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Characteristics of Speech (Part 1) and Language (Part 2) for Hearing Devices (Aids)

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Earl Johnson, AuD, PhD

As noticed, this presentation is in the English language, but this reality does not much matter with regards to amplification recommendations for hearing devices.

No specific mention of prosody and phonologic rules (speech) or form, content, and use (language) is made.

I am not an expert on these matters.

STANDARD DISCLAIMER

- *Any opinions expressed are those of the presenter and do not necessarily represent the official position of the U.S. Department of Veterans Affairs or the United States government.*

What is speech?

- The Hindu have a saying known as *Nada Brahma*, one translation of which is "The world is sound."
- The most relevant sound to human communication is speech.
- Speech is the expression of or the ability to express thoughts and feelings by articulate sounds.

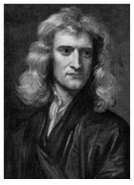
I would like use the following three-analogy.

Speech Mapping is to a **Real-Ear System** is to **Hearing Measures**

as

Driving Directions is to a **Global Positioning System (GPS)** is to **Surveying Measures of Land and Water**

- The reason both Speech and GPS mapping work so well is that some prominent forerunners have been there many times before.
- A statement from Issac Newton has some relevance here.
  - "If I have seen further it is by standing on the shoulders of giants."



Moving on to a Notable *Giant* in Hearing Research

- Denis (a psychologist by early training), Director of Research for the Australian National Acoustic Laboratories, often described some practices in audiology as "missionary-based" rather than science-based.
  - By which he meant that proponents of an idea sometimes espouse the idea with a vigor that exceeded the objective evidence available.

Source: NAL Historical Background

- Although the widespread beliefs of his day were that there was little benefit to be gained by individual prescription of hearing aids, Dr. Byrne became convinced that this was not true.
- The specific goal was to *raise each critical band of speech to the same loudness as all the other bands*, while still achieving the average gain required by the half (actually 0.46) gain rule.
  - The publication by Byrne and Tonisson in 1976 and became known as the NAL prescription rule.

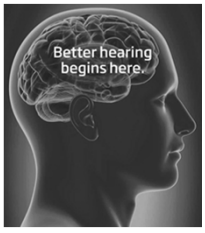
Source: NAL Historical Background

- To make life easy for the clinician (remember, there were no computers then to make life ''easy'') the formula was turned into a slide rule.
  - As soon as commercially available, probe-tube measurements were incorporated into all hearing aid fittings (Dillon & Murray, 1987).

- Over a three-year period following introduction, battery consumption per hearing aid increased by 50% without there being any change in the models or delivery of hearing aids being issued.

Source: NAL Historical Background

So what had Dr. Byrne learned to make his contribution?



Characteristics of Speech

Sounds of Speech

- Since the 1900s, Bell Laboratories had been studying 39 phonemes of English.
- Now, 44 phonemes and 4 blends are readily accepted.
  - 18 consonant phonemes
  - 5 consonant diagraph phonemes
  - 16 vowel phonemes
  - 5 R-controlled phonemes
  - 4 blends

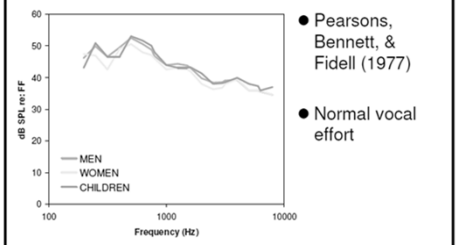
B	C	D	F	G	H	J	L
M	N	P	R	S	T	V	W
Y	Z	NG	ZH	CH	SH	TH	A
E	I	O	U	OO	AI	EE	IE
OA	EW	OU	OY	AH	AU	ə	ER
AR	OR	AIR	EAR	EUR	QU	YEW	X

https://www.youtube.com/watch?v=xiqUVnXExTQ

What was learned from studying the phonemes?

- The spectra for the 39 phonemes studied by Bell Laboratories can be shown in graphs of frequency versus time for…
  - "Joe took father's shoe bench out." and "She was waiting at my lawn."
- These celebrated sentences were used to demonstrate all the fundamental sounds that contribute to speech amplitude.

Effects of gender & age:

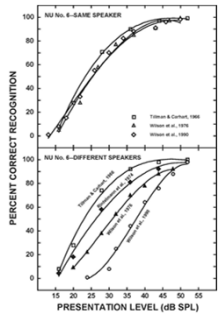


Source: S. Scollie

What makes speech hard to hear?

- Myth: When there is high-frequency sensorineural hearing loss, the speech of women and children is harder to recognize because they have a higher fundamental frequency (i.e., ~220 Hz) than men do (i.e., ~110 Hz).
- Reality: There is no evidence that the fundamental frequency of speech – how high or low it sounds – has a direct role on its intelligibility.

So Do Different Talkers Have Different Intelligibilities?

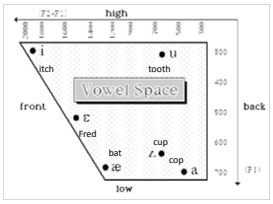


- Yes, even the same material has a different transfer function if spoken by another person!
- The effects of coarticulation and even dialect are at play.
- The implication is that we must use recorded speech material with known transfer functions when evaluating speech recognition.

Source: R. Wilson

Bradlow, Torretta, & Pisoni (1996)

- 20 talkers, 100 sentences
- Investigated talker characteristics of gender, F0 and speaking rate.
  - Findings showed female talkers to be more intelligible as a group than male talkers!
  - The F0 and speaking rate did not correlate with intelligibility.
  - Talkers with larger vowel spaces were more intelligible than talkers with reduced spaces.



Bradlow, AR, Torretta, GM, Pisoni, DB. (1996). Intelligibility of normal speech I: Global and fine-grained acoustic-phonetic talker characteristics. *Speech Communication 20*(3): 255-272.

Measuring Speech

Examples of test signals:

- Speech
  - Some offer pre-recorded, calibrated samples
  - Others let the individual talker's voice fall where it may (as recorded).
  - Others use any live voice signal (you, the spouse, the parent, etc).

Source: S. Scollie

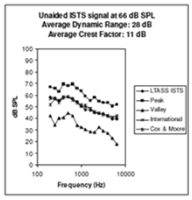
Speech Analysis Notes

- Real time measures (i.e., a running display of the signal peaks) are best for illustrating the fitting to your client.
  - They are more realistic… you will see the signal fluctuate with your speech.
  - They are best for determining if a sound will be audible or not (by comparing the peaks to thresholds).
  - They are best for quickly capturing brief sounds (like intermittent feedback).
- In the AudioScan Verifit 2 unit, the average of running speech is taken over a 12.8 second passage – 100 measures once every 128 ms.

Source: S. Scollie

ISTS (Holube, 2007)

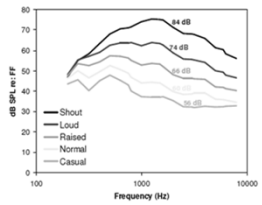
- "21 female speakers in six different mother tongues (American English, Arabic, Chinese, French, German and Spanish) were reading the story "The north wind and the sun" [1] several times using natural articulation."



http://www.audiologyonline.com/articles/20q-getting-to-know-ists-13295

Dr. Inga Holube

Effects of vocal effort level:



Pearsons, Bennett, & Fidell (1977)

Source: S. Scollie

How do we use the preceding to calculate an estimate of speech intelligibility and recognition?

What is needed?

– A theoretical structure that provides the basis for calculating a prediction

1. Articulation theory (Fletcher and Galt, 1950)
2. French (1942), French and Steinberg (1947), and Beranek (1947) version of the AI (ANSI, 1969),
3. Speech intelligibility index (SII) (ANSI, 1997).

– Each has a reliance on quantification of amplitude and frequency information.

Factors to Consider

- Loss of audibility
  – Pure tone threshold levels are converted to equivalent internal noise spectrum levels.
    – A "fictitious" internal noise that would, if externally presented, give rise to an equivalent pure tone threshold.
      » Uses the critical ratio described in Pavlovic (1987) to do so.
- Upward spread of masking
  – Accounts for the masking of higher speech frequencies by lower speech frequencies.
  – Total masking is the larger of:
    - self-speech masking
      or
    - the background noise

Other Factors

- Speech level distortion (SLD) Factor
  – When speech audibility is held constant, higher than normal speech levels have a negative effect on speech recognition (French and Steinberg, 1947; Fletcher and Galt, 1950).

Other Factors

- Hearing loss desensitization (HLD) Factor
  – Better known as Chas Pavlovic's Dog

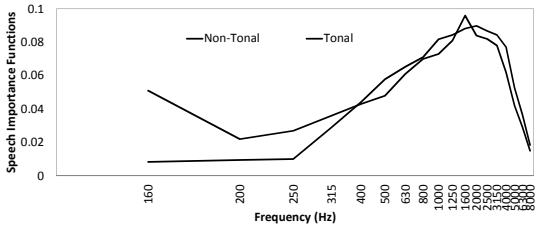
One of Pavlov's dogs

  – Corrects speech score predictions for the observation that, given full sufficient audibility, persons with more hearing loss will, on average, recognize speech less well than persons with less hearing loss.
  – Several HLD factors exist:
    1. National Acoustic Laboratories by Ching and Dillon (2013)
    2. Sherbecoe and Studebaker (2003) utilized in Humes (2002)
    3. Pavlovic (1986)

What Else is Needed

- A speech test with well known characteristics under conditions of reduced audibility.
  – Specifically, there is need to know the test's
    - frequency importance function (FIF) &
    - transfer function (TF).

Frequency Importance Functions Between Language Types

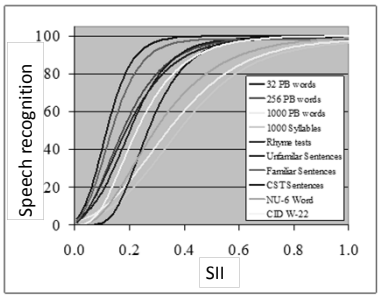


Transfer Functions from SII to a Percent Correct Score

Authors	Material	Q	N
Wong et al (2007)	Chinese Hearing in Noise Test (CHINT) sentences	0.1844	12.58
DePaolis et al. (1996)	Phonetically Balanced (PB-50) words	0.641	2.436
	Speech Perception in Noise (SPIN) sentences	0.329	4.481
	Continuous discourse	0.353	8.943
Eisenberg et al (1998)	Hearing in Noise Test (HINT) sentences	0.235	15.13
	American National Standards Institute (ANSI) S3.5 standard	0.247	16.9
Henry et al (1998)	Consonant-nucleus-consonant (CNC) monosyllables - Australian recording	0.474	2.518
Sherbecoe and Studebaker (2002)	Connected Speech Test (CST) passages	0.227	10.26
Sherbecoe and Studebaker (1991)	Central Institute for the Deaf (CID) W-22 words	0.283	4.057
Studebaker et al (1993)	Northwestern University (NU-6) words - Auditec recording	0.404	3.334
Sherbecoe and Johnson (2015)	Northwestern University (NU-6) words - VA recording		
Magnusson (1996)	Swedish Phonetically Balanced (SPB) words	0.396	2.73
Magnusson (1996)	Hagerman sentences	0.158	4.9
Sherbecoe and Johnson (2015) analysis of Causey et al (1984)	CNC monosyllables - Veterans Affairs recording	0.541	1.917
Sherbecoe and Johnson (2015) analysis of Silberer (2014)	Minimum Speech Test Battery (MSTB) CNC monosyllables	0.558	1.85

Equation	Prediction of
$S = (1-10^{-(I \cdot P)/Q})^N$	Score
$I = -(Q/P) \cdot \log(1-S^{(1/N)})$	Index

Effect of Target Material



Source: B. Hornsby

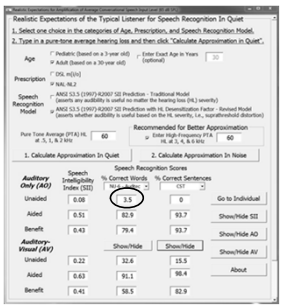
Let us consider…

The patient complaint of …
"I can hear, but I can't understand."

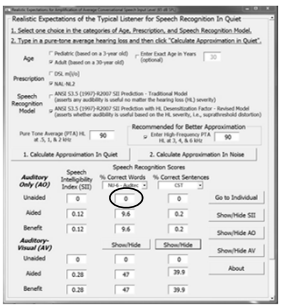
Here, in this presentation, we will substitute "understand" for "repeat" speech.

Reference: 100% for the Person with Normal Hearing Sensitivity

Flat 60 dB HL



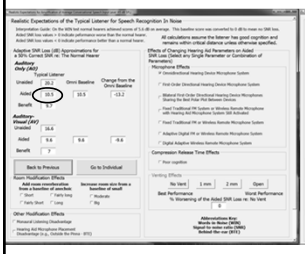
Flat 90 dB HL



What about speech recognition in noise?

Reference: 0 dB SNR Loss for the Person with Normal Hearing Sensitivity

Flat 60 dB HL



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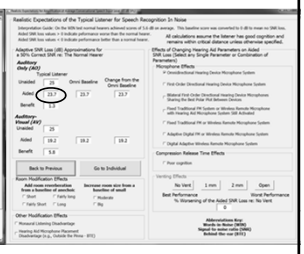
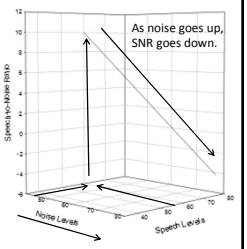


Speech-to-Noise Ratio At Differing Input Levels

- Pearsons et al (1977) data included schools, homes, hospitals, department stores, trains, and airplanes).
  - The main results have been summarized in a paper by Olsen (1998).
  - For low-level noise (below 45 dBA SPL), the speech level was fairly constant, around 55 dBA SPL (a 10 dB SNR).
  - Speech increases at a rate of 0.6 dB/dB of the background noise (i.e., makes SNR worse)

Speech Level = 0.6(Noise Level) + 28



Speech-to-Noise Ratio Commonly Encountered

- Agreeing with the Pearson et al (1977), Teder (1990) indicated SNR of conversational speech averaged 4.8 dB in noisy environments.
- For hearing aid wearers, there were very few recorded situations where the SNR was negative or close to 0 dB (Smeds et al, 2014).

  Average SNR = 5 dB

Do improvements in one environment lead to similar perceptual benefit in other environments?

- Not necessarily…
  - The patient complaint

    "I can hear in some situations, but I cannot hear in others."
- Different talkers
- Different speech target materials
- Different topics
- More background noise or competing speech

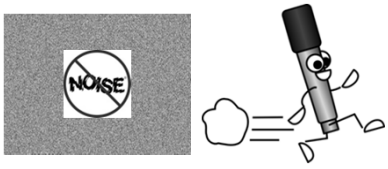
Effects on Speech Recognition In a Background of Noise

- 885 psychometric functions of speech recognition in noise from 139 different studies
- Large variations in slope
  - Ranged from 1 % per dB to 44% per dB (median 6.6% per dB).
- Improving SNR by 3 dB (6.6% per dB) with a directional microphone is a 19.8% change!
- A compression release time that is too fast for individuals with poorer working memory can worsen SNR by about the same amount (Souza, 2012)!
- **Overall Study Conclusion**
  - Major factors
    - type of masker (background noise)
    - number of maskers (background noise)
  - Minor factors
    - Characteristics of the speech other than the material type (e.g., syllables, words, and sentences)

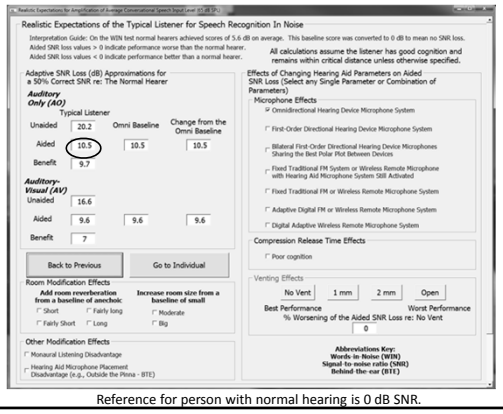
Get rid of the NOISE!

MacPherson, A. & Akeroyd, M.A. (2014). *IJA*

Noise Averting Microphones

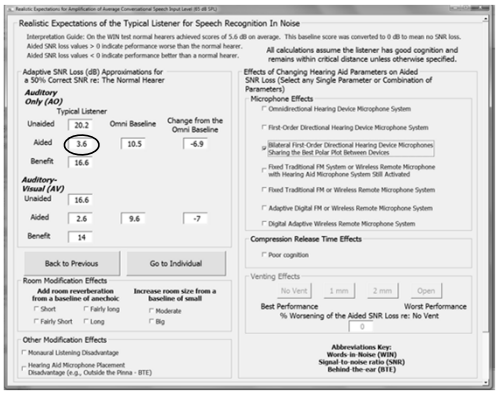


Flat 60 dB HL



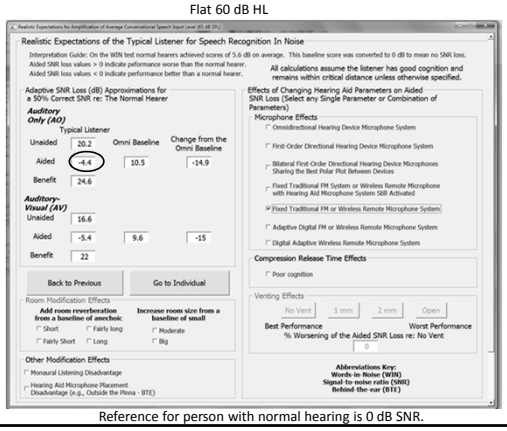
Reference for person with normal hearing is 0 dB SNR.

Flat 60 dB HL



Reference for person with normal hearing is 0 dB SNR.

Flat 60 dB HL



Reference for person with normal hearing is 0 dB SNR.

Noise Averting Digital Signal Processing

The ability to separate speech in the presence of noise is so limited that we have not only been unsuccessful in finding a solution, but we do not even know whether it is possible to improve the intelligibility of speech in noise by any significant amount (Levitt, 1997; Dillon, 2012).

- We will not discuss further here.

Affecting Speech Recognition Other Than Acoustic Audibility and Noise Averting Microphones

McArdle, R. and Wilson, R. (2008). Predicting word-recognition performance in noise by young listeners with normal hearing using acoustic, phonetic, and lexical variables. *J Am Acad Audiol, 19*:507-518.

Neighborhood Activation Model

- Theory describing the organization of perceptual information in long-term memory and how that information is used (Luce, 1986).
- Spoken word is perceived, activates a group of representations of similar-sounding words in memory called a similarity neighborhood.
- This neighborhood consists of:
  - a target word and all other words that can be created from target word by adding, deleting, or substituting one phoneme
  - Example: Neighborhood for "bat" includes "cat", "bit", and "bar".

Variables That Influence Recognition

- **Acoustic**
  - rms level – higher rms amplitude level → better recognition
    - Up to a certain level, of course
      - Beyond there are level distortion factors to consider and a risk of hearing loss due to exposure levels
  - Duration – greater number of sounds per word, slower rate of speech → better recognition
- **Phonetic**
  - Consonant features – significant effect on recognition
  - Vowel phoneme – inconsistent findings (for English anyway)
- **Lexical**
  - Word frequency – words that are occur often are easier
  - Word familiarity – words with more familiarity are easier

Results (Acoustic Variables)

- As RMS levels increased, speech recognition was largely the same.
  - Remember these participants had normal hearing sensitivity.
- As duration of a word decreases, speech recognition decreases (i.e., hear longer words better).

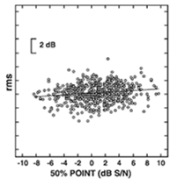


Figure 1. A bivariate plot of the mean 50% points (abscissa) and root-mean-square (rms; ordinate) of each of the 490 monosyllabic words. The regression line is shown with a slope of 0.06 dB/dB.

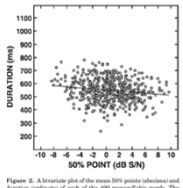


Figure 2. A bivariate plot of the mean 50% points (abscissa) and duration (ordinate) of each of the 490 monosyllabic words. The linear regression has a slope of −4.1 msec/dB.

Results (Phonetic Variables)

- **Manner:** Affricates (i.e., /ʤ, ʧ/) were easiest to recognize; Liquids (i.e., /l, r/) were most difficult recognize.
- **Place:** Alveopalatals (i.e., /ʤ, ʧ, ʃ, ʒ/) were easiest to recognize; Bilabials (i.e., /b, p, m/) were most difficult to recognize.
- **Voicing:** Voiceless phonemes (i.e., /ʧ/) were easiest to recognize; Voiced phonemes (i.e., /ʤ/) were the most difficult to recognize.
- /ʧ/ may be the easiest phoneme to recognize.
  - As examples,
    - *church and choo-choo* are really easy words;
    - *judge* is a rather easy word;
    - *pillar* is not so easy.

Results (Lexical Variables)

- Words were categorized as **H** (above 50%) and **L** (below 50%) in regards to the median values for lexical variables.
- Lexical variables
  1. word frequency – how often a word occurs
  2. neighborhood density – how many words are phonemically similar
  3. neighborhood frequency – how often the similar words occur

Easiest
High word frequency,
Low neighborhood density,
Low neighborhood frequency

Hardest
Low word frequency,
Low neighborhood density,
High neighborhood frequency

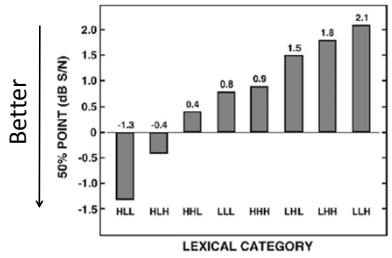


Figure 3. Mean 50% points (ordinate) for each lexical category (abscissa). All lexical categories are named using the same convention so that target word frequency is indicated as low (L) or high (H) in the first position, neighborhood density is indicated as L or H in the second position, and neighborhood frequency is indicated as L or H in the third position.

Significant Predictors

Table 4. Significant Predictor Variables from the Multiple Regression

	Predictor Variable	R^2	R^2 Change
Best	Final Phoneme Manner	0.14	0.14
	Initial Phoneme Manner	0.24	0.10
	Final Phoneme Voicing	0.31	0.07
	Initial Phoneme Place	0.37	0.06
	rms SPL	0.41	0.04
	Final Phoneme Place	0.45	0.04
	Familiarity	0.48	0.03
	Duration	0.50	0.02
Worst	Initial Phoneme Voicing	0.51	0.01

Conclusion

- Findings support that the acoustic properties of speech sounds are the foundation for speech perception.
  - One reason why evidence-based hearing aid prescriptions that remove variability of access to acoustic information are really important!!!
- **Bottom-up processing** (acoustic characteristics) is a *good predictor* of recognition performance in monosyllabic words-in-noise tests.
- **Top-down processing** (lexical characteristics) is a *poor predictor* of recognition performance in monosyllabic words-in-noise tests.
- Phonetic characteristics are rather good predictor secondary to acoustic characteristics.
  - Manner (e.g., affricate versus liquid) was actually a better predictor than place.
    - "This is exceeding interesting in view of the forest of trees sacrificed to publish research on *pa*, *ta*, and *ka*, (not to mention *da*)."
      - Jerger editorial on the McArdle and Wilson article

A Recap for All of Us

- Speech is easier to hear if we speak familiar words.
  - Think *children* instead of *youngsters*.
- Speech is easier to hear if we speak with *unvoiced affricates* and *avoided liquids.*
  - Think *church* instead of *abbey*.
    - In the southeastern USA, church may also be the more familiar word.
- Speech is easier to hear if we use longer words.
  - Think Snuffleupagus instead of Snuffy.
- You get the idea…

My Thoughts

- This is easier said than done.
  - Or is it? (Pun intended)
  - We tend to say the words we have been ACCULTURATED to use (i.e., our own familiar words).
- Our choice of words could change overtime to make words easier to hear.
  - But any narrow attempt to alter common usage among people would most likely be unsuccessful.
  - Consider the difficulty makers of dictionaries (e.g., Merriam-Webster) had and still have keeping up with word introductions and changes.
  - Consider the difficulty employing the use of English grammar rules until Richard Lowth came along.

Clinical Application

- The study suggested to the authors that clinicians should use monosyllabic words instead of sentences in speech recognition testing.
- **Sentences** would provide more influence from top-down processing.
- **Monosyllabic words** reduce variability through bottom-up processing and are the most accurate clinical measure of word recognition in noise.

But what word test?

- Several tests have been normed and studied for list equivalency.
- Tests need to include recognizable words for the intended audience; although, familiarity with the words can vary with a reasonable range.
- The test material should be spoken by a person of sufficient familiarity for the listener to have proficiency.

Words That Survive And That Are Good For Speech Recognition Testing Are

- Monosyllabic and common in everyday discourse
  - Long lasting words occur 16 times a day by an average speaker in at least three language families.
- Achieve, if possible, phonemic balance (PB)
- Preferably have a consonant nucleus (vowel) consonant (CVC) structure
  - CVCs represent 34% of all syllables spoken in English
  - CV and VC structure represent 40% of syllables (20% each)
    - For a total of 74% (Fletcher, 1953; Allen, 1994).
- The word "hear" itself is said to have survived for about ***15,000*** years now (Pagel et al, 2013, Brown, 2013).

A Summary of Speech As a Collection of Words

1. Speech is the acoustic reflection of movement.
   - Hearing aids can partly address
2. Speech is the path to the intent of the talker.
   - A cognitive and psycholinguistic view
3. Speech is a stream in a bigger river.
   - What we want to listen to is occurring in a complex environment.
   - When speech mixes with noise, hearing aids can not separate the two; directional microphones intend to steer in the direction of speech before speech can become mixed with noise.

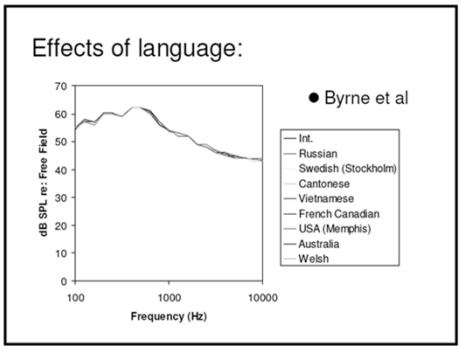
Source: D. Schum (2012)

Language: Part 2

What is language?

- To the Elizabethans…
  - "Language is decorated silence."
- Language is the method of human communication, either spoken or written, consisting of the use of words in a structured and conventional way.
- In language, infinitely many words can created with a small set of letters or characters.

Effects of language:



Source: S. Scollie

Byrne et al (1994) JASA

- In total, the article included 12 languages…
- Non-Tonal
  - Indo-European
    - English (several dialects)
    - Swedish
    - Danish
    - German
    - French (Canadian)
    - Welsh
    - Russian
    - Sinhalese (Sri Lanka)
  - Austroasiatic
    - Vietnamese
  - Japonic
    - Japanese
- Tonal
  - Sino-Tibetan
    - Cantonese
    - Mandarin

Byrne D, Dillon H, Tran K, Arlinger S, Wilbraham K, Cox R, Hagerman B, Hetu R, Kei J, Lui C, Kiessling J, Kotby MN, Nasser NHA, El Kholy WAH, Nakanishi Y, Oyer H, Powell R, Stehpens D, Meredith R, Sirimanna T, Tavartkiladze G, Frolenkov GI, Westerman S, Ludvigsen C.

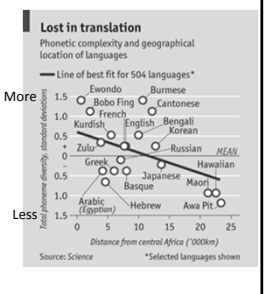
Where are languages from?

- The question is as old as human beings' ability to ask and has two sorts of answers.
- The first is evolutionary: when and where human banter was first heard.
  - Quentin Atkinson, University of Auckland, New Zealand
- The second is ontological (study of being or coming into existence): how an individual human acquires the power of speech and understanding.
  - Michael Dunn, then Max Planck Institute for Psycholinguistics, Netherlands and now Uppsala University, Sweden.
- Each have published their results in the two greatest rivals of scientific journalism.
  - Dr. Atkinson's in *Science*
  - Dr. Dunn's in *Nature*

Source: The evolution of language. Babel or Babble? *The Economist.*

Where are languages from?

- Dr. Atkinson examined 504 languages.
- Plotted number of phonemes and the distance between the location where the language is now spoken and Central Africa.
- The relationship suggests the actual point of origin is in central or southern Africa, and that all modern languages do, indeed, have a **common root**.



Source: The evolution of language. Babel or Babble? *The Economist.*

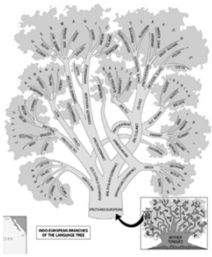
Where are languages from?

- The originator of the common root hypothesis was Noam Chomsky, a linguist at the Massachusetts Institute of Technology.
- Dr. Chomsky argues that the human brain comes equipped with a hard-wired universal grammar.

Source: The evolution of language. Babel or Babble? *The Economist.*

Where are languages from?

- To find out whether linguistic features travel together, and might thus be parts of Chomskyan modules, examining past linguistic family trees is needed.



Source: The evolution of language. Babel or Babble? *The Economist.*

Where are languages from?

- Dr. Dunn offered the task of creating probability distributions from cognates (words with similar origin) to a computer using Markov Chain Monte Carlo (MCMC) statistical methods.
- One cognate set, for example, contains words like “night”, “nacht” and “nuit”.
  - Another set includes “milk” and “Milch”, but not “lait”.
  - A third set is the French “tu”, the English “thou”, and the Hittite “tuk”, all meaning “you”.
- And what he found did not support a common root!

Source: The evolution of language. Babel or Babble? *The Economist.*

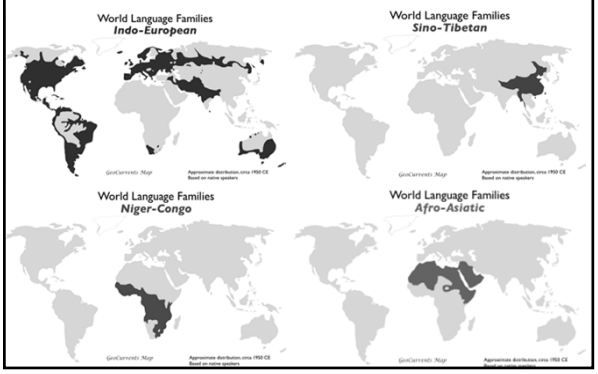
Where are languages from?

- Dr. Dunn found several hundred equally probable family trees.
- In a *word*, his results support ACCULTURATION!
  - Consider for a moment…
    - how much time parents spends with their children
    - how many years you were taught English in school and
    - how often this has happened in history.
- If Dr. Dunn is correct, that leaves Dr. Chomsky's ideas in tatters, and raises questions about the very existence of a language organ (a universally-hard wired instinct).
- Enter cognitive linguistics!
  - Knowledge of language arises out of language use.

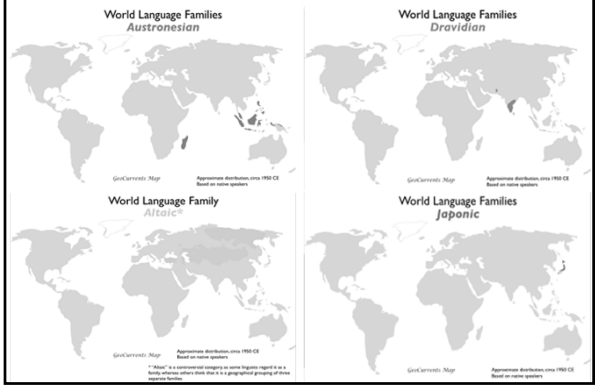
Provided it is difficult to know the origin of languages…

What are the current classifications of languages today?

Language Families



Language Families

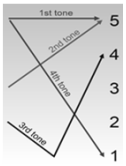


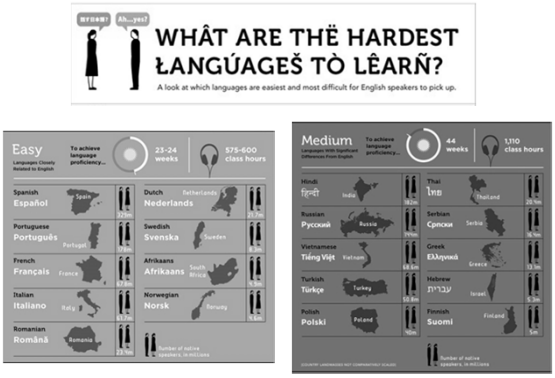
Language Families

Modern Day Languages

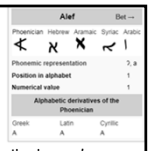
- Approximately 70% of all languages have tonality.
- Mandarin Chinese has a set of five tones.
- These tones combine with a syllable such as "ma" to produce different words.

1. mā (媽/妈) "mum/mom"
2. má (麻/麻) "hemp"
3. mǎ (馬/马) "horse"
4. mà (罵/骂) "scold"
5. ma (嗎/吗) (an interrogative particle)





Language to Represent Things or Sounds



- Mainland of Europe has its roots in pictographs.
  - *A* comes from the Semitic Aleph, meaning "ox" and described an ox's head.
    - Semitic peoples mostly originated in the Near East.
    - The Phoenicians spread most phonetic alphabets still in use today.
  - *B* comes from the Semitic Bēth, meaning "house". And so on.
- People of the Near East made an important leap of thought though.
  - Began to use pictographs to represent *sounds* rather than *things*.
  - Example: Egyptian symbol for the word *ra* or *re*
  - Began to represent not only the sun but any syllable pronounced "ray".

Source: B. Bryson, The Mother Tongue

Sounds or Things: Impact on Spelling and Pronunciation

- Two ways of rendering speech into writing.
  1. Pictographic, ideographic (most often not related to pronunciation now)
  2. Alphabetic (most always related to pronunciation now)

Source: B. Bryson, The Mother Tongue

Pictographic, Ideographic System (Advantages)

- It can be read everywhere.
  - As a collection of dialects, this is not true in the language's spoken form.
    - A person from *Fukien* can no more understand the speech pronunciation of people in *Shanghai* than…
      a *Londoner* can understand what people are saying in *Warsaw* or *Stockholm*.
    - Yet, newspaper reading of the written form is easy.
    - Again, pronunciation is different, but reading is the same.
      - Just like the numbers 1, 2, 3 means the same to the English as it does to the French.
        - » The English pronounce it as "one, two, three".
        - » The French pronounce it as "un, deux, trois".

Source: B. Bryson, The Mother Tongue

Pictographic, Ideographic System (Advantages)

- Such languages can be read by people over vast periods of time.
  - Literature from over 4,500 years ago can be read as well as yesterday's newspaper.
  - If Confucius (551 BC to 479 BC) were to come back to life today, no one but a few scholars would understand what he was saying, but if he wrote it down people of his own language could read it as easy as a shopping list.
  - Have you ever tried to read Old or Middle English?

Source: B. Bryson, The Mother Tongue

Pictographic, Ideographic System (Disadvantages)

- Dictionaries are difficult as there is no sensible way to arrange words.
  - Most are divided into arbitrary clusters based on the radicals (Mandarin has 214 radicals). e.g., 土 for earth (tǔ) or 小 for little (xiǎo)
    - Finding the correct spelling within any cluster is cumbersome.
- There are no crossword puzzles, games like Scrabble, palindromes, anagrams, or Morse code.
- Often organizing documents is impossible and office filing systems may exist only in peoples head (i.e., no alphabetical order).
  - If the secretary leaves, the whole office can fall apart.

Source: B. Bryson, The Mother Tongue

The Alphabetic System (Advantages)

- Can alphabetize and have fun word games.
- As an alphabetic language, English orthography has some strengths.
  1. Consonants are fairly regular in pronunciation
  2. Free of diacritical marks
  3. Preserves the spelling of borrowed words
- Just a mere 3 percent of English words are orthographically troublesome.

Source: B. Bryson, The Mother Tongue

The Alphabetic System (Disadvantages)

- The 44 phonemes of English can still be spelled in more than 200 ways.
  - "sh" in up to 14 ways (shoe, sugar, passion, ambitious, ocean, champagne, etc.)
  - "ā" in more than 12 ways (hey, stay, make, maid, freight, great, etc.)
  - "air" in up to 38 ways (air, heir, blare, pair, etc.)
- As such, misspellings can occur.

Source: B. Bryson, The Mother Tongue

A Plan for the Improvement of English Spelling by Mark Twain (Samuel Clemens)

- For example, in Year 1 that useless letter "c" would be dropped to be replased either by "k" or "s", and likewise "x" would no longer be part of the alphabet. The only kase in which "c" would be retained would be the "ch" formation, which will be dealt with later.
- Year 2 might reform "w" spelling, so that "which" and "one" would take the same konsonant, wile Year 3 might well abolish "y" replasing it with "i" and lear 4 might fiks the "g/j" anomali wonse and for all. Jenerally, then, the improvement would kontinue iear bai iear with lear 5 doing awai with useless double konsonants, and lears 6-12 or so modifaiing vowlz and the rimeining voist and unvoist konsonants.
- Bai lear 15 or sou, it wud fainali bi posibl tu meik ius ov thi ridandant letez "c", "y" and "x" -- bai now jast a memori in the maindz ov ould doderez -- tu riplais "ch", "sh", and "th" rispektivli.
- Fainali, xen, aafte sam 20 iers ov orxogrefkl riform, wi wud hev a lojikl, kohirnt speling in ius xrewawt xe Ingliy-spiking werld.

With these thoughts…

- Let us take a few minutes to reflect on the history of English and how it came into its current, but changing, usage.

A Short History of English

- English arose in the Anglo-Saxon kingdoms of England and what is now southeast Scotland.

- Great Britain and the United Kingdom from the 17th to mid-20th centuries propagated English around the world.
- American-dominated media and technology has made English the leading language of international discourse and is the *lingua franca* in many regions.

Source: Wiki

A Short History of English

- The invasion in Britain of the Celts people occurred around 410 AD.
  - This occurred when Roman soldiers withdrew from the area as the Roman Empire began to crumble (the Dark Ages).
- The invading Anglo-Saxon kingdoms were pagan (meaning other than main world religions – usually indigenous and polytheistic).
  - This is still preserved in English vocabulary today.

Source: B. Bryson, The Mother Tongue

Every Day Examples

Sunday - Sun's day
Monday - Moon's day
Tuesday - Tiu's day
Wednesday - Woden's day
Thursday - Thor's day
Friday - Freya's day
Saturday - Saturn's day

- Woden is the chief Anglo-Saxon/Teutonic god. He is identified with the Norse Odin.

A Short History of English

- The earliest surviving example of Anglo-Saxon writing in Britain (~AD 450-480) was found on a gold medallion in a field in Suffolk in 1982. It said "gaegogae maegae medu".

- Which translates to "This she-wolf is a reward to my kinsman." in modern English. In essence, making it the first known sentence in English.



Short History of English

- Influenced early by the Old Norse language (inhabitants of Scandinavia) through Viking invasions in the 9th and 10th centuries.
- The Norman conquest into England in the 11th century gave rise to heavy borrowings from French.
- Developed a close relationship with Latin-derived Romance languages by the time of Middle English (12^{th}-15^{th} century).
  - Chaucer's *The Canterbury Tales* written in ~1390 is a familiar example of Middle English.

Source: Wiki

Short History of English

- The Great Vowel Shift in the 15th century marked the emergence of Modern from Middle English.
- For example, "long e" in Chaucer's "sheep" had the sound of a Latin "e".
  - Middle English "sheep" sounded like…
  - Modern English "shape"

Source: www.harvard.edu on Geoffrey Chaucer and the Great Vowel Shift

How is all this knowledge about speech and language considered in AMPLIFICATION recommendations for hearing devices?

Considered?

- A lot of the details of history are not and do not need to be in order to address losses in hearing sensitivity now (i.e., audiograms).
- An amplification recommendation provides the wearer access to acoustics for the attainment of his/her individual speech and language goals and abilities.
- The recommendation should do so in a way that the wearer does not reject the device (i.e., as part of even a rehabilitation plan).
  - It is as if the HEARING device is important, but it is also more or less a speech and language ENABLER.

What Now?

- What else can audiologists do to address losses of hearing?
- Audiologists and society have need to decide whether meaning of the word hear is:
  1) as restricted as past science attempts to compel
     or
  2) as unending as seeking *inputs* for learning to *gain* understanding for the ultimate *output* of human aptitude.

Better Hearing In Its Many Forms

FORM 1

For any person, but intended for non-hearing impaired consumers

Personal Sound Amplification Products (PSAPs)

Remaining Forms

To include a case history, hearing evaluation, and medical waiver or clearance

FORM 2

For a person with hearing loss

Self-fitting hearing aids or hearing aids out of the box with a software first-fit

FORM 3

For a person of a given audiometric hearing loss

Hearing aid amplification at a real-ear verified prescription(s) suitable for the degree and configuration of the hearing loss with subsequent fine tuning

Better Hearing In Its Many Forms

- Form 4 of hearing amplification device delivery is accompanied by professional service that includes…
  - For the individual person of any measured hearing loss
    - Service provision with hearing aids that treat the person, the loss of audibility, and presence of distortion.
      - This includes, but is not limited to,
        1. addressing patient-specified listening goals and personal needs,
        2. a verified prescription and SNR-improving/noise mitigating product features,
        3. follow-up and fine-tuning visits,
        4. individual or group participation in a rehabilitation program.

Most Always In Life

Form

follows

Function

What functions are trying to be accomplished?

1. *Putting an amplification product in the ears of every person wanting better hearing*

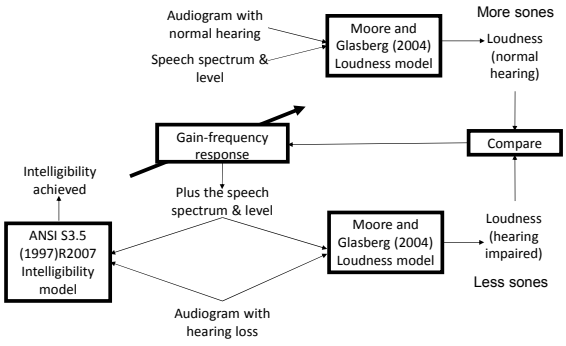
and/or

2. *Ensuring the successful uptake and positive outcomes of patients who are seeking better hearing*

Philosophy With Evidence

- Developed prescriptions for hearing aid amplification were not simple minded and are not a *barrier* to access.
  - Regard them as suggestions for OPERATION not for USE/NONUSE.
- Prescriptions have been the result of scientific coalescence of current knowledge.
- One validated-prescriptive amplification recommendation is NAL-NL2.
- Speech and language are intertwined with hearing, but the role of the professional in service delivery can be different.
  - At times, the roles of both are suitable.

NAL-NL2 – As a Theoretical and Practical Model



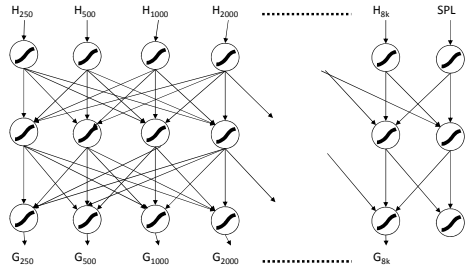
Deriving optimal gains - Step 1

Audiogram 1	Speech level 1	Optimal gain frequency response
Audiogram 1	Speech level 2	Optimal gain frequency response
Audiogram 1	Speech level 3	Optimal gain frequency response
Audiogram 2	Speech level 1	Optimal gain frequency response

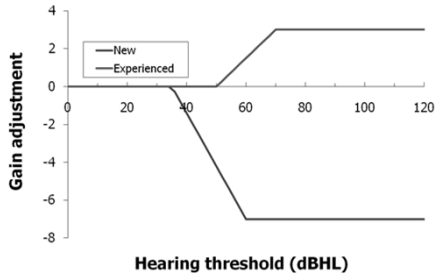
200 audiograms x 6 speech levels → 1200 gain–frequency responses, each at 20 frequencies from 125 Hz to 10 kHz

Multi-dimensional equation:

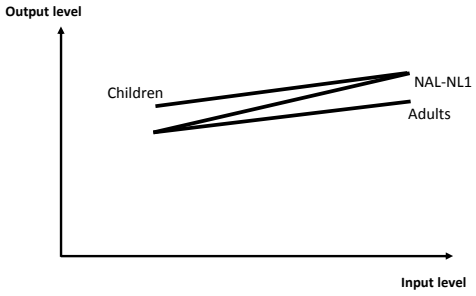
A neural network



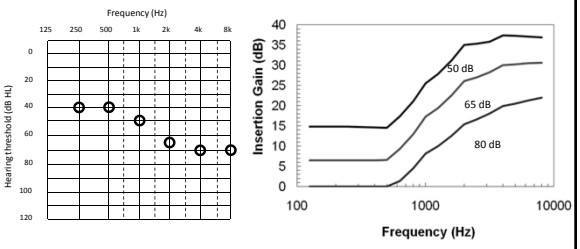
Adjustments to prescription to allow for experience



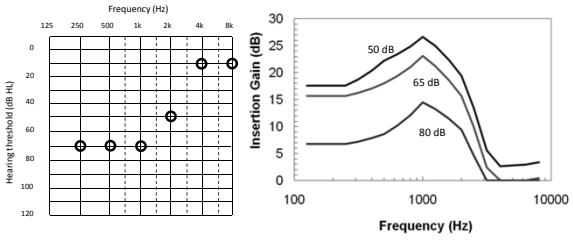
Empirical evidence: Variations from NAL-NL1

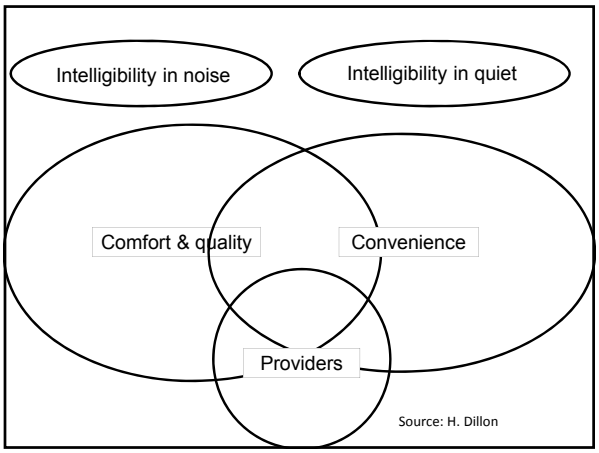


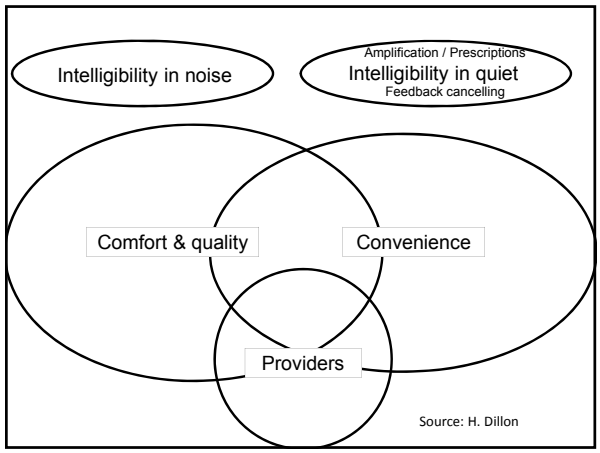
Example audiogram: Mild to severe

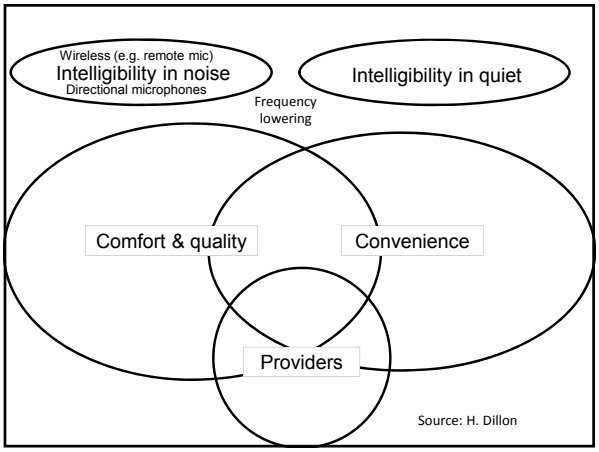


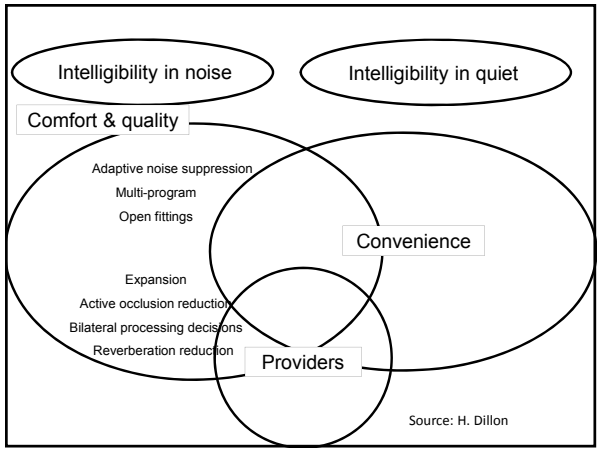
Example audiogram: Reverse sloping

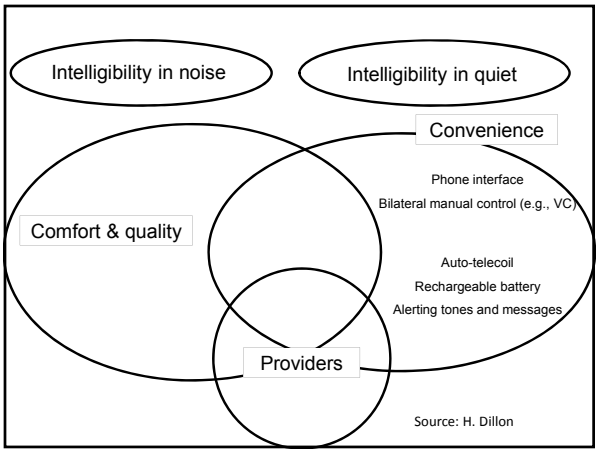


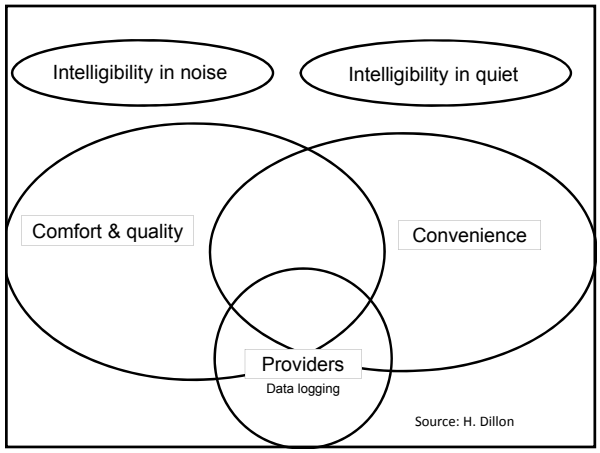

Intelligibility in noise
Intelligibility in quiet
Comfort & quality
Convenience
Providers
Source: H. Dillon

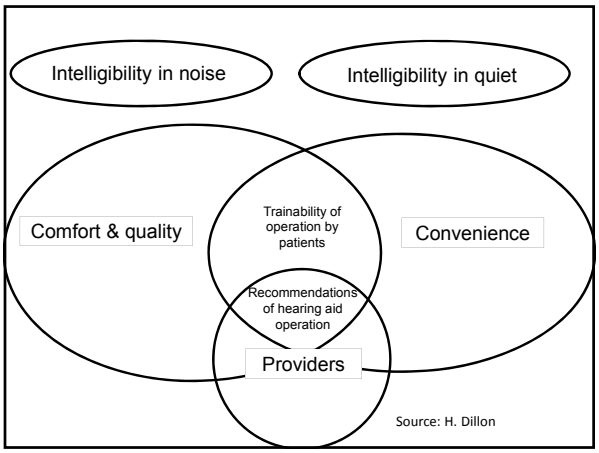

Intelligibility in noise
Amplification / Prescriptions
Intelligibility in quiet
Feedback cancelling
Comfort & quality
Convenience
Providers
Source: H. Dillon


Wireless (e.g. remote mic)
Intelligibility in noise
Directional microphones
Intelligibility in quiet
Frequency lowering
Comfort & quality
Convenience
Providers
Source: H. Dillon


Intelligibility in noise
Intelligibility in quiet
Comfort & quality
Adaptive noise suppression
Multi-program
Open fittings
Convenience
Expansion
Active occlusion reduction
Bilateral processing decisions
Reverberation reduction
Providers
Source: H. Dillon


Intelligibility in noise
Intelligibility in quiet
Convenience
Phone interface
Bilateral manual control (e.g., VC)
Comfort & quality
Auto-telecoil
Rechargeable battery
Alerting tones and messages
Providers
Source: H. Dillon


Intelligibility in noise
Intelligibility in quiet
Comfort & quality
Convenience
Providers
Data logging
Source: H. Dillon



Beyond Hearing…

- Not only do we lose hearing…
  –We are losing our listening.
- Roland Barthes, a linguist, distinguishes between hearing and listening, stating…

"Hearing is a physiological phenomenon; listening is a psychological act."

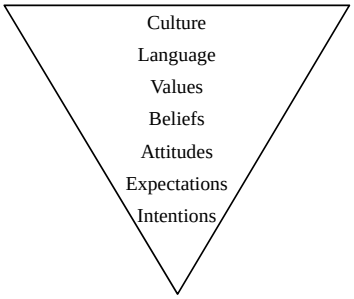
Listening

- Hearing is always occurring even if most of the time subconsciously.
- Listening is the interpretative action taken by the listener in order to understand and potentially make meaning out of the sound waves.
- Listening can be divided into three levels:
  1. alerting,
  2. deciphering,
  3. determining how the sound affects the listener.

International Listening Association

How and What We Listen To

Is affected by our psycholinguistic filters!



Beyond Listening…

- There is learning and even persuasion.
- In persuasion, we encounter how attitudes form and change as a result of hearing and listening.
  1. decision making of most all kinds
  2. marketing/advertising
  3. religion and philosophy

Listening

- Listening can result in LEARNING…

"Education is the ability to listen to almost anything without losing your temper or your self-confidence."
- Robert Frost

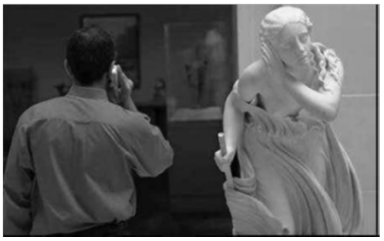
- I have said all this to say… HEARING is a VITAL and important sense organ!

As a communication disorders healthcare provider…

"You is kind, You is smart, You is important."

- Kathryn Stockett, *The Help*

Thank you for lending me your ears this day.



Source: J. Northern