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# COM3502/4502/6502 SPEECH PROCESSING

Lecture 20  
**Final Overview**

$y = k$

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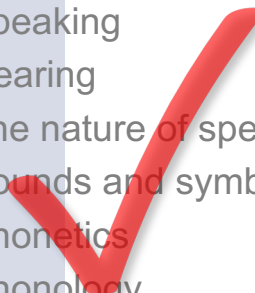
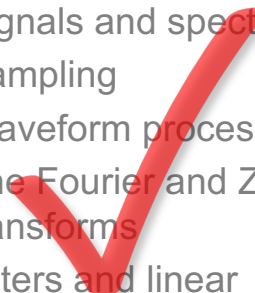

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## This course has covered ...

- Speaking
- Hearing
- The nature of speech
- Sounds and symbols
- Phonetics
- Phonology
- Prosody
- Signals and spectra
- Sampling
- Waveform processing
- The Fourier and Z transforms
- Filters and linear prediction
- Cepstral analysis

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# So, what have we learnt?

*... about speech*

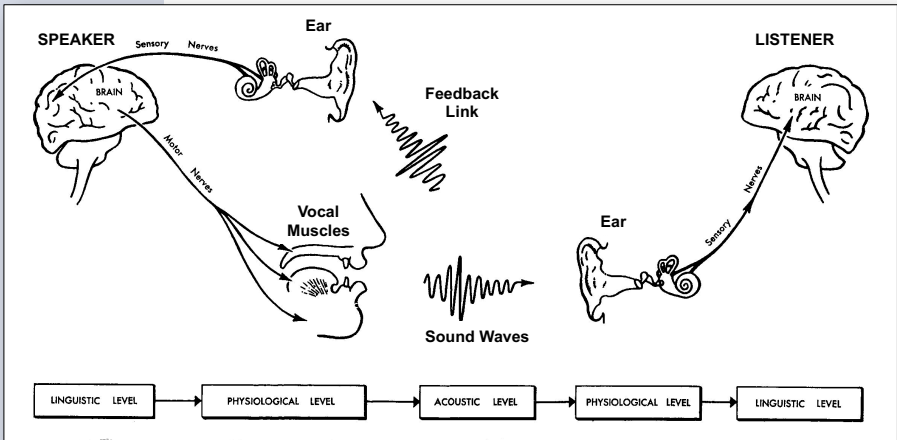
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# The Speech Chain



The diagram illustrates the speech chain between a speaker and a listener. On the left, the **SPEAKER** has a **BRAIN** connected to **Sensory Nerves** and **Motor Nerves**. The **Motor Nerves** lead to the **Vocal Muscles**, which produce **Sound Waves**. These waves travel through a **Feedback Link** back to the speaker's **Ear**. On the right, the **LISTENER** has an **Ear** that receives the **Sound Waves**, which are then processed by **Sensory Nerves** leading to their **BRAIN**. Below the diagram is a flowchart with five boxes: **LINGUISTIC LEVEL** → **PHYSIOLOGICAL LEVEL** → **ACOUSTIC LEVEL** → **PHYSIOLOGICAL LEVEL** → **LINGUISTIC LEVEL**.

**Taken from: Denes, P. B., & Pinson, E. N. (1973). *The Speech Chain: The Physics and Biology of Spoken Language*. New York: Anchor Press.**

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# Phonetics

[fəˈnetɪks]

The collage includes:
 

- The International Phonetic Alphabet (IPA) chart, showing consonant and vowel symbols.
- A sagittal cross-section of the human vocal tract, illustrating the vocal cavity and the path of sound waves.
- A series of diagrams titled 'ELEMENTS OF ACOUSTIC PHONETICS' and 'THE PRODUCTION OF SPEECH', showing the acoustic phonetics of the word 'head' and the production of speech sounds.

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# Phonetics

The comic strip shows two men talking about espresso. The first man asks, 'IS THAT EXPRESSO? I DON'T LIKE EXPRESSO.' The second man replies, 'IT'S EXPRESSO.' The first man says, 'THAT'S WHAT I SAID.' The second man says, 'YOU SAID YOU DON'T LIKE EXPRESSO.' The first man replies, 'I DON'T.' The second man says, 'THERE IS NO PLOSIVE IN EXPRESSO!' The first man replies, 'MAYBE IT WOULD TASTE BETTER IF YOU PUT SOME IN.'

[ekspɹesəʊ] vs. [espɹesəʊ]

elision

↙ ↘

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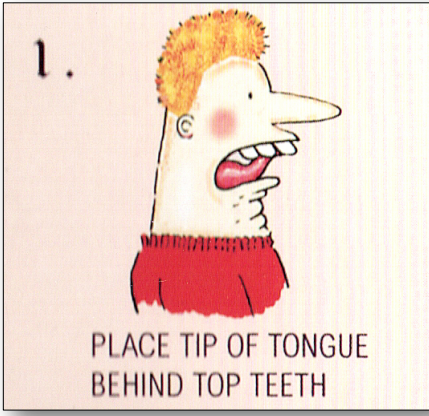

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# Phonetics

How to pronounce "th" [θ, ð]



1.

PLACE TIP OF TONGUE BEHIND TOP TEETH



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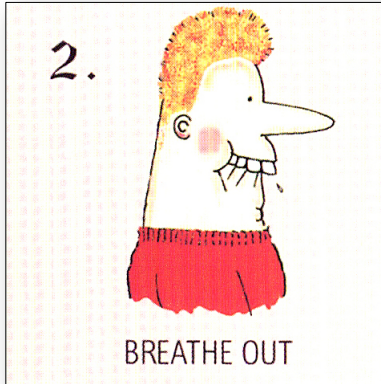

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# Phonetics

How to pronounce "th" [θ, ð]



2.

BREATHE OUT



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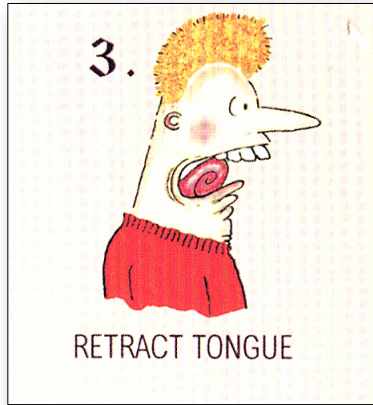

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# Phonetics

How to pronounce "th" [θ, ð]



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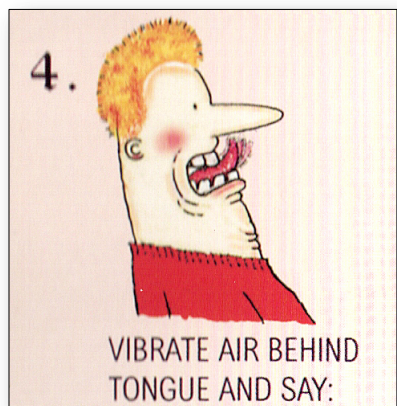

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# Phonetics

How to pronounce "th" [θ, ð]



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# Phonetics

How to pronounce "th" [θ, ð]




5.



*"The Smiths wear thin clothes throughout the winter months"*

/ðə smɪθs weə θɪn kləʊðz θru:əʊt ðə wɪntə mɒnθs/



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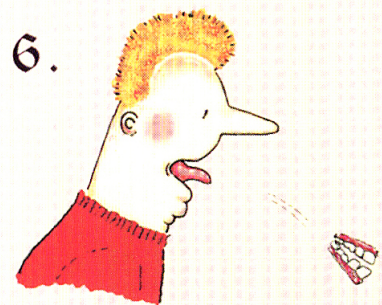
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# Phonetics


How to pronounce "th" [θ, ð]



6.



CONSULT DENTIST



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# Consonants carry more information than Vowels




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# Accents, Dialects & Languages



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# The Vocal Tract

'Hoover' the seal



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# What have we learnt?

*... about signal processing*

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# Codes & Signals

The collage includes a traffic light with red, yellow, and green lights. A circular genetic code wheel with nucleotide bases (A, C, G, U) and amino acid abbreviations. A waveform diagram showing signal pulses for letters like 'CK', 'K', 'F', 'S', 'LL', 'I', 'E', 'V'. A spectrogram showing frequency components (F1, F2, F3, F4) over time for the words 'THE N EW' and 'D R I K ER'. A semaphore operator holding a flag. A pair of hands in a signaling gesture.

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# Speech Coding

The collage includes a collection of mobile phones of various models. The ETSI logo. The Skype logo. A blue square with a white compass rose. A hand holding a modern smartphone.

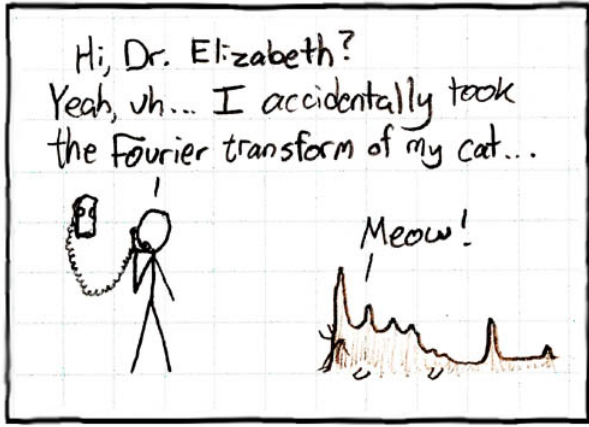
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# Spectral Analysis



Hi, Dr. Elizabeth?  
Yeah, uh... I accidentally took  
the Fourier transform of my cat...

Meow!

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# What have we learnt?

*... about speech processing*

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# Speech Processing Can be Useful

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# Speech Processing Can be Useful

<https://youtu.be/pIEFKWYw8bg>

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# Speech Processing Can be Useful




Introducing Translate for Animals  
google.co.uk/translateforanimals

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# Speech Processing Can be Useful



**Alex**  
FEATTIE + TAYLOR

I WAS READING ABOUT THIS NEW PORTABLE LIE DETECTOR THAT'S JUST COME ON THE MARKET, BRIDGET. IT'S CALLED A "HANDY TRUSTER".

IT DETECTS STRESS PATTERNS IN THE VOICE AND CAN BE PLUGGED INTO A TELEPHONE...THE THOUGHT THAT SOMEONE MIGHT BE USING ONE ON ME MAKES ME TOTALLY PARANOID...

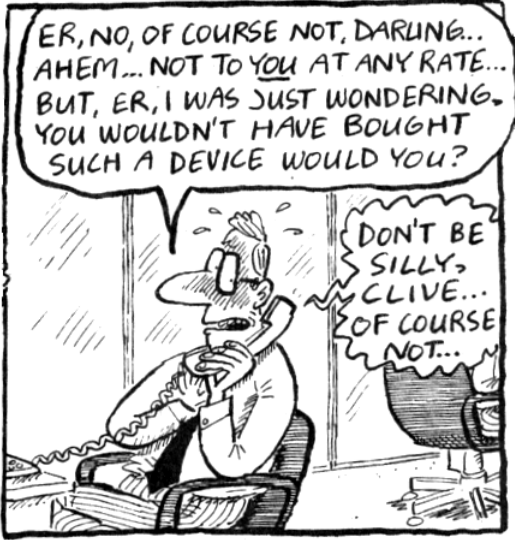
WHY, CLIVE? DO YOU TELL A LOT OF LIES?

email: alex-cartoon@elgate.co.uk

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ER, NO, OF COURSE NOT, DARLING...  
AHEM... NOT TO YOU AT ANY RATE...  
BUT, ER, I WAS JUST WONDERING,  
YOU WOULDN'T HAVE BOUGHT  
SUCH A DEVICE WOULD YOU?

DON'T BE  
SILLY,  
CLIVE...  
OF COURSE  
NOT...

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SHE'S LYING...

\$129.99

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http://www.love-detector.com/

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# Speech Processing Can be Useful

## Voice Stress Analysis

**Micro tremors are tiny frequency** modulations in the human voice. When a test subject is lying, the automatic, or involuntary nervous system, causes an inaudible increase in the Micro tremor's frequency. The CVSA detects, measures, and displays changes in the voice frequency.

**A state-of-the-art computer processes** these voice frequencies and graphically displays a picture of the voice patterns. The CVSA is not restricted to "yes" and "no" answers and is able to analyze accurately, tape recordings of unstructured conversations.

**CVSA Outperforms Any Other Method**

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# Speech Processing Can be Useful

**Eriksson, A., & Lacerda, F. (2007). Charlatany in forensic speech science: a problem to be taken seriously. *Int. J. Speech, Language and the Law*, 14(2), 169-193.**

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# Speech Processing can be Difficult


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# Speech Processing can be Difficult



<https://youtu.be/JepKVUym9Fg>

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# Speech Processing Can be Funny



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# Speech can be Manipulated



the worldwide standard in professional vocal processing tools



Cher's 'Believe' (Dec 1998) was the first commercial recording to feature the audible side-effects of Antares Auto-tune software



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# Speech can be Manipulated



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# Speech can be Manipulated

Child → Teenager → Adult

**Voice Morphing**

$\mu_T = \mu_s + k(\mu_R - \mu_s)$   
 $\sigma_T = \sigma_s + k(\sigma_R - \sigma_s)$   
 $0 < k < 1$

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# Speech can be Manipulated

Downloadable from

<http://staffwww.dcs.shef.ac.uk/people/R.K.Moore/research/downloads.html>

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# Fun Voices



<http://www.vintagesynth.com/misc/electrixwarp.php>



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# Voices in TV & Cinema



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# Singing Speech Synthesis

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# Singing Speech Synthesis





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## So, that's it!

- Speaking
- Hearing
- The nature of speech
- Sounds and symbols
- Phonetics
- Phonology
- Prosody
- Signals and spectra
- Sampling
- Waveform processing
- The Fourier and Z transforms
- Filters and linear prediction
- Cepstral analysis



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# But, don't forget ...

*“Speech is the most sophisticated behaviour of the most complex organism in the known universe!”*

# So keep talking!



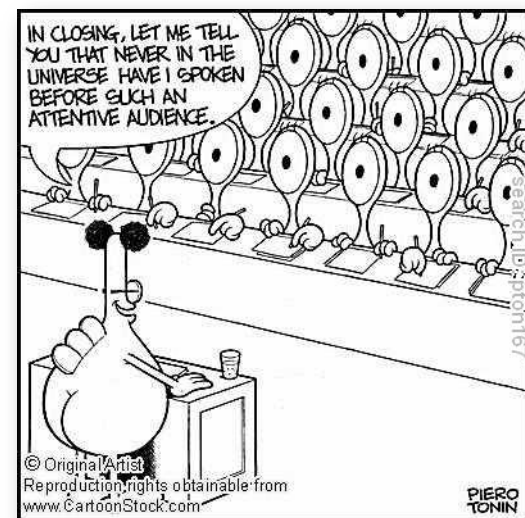
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# That's All Folks 😊



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PIERO TONIN

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# Thanks & Goodbye

/ənd gud lʌk wið jə: fju:ʃə kəriəz/



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