulatory obstruction
    - Assesses effectiveness of velopharyngeal function for oral consonants and if lungs have delivered enough air pressure for speech sounds
    - If air escapes through velopharynx- cannot articulate **pressure consonants**
    - measured using open-ended tube inserted into oral cavity behind obstruction
  - Nasal airflow (indirect method)
    - Measured from nares
    - Using airflow to inference place of velum (velopharyngeal function)
      - May not be direct correspondence (is it 1:1)
      - Diffective= more nasal consonants
      - Hard time producing pressure consonants (plosives)
  - Subglottal air pressure:
    - Invasive- needle below larynx
    - Indirect method: record max intraoral pressure during voiceless consonants
- Example- measure airflow of nasal and oral cavity during [mp]
  - More nasal flow for sound [m], and more oral pressure build-up for [p]
- Large inference in acoustic signal. Can infer from spectographic analysis of speech
    - VOT to infer lip closure. Acoustic consequences of where the lips are

Physiological requirements of speech production

- We often speak at a rate that is maximally possible
- Conversational speech just as fast as repeating the same syllable at max speed
  - Interesting bc more phonetic variation in speech
- Faster rates does not mean the articulatory movement is increased- blended speech that is still efficient enough to be discriminated
  - Children have not acquired optimal postural solutions for fast speech

Multiarticulate System

  - Different articulators active simultaneously, simultaneous movement of structures
  - Affected by following vowel, preceding context, coordination of movement
    - Coarticulation of "soon"- velum descending during vowel for n=nasalized vowel

    - More than one physiological measure at the same time (EEG with intraoral pressure measures)
    - Have to record speech with video frames
    - Have to coordinate them
- Figure 8-12
    - Comparisons with surrounding phonemes
- Figure 8-13
    - Electric signal in muscles are measureable but they precede the acoustic output
    - Muscle take some time to actually contract
    - Things it fails to infer correctly

Chapter 10: Speech Perception

- First tools used to study speech perception: spectrograph (analyze) and pattern payback (synthesis)
- Don't know enough to validify any
- Important: don't have to know who did what when. **What do we have to take into account when making a theory? What needs to be explained**
- Acoustic perception invariance in speech
    - Each sound can vary from one production to the next
        - Different phonetic environments, different speakers
    - Perceptual constancy: identifying acoustic properties as the same when they vary by so much. We hear different signals as the same. Different formants, but hear the same thing
    - Solutions:
        1. Prototypes: expected sound categories are made in order group sounds on relatedness
            - Idealized version of "e"- info coming in compared to template
            - Problems: female and male voices templates different
                - Solution to use normalization
            - Incoming sounds **compared** against ideal representations and best fit is selected
            - **Perceptual magnet effect**: perceptual magnet warps the perception of a sound so that acoustic patterns that are close to the center of a phonetic category (the magnet) are perceived as highly similar
            - How are prototypes formed? Experience with specific language, creates perceptual magnets used to organize stimuli
        2. Phonological Features- incoming sound analyzed by features.
            - Ex. [b]- stop, voiced, bilabial (change in feature= change in sound)
            - Downfalls- difficult to define and describe a feature, neglects time
            - Different levels of features: articulatory level, acoustic level, perceptual level

Lecture 18: Chapter 10

November 25, 2015 11:37 AM

- Higher order variables: focus on speech sources and not speech sounds
- Innate systems: born with mechanisms to achieve perceptual constancy
  - Problem: when and how is it used?
  - Mondegreen- getting song lyrics wrong

Experimental phenomena in speech perception

- Categorical perception of speech: phonemic categories
  - Different phonetic attributes but we hear them as the same
  - Could mean general perceptual process adapted to speech, but can be like general perceptual process
    - General processes not specific to humans as thought
  - Category boundaries depends on linguistic background
  - Members of categories harder to tell apart than VOT around boundary
- Research on VOT
  - Is VOT relevant cue for speech perception- or small # of languages with voicing contrast?
    - Universal acoustic properties of speech
  - Unique to speech? Is it acquired?
    - Shared with nonspeech acoustic continuum (Tone Onset Time continuum example)
    - Present in infancy, does not require adult-like language skill
  - Unique to humans?
    - Dogs have VOT category distinction- not human specific, also multimodal
  - Lexical and speaking rate effects on VOT boundaries
    - Lexical- real words vs. non words demanding different distinctions of VOT (**lexical identification shift)**
    - High frequency vs low freq/nonword. May vary boundaries
    - Rate of speech alters boundaries "sentence level-rate" alter perception of phonetic category
- Laterality Effects
  - 2 ears don't have same perceptual abilities
  - Bilateral listening- **right ear advantages** in most individuals (left hemisphere responsible for language). Mostly stops. Left ear advantage for tones and constant vowels
  - Innate- basic sensory processor
- Adaptation- perceptual boundaries can shift after repeated exposure to extreme member of a continuum
  - Shifts towards extreme member just heard- stimulus becomes less effective in evoking the phonetic property of voiceless/voiceness
- Trading relations
  - Speech sounds associated with 2+ cues, perception integrates these cues- phonemic perception
  - Timing relationship of cues changes (ex. Affricate vs. fricative, same cues but vary on duration of silence and frication)
  - Not every speech sound is condensed in fast speech, some cues more condensed than others
  - Trade-off noise for silence. Talk fast, less silence
  - One cue more relevant for distinction (stop consonants- defining feature is burst, not formant transitions)
- Segmentation- we can segment no matter how run together speech is
  - How do we detect word boundaries?
    - We use a set of possibilities and pick which ones make sense
    - Stress and prosodic features(syllable strength) metrical structure: silence and pauses
    - Phonotactics- patterns in which phonemes and features can be arranged. Some phonemes dont occur in certain positions or together

Cant have a model with templates- requires us to consider cue used in speech sounds affected by rate of speech
Also coarticulation

Auditory Illusions in Speech Perception

- Phonemic restoration- failure to recognize part of speech signal has been replaced by a non-word
  - Move to syntactic boundary (pause)
  - Restored a sound that wasn't audible using syntax and semantics
  - You hear an [s] because you think the word was supposed to be plural
    - No other cues in the sentence to indicate plural
- Verbal transformation
  - Change in perception but physical speech signal is the same (same word repeated many times)
    - Perceptual system constantly testing new hypothesis against signal

Theories of Speech Perception

- Passive theories: not much cognitive effort needed. Relies on passive responses thresholds
- Active theories: involves perceiver work . Generates hypothesis about stimuli. Seeking out info you want to decode (semantics, syntax) consulting other info
- Autonomous theories: only need basic perceptual processing. No other source of info are needed (knowledge or world, or communicative context)
- Interactive theory: perceptual decision making relies on various sources of info

1. Motor theory: speech as an auditory code (characteristics of the code are elaborated)
   - Acoustic varies with the phonetic message but the control of articulators is invariant
   - Articulation is referent for perception-perceive speech bc we can produce it
   - Focuses on small parts, syllable as fundamental unit of perception
2. Logogen model of speech perception- neural representation of a word that is activated by physical stimulus that matched the stored representation no details, creation of a word (NO QUESTIONS)- know what it takes into account.
   - Comparative, passive threshold, bottom-up, autonomous theory
3. Cohort theory: checking beginning and getting all possibilities of words
   - Bottom-up semantics/syntax involved after cohort prduces possibilities
   - Passive bottom-up autonomous
   - No top-down, produced implausible options for words
4. Interactive-activation model: layers of activation. Activation and inhibition
5. Event perception theory: articulatory movements is the event, and we need to recover info from event using speech signal
6. Lexical neighboring activation: frequency affect activation of neighborhoods. Acoustic-phonetic properties source for initial access to lexicon

Issues in Speech Perception

- Speaker normalization- specific freq of vowel don't tell you who is speaking. Idealization to compare speech to. Male and female voices, age
  - Size of vocal tract/vocal folds
  - Innate- appears in infants, no need for language expertise

    - Taps into cognitive resources. Trade-off for recognition if many speakers
    - Solution: vowel formants and fundamental frequencies
- Time normalization: continuous changes in rate of speech. VOT shifts with rate
- Integrating segmental and supra-segmental info
- Defining the unit of speech perception: different sized units at different ages (children= syllables), how units of different sizes are combined
- Cross-model aspects of speech perception: lip reading, body language. McGurk effect- visual information overrides or complements auditory info. Hand over speakers face

Speech and Normalization

What we have to take into account

- Acoustic signals have lots of overlap- speech decoding mechanism
- Accents
- Speeds of speech productions- we can understand but its not ideal
    - We can cope with speed of production of phonemes- doesn't mean each phoneme is cut down, some sounds are compressed more than others (vowels?)
- We integrate segmental and suprasegmental information (affect different aspects of speech)
- We also cope with coarticulation- ways in which phonemes are produced by an individual
    - Seep and sweep (coarticulation of s and proceeding vowel
    - Any given instant you are articulating more than one sound simultaneously
    - Top-down influence- can hear a phoneme that's not actually there
- Structure of speech and written language
    - More repetition in speech
    - Reading transcripts aloud can be difficult to understand
    - Speech is expansive, same the same thing in different ways (redundant and ambiguous- cues you get have a number of different interpretations)
    - Goal in writing- to condense and not much repetition
    - Hearing impaired- make sure topic is explicit, light on the face of talker
- Sound difference btwn plosive consonants last very very short time- lots of ambiguity
    - p, t, k not easily distinguished from each other (acoustic difference lasts a very small about of time)
    - Confusion matrix table- when no context and no helping cues sounds are more ambiguous
        - What was said and what was heard
        - To determine what sounds are intelligible and not easily discriminated
- Basic unit of perception- do we hear and decode, phonemes, syllables, words?
- Cross-model perception- we take into account more things than we think we do
    - To a certain degree- we all lip read

Lecture 19: Chapter 11

November 30, 2015 1:05 PM

Chapter 11: Theories of Speech Production

- Understand theories of speech production
  - Why theories matter- know it
    - Theory used in science- attempt to globally explain something that we know
    - Some degree of uncertainty in the area= theories make predictions, explains things beyond what we current know is true
      - These predictions become focus point for research
      - Theories are refined but can also be scratched when the data shows otherwise
    - Paradigm shift: particular period in time known by theories that interpret the known facts and help direct future research

- Speech consists of a series of events that must be completed in the correct order, without error to be fully intelligible
- THINGS TO TAKE INTO ACCOUNT WHEN MAKING A THEORY:
  - Takes into account normal speech, speech development and speech disorders
  1. Regulating Serial order:
     - What are the units?
       - Most likely phoneme of syllable (but also arguments for breath group and word)
     - How are they controlled?
       - Combined into stress patterns
       - Problem: amount of time it takes muscles in speech
       - Errors in production used to uncover underlying organization of speech. Include errors of syllable or word structures
         - Slots and fillers concept: two parallel processes for production. Slots= info on syllable pattern and stress. Fillers= info on phonetic elements to be inserted into slots
           - Errors in speech= error in procceses matching fillers and slots
         - Initial and final sounds interchange with initial and final sounds
         - Syllable and word position part of serial planning element
       - Anomalous utterance: patterns irregularity, patterns of errors
       - We make errors that assimilate to our language- same phonosyntactic
       - Many errors transpose phonetic elements while preserving stress pattern
       - Regularity of errors can be due to the perception mechanism of the hearer
       - Tongue twisters= errors = similarity in phoneme in same syllable (easier to say phonetically diverse sentence)
       - Developmental aspect: slot= mandibular movement, fillers= phonetic content (early control over lips and tongue therefore first sounds are usually b and d)
     - What order are signals sent out in, if the transit time to various muscles are different?
       - Are signals pre-programmed? Prepared in advance- no reliance on feedback
       - Feedback control? Waits for feedback of instruction completion then sends out instruction for next sounds
       - Could be combined- basic set of instructions, feedback intermitted to check performance
       - Feedforward theory: advance signals to muscle set proper conditions for control of speech movements
  2. Degrees of freedom
     - Freedom of articulators to assume a different position
     - Lots of ways to go wrong, yet we speak efficiently
     - By some mechanism we have to reduce the number of ways we can make an error to speech that is almost flawless
     - Not just relevant to speech, but all coordinated muscle movement
     - How does the system control so many degrees of freedom?
       - Group muscles (functional collectives)
         - Ex. Labial closure- involves mandible, lower lip and upper lip
  3. Context- sensitivity
     - Context changes the articulation of phonemes
       - Also affected by rate, stress, and precision of articulation
     - Problem for theories based on idea of simple library of motor commands involved for each phoneme
       - Speech units sensitivity to context (context-sensitive allophones)
       - Feature spreading: coarticulation because features spread to adjacent segments, as long as they don't contradict phonetic requirements for the segments
     - Coarticulation/ assimilation to positions further than 1 or 2 phonemes away
     - Theory has to permit the variation necessary for coarticulation
     - Not just /k/ /a/ and /t/ put together- coarticulation is happening
     - At what level is this taken into account (dictionary of all possible contexts)

How much context is in memory and how much is retrieved

Theories of Speech Production

1. Stage theories (translation theory)
   - levels of organization (figure 11-2)
   - Processing by stages
     - Segmental specification: phonemic segments (usually syllables, allophones or phonemes)
       - Highest level of motor regulation, language component to segment specification
     - Feature/ goal composition: muscles needed to perform. Divide segment and motor command
     - Motor command generation: regulate sequence of muscle contraction (strength and duration)
   - Some other models implement stage for higher order organization (stress, rate, suprasegmental variables

Lecture 20: Chapter 11/12

December 2, 2015 11:31 AM

2:30- 420 ARTS

Speech Production

2. Quantal theory
    - Articulatory movements not equal in acoustic output.
    - Some variablility in articulatory movement without altering speech sound. Takes into account coarticulation and errors
    - Making a jump from one step to another (never in between)
    - Right angle bend in vocal tract
    - Can produce **maximally distinct** vowels- don't want sounds to be mistaken for each other
        - Don't want to have to make large distances for different sounds
    - Perceivers point of view- hear one vowel or another nothing in between
    - Distinct vowels created by minimal movement of articulators

*jump from one sound to another, nothing in between

Tongue can be approximate but a little movement will change phoneme perception

    - Right angle vocal tract product of bipedalism
    - Quantum theory (production).... Categorical theory (perception)
    - Difference between plosive to fricative articulation is small, but production is distinct
    - Solves the problem of transmitting information quickly ?????
3. Linguistic- Communicative H&H Theory (hyper and hypospeech)
    - Relate to communication goals of speaker and not speech movements
    - **Not formal vs informal speech**
    - Need for intelligibility- effort to ensure perceptual adequacy of speech signal
    - VS physiological effort- need for energy reduction/speed. Making articulation easiest as possible

***possible paragraph question**

        - Clarity VS speed (ex. Need to warn fellow hunter of tiger- need clarity and speed)
    - Universal principles for human movement- not special for just speech and language (multimodal)
    - Constant struggle between the 2 needs- always changing speech to accommodate
        - Utterances differ depending on communicative setting. Same phonetic message produced in different ways depending on intention, and communicative setting
    - Hyperspeech- ensures discrimination in speech "output-oriented"
    - Hypospeech- Principle of Least effort. "system-oriented"
    - not the same thing speeded up, you choose different movements for different speeds

Example: when speakers are rely on context and topic familiarity than hypospeech is used

    - Not one universal solution
        - Variable regulatory process- Constant adjusting to present constraints (ex. Lawnmower running in distance- adjust loudness of speech)
        - NOT SOCIAL CONSTRAINTS
    - We can communicate under various conditions of interference with listeners of various linguistic competence by adjusting speaking style to get the message across

Chapter 12: Applied Speech Sciences

Human-machine speech communication:

- Fewer risks than typing at a desk and is comfortable for most people
- Speak to a machine as if having a conversation with it (speech much different from writing, would have to take into consideration repetitious form
- Fastest method of getting communication across is speech

Digital Speech Coding

- Speech synthesis: goal to produce as natural and intelligible as possible
- Automatic speech recognition: speech input compared to store reference patterns
    - Frequencies of certain morphosyntactic patterns and words

has to take into account normalization, coarticulation

Forensics

- speaker identification
    - 3 approaches: aural (acoustic) recognition, automatic machine recognition, spectrograms
        - Compared to suspect
    - 2 primary differences: anatomic differences (physiological) and accent differences(behavioral)
        - Interpersonal similarity- Overlap in parameters among individuals
    - Loudness of speech, health, toxins, rate of speech
    - Small sample- not much evidence
    - Poor quality sample- quality of recording made to distinguish speech sounds not analyze acoustics
    - Disguised voice- fake accents, muffled voice
    - Is there a common F0 among populations, is fundamental frequency genetic
    - Voice source parameters:F0, contour of F0, fluctuation in F0 and glottal wave shape (laryngeal properties)
    - Vocal tract resonance parameters: formant frequencies, envelope function, formant bandwidths

Lecture 21: Chapter 13/14

December 7, 2015 1:04 PM

Chapter 13: Evolution of Speech

Protolanguage *hallmark of language- small pieces that can be put together

- First concept of language is lesser than modern language
- Had a sizeable vocabulary (greater than simplistic cries but no grammar)
  - No protolanguage, because as soon as there were 2 words you have syntax
  - Other argument: anything less than language is not languagae
  - Holistic cries- cannot parse
  - At some point phonetic parts of words got combined- rapid increase in vocabulary size
  - Holistic calls ---------- modern syntax (in between is protolanguage)
  - Difference between holistic and pieces of
- Speech sounds can be combined
  - Holistic calls from monkeys not recombined
- For the longest time language has been spoken
- Biological conditions for language must have developed
- Evidence that vocal apparatus was adapted for speech
  - Tradeoff of precision of a sound
- Adaptation- using structures that already exist
  - Tongue exceedingly mobile. Not a whole lot of adaptation is needed to make speech sounds
  - Right angle bend was adaptation for speech- NO exploited by speech but product of bipedalism
    - Other animals have right angle bends based on standing orientation
- Cognitive capacity
  - Compared hypoglossus nerve hole in humans and animals- nerve has to larger to carry more dexterity info

Chapter 14: embryology

- Fertilized egg(conception) to Embryo to fetus
- Early in development, mammals look the same
- Ontogeny (development of individual human and not human) recapitulates phyloneny
  - Development of human is the same as evolution of all species in phylum (humans have ancestors that are fishes)
  - Our branchial archs turn into lungs, whereas fish turn into gills
- Branchial grooves- develop into different structures for different animals (3 weeks)
  - Ex. Middle ear bones of mammals are found in the jaws of amphibians (same arch)
  - Arch one- mandible malleus and incus
- 14-1 the same for every mammal DON'T MEMORIZE
  - 1 arch= mandibular 2 arch- hyoid arch
- Merging of 5 processes: one frontonasal, 2 maxillary and 2 mandibular
- Oral pit- hole that turns into the mouth (stomodeum)
  - Fish- one hole, no nose
  - Humans: split into 3 openings- mouth and 2 nostrils
  - Medial nasal process separates 2 nostril holes
  - Palate comes out from sides of hole
  - 2 boney processes (palatal shelves) fuse in the middle to separate hole into nasal and oral
- Palate made of 3 parts (suture lines) seal and join, also maxillary bones come together and fuse in middle (complete closure a 8-9 weeks, uvula at 10 weeks-makes swallowing possible)
- timing is very important to gestation, scheduled time of events
- Teratogens- toxic substance that causes birth defects- may cause harm at one moment but not the other
- VPI- soft palate does not fully close off velopharyngeal passage
  - Speech= creates hypernasality (can make high pressure consonants)
- Cleft palate+ lip (develops in 7-11th week)
  - Uvula on 2 different sides
  - Cleft lip= cleft maxilla
    - Not in middle-one side of shelf has not fused to medial nasal process (unilateral vs. bilateral)
  - Can have one without the other or both
  - Fistula- holes along suture line
- VPI, cleft is a syndrome continuum
  - Most commonly occurs in Asian populations, and indigenous
  - Least common in Caucasians and black ppl
- Pierre Robin Syndrome- undeveloped mandible, does not allow tongue to descend, preventing closure of palate. Result= small mandible (hypoplasia)
- Learning problem left unrepaired
  - Completely normal soft palate valve and musculature but don't learn distinction for closed velum bc it doesn't make a difference closed or not
- Submucosa cleft- bone not fused but close enough that soft tissue develops overtop
- 3rd month larynx is created by reabsorption of membrane- incomplete reabsorption= webs on vocal folds
- Ear completed by 5th or 6th month
- Larynx assumes position in neonate at 6th cervical vertebrae (29 weeks)

Final Review

December 9, 2015 1:00 PM

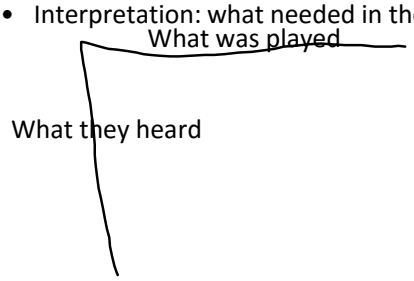
LMR405

Cleft palate- mentioned in Chapter 12
Laryngography/electroglottal graph: device used to record function of vocal folds during phonation

- 2 Surface electrodes: INDIRECTLY measures state of glottis (more direct than spectrogram)
- Infer what is going by pattern of electrical currect

Confusion Matrix

- Interpretation: what needed in the perceptual system: some sounds are more easily discriminated than other



- No cues for interpretation
- p, t, k not much acoustic information (heard as different sounds)
- Some sounds have much higher rates of being heard correctly

- Right angle bend, quantal theory
  - Was once believed that right angle was adapted for speech- drove this physiological change
    NOT TRUE product of bipedalism (head on top of thorax)
  - Acoustic theory: right angle bend emits quantal variable
  - Maximally different

Speech production

- Degrees of freedom: enormous amount of degrees of freedom (size of pharyngeal cavity, larynx, vocal fold length)
- How does system cope with this freedom?
- Coping with the sequencing to muscles

Ultrasound

- Above human hearing (in thousands)
- How far away the structure is that sound bounces is off
- Speed at which sounds bounces off fat and muscle is different
- Measure amount of time and direction thing is pointing
- Device sends out and retrieves sound
- Low frequency sounds penetrate better than high frequency
- Doesn't go through air well
- Change in material= change in propgation of material, some reflection
- Cannot see across air gaps and bone
  - Can see when the tongue touches the palate, but as soon as the tongue stops touching the palate there is air and only the top of the tongue

Speech

- Redundant and ambiguous
- Confusion matricies
- No context= harder to discriminate speech sounds
- Acoustic emissions overlap
- More than one piece of info that tells you something. Multiple cues
  - Acoustic info+ context info

Physiological methods

- Ultrasonic imaging
- Laryngograph (electroglottograph):
- Magnetomotry: clue tiny magnets to track movement

- Electromyography: measuring, recording electric activity of muscles
    - Electrical potential difference- not in surface electrodes or needle electrodes
    - differential micro electrode-insulated wires (barbed- not insulated): 2 wires. Kind
    - Doesn't amplify what comes to the wires, just tells you what is different between the wires
- x-ray cinegraphy
- Airflow/air pressure measurements
    - Microbeam technique

neural imaging fMRI shows change over time
Problem: not a high frame rate (not smooth movement)

Regulating serial order of speech
- Different order in which commands are sent out has to be different than the order in which they are said
    - Different distances in nerve impulses
- Errors fall in patterns that relate to the syllable and the word
- Why do we make mistakes, patterns of mistakes
- Why does the system mix up tongue twisters? Why is it so hard?

Palatal shelves come together in oral cavity
Around edge- maxillary processes come together

Laterality effects of speech perception
Binaural hearing effects- 2 ears connected to 2 different hemispheres
- Better perception for right ear- to left hemisphere
- Stereo stimuli, dichotic stimuli
- Hemisphere specialization

Vagus innervates larynx- not much else

Speaker normalization- different speakers make different noises
- Able to normalalize for different speakers with different sizes of vocal tracts but we hear the same sounds

Timing relationship
- Rate of speech, we can compensate for rate of speech
- Can take out variation and perceive, comprehension

Trading Relations
- Ratios of cues: fricative and silent
- Trade-off
- Relationship between length of silence and fricative