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Speech production Theory:
Normal vs Deviant
Development

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Scottish Cochlear Implant
Programme

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Aims

- Give you an overview of:
 - Phonology
 - How we make different sounds
 - How to describe sounds
 - How 'normal' speech develops
 - Key issues to identify speech problems related to a hearing loss
 - Practical suggestions for activities to encourage good speech production
- Always consult a Speech and Language Therapist if you are in any doubt about a child's speech production

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Phonology

- Each human language is produced using its own unique range of sounds (phonology).
- A phoneme is the smallest unit of sound in a word that can change its meaning.
- Phonemes are different to letters. e.g. Word "through" has 7 letters, but 3 phonemes - 'th' 'r' and 'oo'
- Sounds (or phonemes) can be combined in a systematic or rule governed way to make words
- Different languages have different sounds and different ways of combining them.

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- **Piraha**, an Amazonian language, possesses the fewest separate phonemes - 10. **'Shudhya Hindi'** has the most - 49
- All languages have vowel sounds. The largest is 55 in **Sedang** (Vietnam) The smallest number of vowel sounds is 2 (**4 languages from the Caucasases**).
- Georgian permits the most consonants in a cluster - **'vprtskvni'** which means "I'm peeling it". Piraha permits the longest vowel cluster **"xohooaaaaa"** which means 'searching intensely'

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English

- There are 44 phonemes in English.
- 24 consonant sounds and 20 vowels in spoken English
- However, not all speakers of our language use all of the same sounds in the same way!

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How do we produce voice?

- Air passes through the elastic **vocal** folds and causes them to vibrate, this produces voice
- The column of air is shaped and changed by the articulators - tongue, palate, cheek and lips to produce different sounds

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Articulation

- Sounds (phonemes) are made by the oral articulators in such a way that makes them intelligible to other speakers of the language (articulation)

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How do we describe sounds?

- 3 Parameters-
 - Voicing
 - Place of Articulation
 - Manner of Articulation

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Voicing

- Whether the vocal folds are vibrating or not.
 - 'ss' vs 'zz'
 - 't' vs 'd'
 - 'k' vs 'g'

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Place of articulation

- **Where** there is a closure or stricture in the vocal tract to produce a different sound e.g.
 - Bilabial e.g. 'm', 'p'
 - Labio dental e.g. 'f', 'v'
 - Alveolar e.g. 's', 't', 'd'
 - Palatal e.g. 'j', 'ch'
 - Velar e.g. 'k', 'g'

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Manner of articulation

- This is the **type** of stricture or closure in the vocal tract
 - Plosive e.g. 'b', 'k'
 - Nasal e.g. 'n', 'm', 'ng'
 - Fricative e.g. 'sh', 's', 'f'
 - Approximant e.g. 'l', 'w', 'r'

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Quiz!

- Describe the sound /k/
 - Voicing: Voiceless
 - Place: Velar
 - Manner: Plosive
- Describe the sound /z/
 - Voicing: Voiced
 - Place: Alveolar
 - Manner: Fricative
- Describe the sound /m/
 - Voicing: Voiced
 - Place: Bilabial
 - Manner: Nasal

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Vowels

- Vowels do not have a constriction or closure in the vocal tract.
- Described by how open or closed the mouth is, how far front or back the tongue is in the mouth and how much the lips are rounded.

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NI THE INTERNATIONAL PHONETIC ALPHABET
COORDINATES (VOWELSPACE)

	Dorsal	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Place	p b		t d		ʈ ɖ		c ɟ	k ɡ	q ɢ		ʔ
Manner	m	ɱ	n		ɳ		ɲ	ŋ	ɴ		
Stop or Fricative		β	f		ɸ		ç	x	χ	ħ	h
Voicing	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Labiodental											
Alveolar											
Postalveolar											
Retroflex											
Palatal											
Velar											
Uvular											
Pharyngeal											
Glottal											

COORDINATES (NON-VOWELSPACE)

Class	Voiced symbol	Ejectives
Labial	ɸ β	ʔ
Dental	θ ð	ʈ ɖ
Alveolar	f v	ɸ β
Postalveolar	ç ʝ	ʂ ʐ
Retroflex	ʂ ʐ	ʈ ɖ
Palatal	ç ʝ	ʈ ɖ
Velar	k ɡ	ʈ ɖ
Uvular	q ɢ	ʈ ɖ
Pharyngeal	ħ ʕ	ʈ ɖ
Glottal	ʔ	ʈ ɖ

VOWELS

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Supra Segmentals

- Airstream mechanism
- Nasality
- Pitch
- Stress
 - Rhythm
 - Intonation
- Loudness
- Voice quality

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Normal Developmental Order of sounds

- Developmental Hierarchy
- Specialism for each language
- Starts with vowels and bilabials
- Progresses through oral articulators
- Labial sounds; Alveolar, Velar, Fricatives, Affricates, Liquid Glides

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Normal Development of Consonants

2 yrs	3 yrs	4 yrs	5 yrs	6 yrs	7 yrs	8 yrs
vowels						
p m, h, n, w, b						
	k, g, d, t, f, y					
	ng (as in ring)					
	r, l					
	s					
	Ch, sh, z, l, th as in 'think'					
		Th as in 'th', v				
			Zh as in 'treasure'			

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Typical Phonology Processes

Process	Example	Age Range
Reduplication	byebye -> baba	Up to 2 years
Stopping 's'	sun -> tun	Up to 3 years
Velar Fronting	cup -> tup	Up to 3y 6 m
Final Consonant Deletion	boat -> bow	Up to 3 years
Cluster Reduction	spoon -> poon	Up to 4 years
Stopping	zip -> dip	Up to 4y 6m
Liquid Glide	red -> wed	Over 5
Simplification		

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Phonology

- Backing e.g. 't' being produced as 'k' (tea – key) or 'd' being produced as 'g' e.g. (dog – gog) is not a normal developmental error and

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Differential Diagnosis

- Compare to normal acquisition of speech sounds
- Identify expected patterns, e.g. final consonant deletion, reduplication, consonant harmony, stopping fricatives, fronting velars etc

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Differential Diagnosis

- **Recognise delay v disorder**
 - Delay means that the child is making mistakes that are a usual part of development but at a later age than might be expected.
 - Disorder means that the child's pattern of mistakes is not part of usual development.
- Take home message
 - If you are in **any** doubt, refer to local Speech and Language Therapist

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Associated Disorders

- Phonology disorder
- Dyspraxia
- Hearing problems
- Cleft lip/palate
- Dental malocclusion
- Family history of phonology problems
- Use of a dummy past 1 year of age

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CI and Speech Production (Early Implantation)

- Expected Development after CI
- Follows normal developmental pattern
- But dependant on access to speech spectrum prior to CI
- "Take home message" – Any delay in speech production should close rapidly following CI

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A Word on Late Implantation

- More variable speech production outcomes
- Learned patterns of speech difficult to change
- Improved speech perception skills do not necessarily lead to improved speech production/intelligibility in this client group
- "Take Home Message" – Speech production is highly unlikely to improve if the child is implanted after the 'critical age' of language development.

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Recognising speech problems related to hearing

- Phonetic level:
 - Vowels can become shortened but are generally realised appropriately (easier to hear)
 - Place contrasts (Easier to see, difficult to hear)
 - 'visemes' usually maintained e.g. 'p', 'b'
 - Manner contrasts (Difficult to see, easier to hear)
 - plosives more likely to be developed/maintained as more auditory cues.
 - Fricatives and affricates vulnerable because they are realised in the high frequencies e.g. 's'
 - Sounds may be articulated but unreleased

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Recognising speech problems related to hearing

- Voice contrasts – Tendency for all realisations to become voiced as this is the most salient feature in terms of auditory, tactile and kinaesthetic cues

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Recognising speech problems related to hearing

- Word structure
 - Unstressed syllables often omitted due to difficulty perceiving them e.g. Crocodile - crocodile
- Syllable structure
 - Often omit final consonants due to difficulty perceiving them
 - Clusters may have intrusive unstressed vowel e.g. Blue – 'bilue'

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Recognising speech problems related to hearing

- Supra Segmental features
 - Airstream mechanism
 - Can be ingressive or ejective
 - Nasality
 - Often hyper nasal (lack of perception of palate movement)
 - Pitch
 - Can be restricted leading to overall high or low pitched voice.
 - Stress
 - Can be affected at word level or sentence level
 - Loudness
 - Can be loud/quiet depending on person
 - Voice quality

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Speech Production Assessment

- Speech Intelligibility Rating (SIR)
- Metaphon
- Edinburgh Articulation Test
- South Tyneside Assessment of Phonology (STAP)
- PETAL (Parker et al)

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SIR Categories

1. Pre verbal
 - Pre-recognisable words in spoken language. The child's primary mode of everyday communication is manual.
2. Unintelligible
 - Connected speech is unintelligible. Intelligible speech is developing in single words (or social phrases) when context and lip reading cues are also available.
3. Intelligible to experienced listener
 - Connected speech is intelligible to a listener who concentrates and lip reads within a known context.
4. Intelligible to listener with little experience
 - Connected speech is intelligible to a listener who has little experience of a deaf person's speech. The listener does not need to concentrate unduly.
5. Intelligible to all
 - The child is easily understood in everyday contexts

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Speech sound assessment

- Check phonetic inventory
- Assess if the sounds can be produced in:
 - Word initial position e.g. 'Cup', 'King'
 - Word final position e.g. 'Sock', 'cake'
 - Word medial position e.g. 'bucket', 'chicken'

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- Take home message -If the child has any of the phonetic or supra-segmental features described-
 - Check aiding
 - Check history
 - Consider referral to SALT (a more didactic approach may be necessary)

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Practical goals for speech production – supra-segmentals

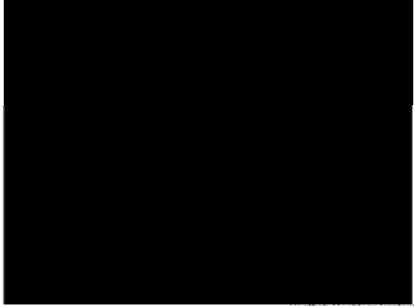
- Intonation
- Attaching meaning to intonation
- Pattern and rhythm
 - E.g. Differences in stress and intensity
- Resources
 - Baby Beats, Nursery Rhymes, Anticipatory Games e.g. Tickling, Hear Say

“Take Home message” – Music tasks can help to improve perception and production of natural supra-segmental features of speech

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Video - Babybeats



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Practical goals for speech production

- Vocal play with speech sounds
 - Using modelling and imitation
- Hear Say resource, 'Learn to listen' sounds
 - Voiced/voiceless
 - Diphthongs (e.g. 'au' vs 'ai')
 - Speech babble/oro-motor rehearsal

“Take home message” – playing and experimenting with speech sounds in the early days gives a good foundation for good speech production

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Video – symbolic sounds

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Adult strategies for speech production goals

- Check technology working!
- Acoustic highlighting
- Auditory closure
- Modelling
- Praise

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Intervention for speech problems

- **Assess and Improve discrimination** of speech sounds
- **Practise speech sounds** in isolation, CV, CVC, single words, phrases, sentences etc
- Facilitate **generalisation** of newly acquired articulation to a variety of contexts
- **Increase phonological awareness** of sounds and sound sequences

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Phonological Therapy

- Phonetic (articulation training) vs phonological (cognitive organisation of sounds and contrasts)
- Perception before production
- Have a planned sequence for increasing complexity e.g. Vowel contrasts
 - Diphthong vs short vowel
 - Diphthong vs long vowel
 - Long vs short vowel
 - Diphthong vs diphthong
 - Long vs long
 - Short vs short
- “Take home message” – Consider referral to SALT at this stage!

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- Thank you for listening.
- Any questions?

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