HAC HEARING AID COUNCIL

REGISTERED HEARING AID DISPENSER EXAMINATION SYLLABUS

REVISED JUNE 2004

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ANATOMY AND PHYSIOLOGY

Outer Ear

Structure and function of the pinna (auricle):

Students should be able to draw a labelled diagram of the pinna.

They should understand the pinna's cartilaginous and non-cartilaginous structure, and epithelial covering, and their relevance to hearing and hearing aid use.

They should understand the pinna's protective function as part of the outer ear and the pinna's role in the collection and directing of air-conducted sound.

Students should understand the pinna's role in the enhancement of air-conducted sound and in the localisation of sound.

Structure and function of the external auditory meatus (external acoustic meatus):

Students should be able to draw a labelled diagram of the external auditory meatus. They should have an understanding of the sebaceous and perspiration glands in the meatus. They should understand the meatus' cartilaginous and bony structure, its orientation and the relevance of this to otoscopy, impression taking and hearing aid use. They should understand the meatus' epithelial covering and its relevance to hearing, impression taking and hearing aid use.

Students should understand the meatus' protective function as part of the outer ear. They should understand the meatus' role in the transmission of air-conducted and bone-conducted vibration. They should understand the meatus' role in the enhancement of air-conducted vibration.

Structure and function of the tympanic membrane:

Students should be able to draw a labelled diagram of a tympanic membrane. They should understand the tympanic membrane's triple layered structure, its shape and its significance in the healthy function of the outer ear. They should understand the tympanic membrane's epithelial covering and its relevance to the overall health of the outer ear.

Students should understand the tympanic membrane's protective function as part of the outer ear. They should understand the tympanic membrane's role in the transmission of air-conducted vibration. They should understand the tympanic membrane's role in the enhancement of air-conducted vibration.

Production and function of cerumen:

Students should understand the location of the ceruminous glands in the external auditory meatus. They should understand the nature of cerumen, its protective function and the potential interference of excessive or impacted cerumen in the transmission of air-conducted vibration.

Middle Ear

Structure and function of the middle ear cavity and ossicular chain:

Students should be able to draw a labelled diagram of the middle ear cavity, its contents and the surrounding structures.

They should understand the middle ear's bony structure, position in the skull and the nature of the surrounding temporal bone (including mastoid air cells) and understand the relevance of these to the healthy function and dysfunction of the middle ear.

Students should be aware of the middle ear's mucosal lining and its role in the healthy function and dysfunction of the middle ear.

Students should understand the middle ear's role in the transmission of sound to the inner ear and its importance in overcoming the impedance mismatch between the outer and inner ear.

They should understand the effect on hearing and expressive speech when the middle ear is damaged or dysfunctional.

Structure and function of the middle ear muscles:

Students should be able to describe the locations of the tensor tympani and stapedius muscles, their enervation and tendons.

Students should understand the reflex protective function of the middle ear muscles, in particular the initiation and actions of the non-acoustic (tensor tympani) and acoustic (stapedial) reflex and the resultant increases in ossicular chain impedance.

Structure and function of the oval and round windows:

Students should be able to describe the location of the oval and round windows and adjoining structures. They should understand the functions of the windows in normal function of the middle and inner ear.

Structure and function of the Eustachian tube:

Students should be able to draw a labelled diagram of the Eustachian tube and surrounding structures. They should understand the Eustachian tube's role in ensuring satisfactory middle ear function and health.

Students should be aware of the effect on middle ear function and hearing when the Eustachian tube is damaged or dysfunctional (especially in children).

Inner ear

Structure and function of the cochlea:

Students should be able to draw a labelled, cross sectional diagram of one turn of the cochlea showing the internal structures and including details of the organ of Corti. Students should understand the structure and dimensions of the cochlea and internal parts. They should understand the structural relationship between the cochlea and the vestibular system.

Students should understand the response of cochlear fluids and membranes to incoming air-conducted and bone-conducted sounds and how this sets up a travelling wave. Students should understand the process of frequency resolution in relation to the point of maximum excitation of this travelling wave.

They should understand the generation and function of the passive cochlear potentials (endocochlear potential and intracellular potential) and the active cochlear potentials (cochlear microphonic and summating potential).

They should understand the generation and effect of afferent and efferent responses from and to the cochlea.

They should understand the process of intensity resolution in the cochlea.

Students should be aware that the central auditory system consists of the auditory brainstem, forebrain and auditory cortex. They should understand that the brainstem is composed of processing centres, nuclei and tracts, where auditory signals are analysed and coded to transmit sophisticated information.

Types of Hearing Loss

Conductive	Students should understand that it is due to reduced transmission through the outer and/or middle ear as a result of dysfunction and/or blockage.
Sensory	Students should understand that it is due to reduced or lack of function of the cochlea.
Retro-cochlea or neural	Students should understand that it is due to reduced or lack of function of the auditory nerve (neural) or reduced function at the level of the brain (central).
Non-organic	Students should understand that it is an apparent hearing loss with no underlying physiological cause.
Obscure Auditory Dysfunction	Students should understand that it is a difficulty with speech discrimination in noise despite a normal pure tone audiogram. Also known as King-Kopetzky Syndrome.

Classification of Hearing Loss by Degree

Students should understand the terms mild, moderate, severe and profound hearing loss as currently defined by the BSA.

Progressive	Students should understand that it is a loss subject to deterioration over time.
Sudden	Students should understand that it is a deterioration developing within 24 hours or less.
Rapid	Students should understand that it is a deterioration developing over 90 days or fewer.

Fluctuating	Students should understand that a-c and/or b-c thresholds vary, showing repeated deterioration followed by whole or partial recovery.

Classification by age at onset

Students should understand:

Congenital:	loss is present at birth.
Pre-natal:	loss develops before birth.
Peri-natal:	loss develops during or shortly after birth.
Acquired or post-natal:	loss develops later in life.
Pre-lingual:	loss develops in a child before speech development.
Post-lingual:	loss develops in a patient after speech development.

Causes of hearing loss in the embryo, the child and the adult

Blockage of the external ear:

Students should understand the common causes of blockage (excessive wax, foreign bodies, swelling as a result of infection or trauma) and the medical procedures associated with their treatment and relief.

Deformation of the external ear:

Students should understand the causes and effects of deformation and abnormalities of the external ear with regard to pre-natal and post-natal causes (congenital, forceps or other trauma). They should be aware of the possible corrective procedures (surgical reconstruction and the use of prostheses).

Blockage of the Eustachian tube:

Students should understand the common causes of blockage (upper respiratory tract infection) in both the child and adult with respect to suppurative and non-suppurative conditions.

Middle ear effusion:

Students should understand the term to mean the presence of a non-infective fluid in the middle ear cavity. They should understand the development of both acute and chronic conditions and the reasons for greater incidence in children. They should have knowledge of and understand the application of the common pharmacological, surgical, and hearing aid treatments for the condition.

Acute middle ear infection:

Students should understand the routes for infection to reach the middle ear cleft. They should understand the classical progressions from Eustachian tube blockage through to potential perforation of the tympanic membrane and discharge. They should understand the symptoms of pain and hearing loss associated with each stage and the common medical treatments likely to be recommended.

Chronic middle ear infection:

Students should understand the progression from an acute to a chronic condition and the associated symptoms. They should understand the common medical treatments and management likely to be recommended.

Students should understand the potential resultant damage to the structure of the middle and inner ear and structures bordering the middle ear space caused by both acute and chronic conditions (cochlear loss, ossicular destruction, mastoiditis, and meningitis).

Cholesteatoma:

Students should understand the classical progression from the formation of a retraction pocket through to the potential for meningitis. They should be aware of more common medical and surgical treatments for the condition.

Otosclerosis:

Students should understand the hereditary post-natal onset of the condition and its causes. They should understand the classic case history indicators associated with the condition, the progression of audiometric results over time with regard to loss of middle ear efficiency and compromise of inner ear activity. They should understand current surgical (eg stapedectomy) and hearing aid treatments for the condition.

Bacterial, viral and fungal infection:

Students should be able to identify common causes and effects of bacterial infection (poor asepsis, airborne infection, waterborne infection). They should be able to identify common causes and effects of viral infection (colds, influenza, CMV, measles, mumps, rubella, herpes zoster). They should be able to identify common causes and effects of fungal infection (otomycosis).

The effects of ageing:

Students should understand the changes in physiology and function with age that may occur with regard to outer, middle and inner ear and retro-cochlea mechanisms.

The effects of noise exposure:

Students should understand the difference between and differential effects of acoustic or noise trauma and blast trauma.

Students should understand the potentially damaging effects of noise exposure from the above on the middle and inner ear mechanisms and the associated symptoms (loss of hearing, tinnitus, loudness recruitment).

The effects of ototoxic drugs:

Students should understand the potential effects, symptoms and damage (temporary or permanent) of the more commonly used ototoxic drugs.

Menière's Disorder:

Students should understand the pathological changes associated with Menière's disorder, the likely progression of the condition and the classic symptoms that may occur. They should understand the more common pharmacological, surgical and hearing aid treatments for Menière's disorder. They should also be aware of other conditions that can also cause hearing loss, tinnitus and vertigo.

Physical trauma and head injury:

Students should understand the potential causes and pathological consequences of trauma and head injury on the outer, middle and inner ear and retro-cochlea systems with the associated hearing loss that may occur.

Vascular disorders:

Students should understand the effects of impaired blood supply to the cochlea as a result of abnormal heart conditions, circulatory disorders and strokes. They should understand the potential for vascular disorders in the retro-cochlea structures.

Metabolic disorders:

Students should be aware that hearing loss can be associated with conditions such as diabetes, gout, hypothyroidism and high cholesterol levels.

Neurological disorders:

Students should be aware of Obscure Auditory Dysfunction (King-Kopetzky syndrome), neurological malfunction (such as acoustic neuroma) and damage in the higher centres of auditory processing which may influence acoustic perception.

Genetic and chromosomal disorders:

Students should understand the concept of genetic transmission through defective dominant and recessive chromosomes with respect to pre-natal and post-natal onset of hearing loss. They should be aware of the more common genetic disorders (eg otosclerosis, osteogenesis imperfecta, Treacher-Collins syndrome and Downs syndrome).

Non-organic hearing loss:

Students should understand the concept and possible reasons for non-organic hearing loss (e.g. psychogenic loss, school failure and malingering).

Tinnitus

Students should understand the possible causes of tinnitus, including conductive, sensori-neural and non-auditory causes.

They should understand the effects of tinnitus on everyday life.

They should have knowledge of possible tinnitus management strategies including treatment of the underlying causes, counselling, tinnitus retraining therapy, acoustical suppression and, where appropriate, drugs to treat any associated side effects of the tinnitus.

Students should note that tinnitus management is usually the preserve of specially trained professionals.

Hyperacusis

Students should understand that hyperacusis is not necessarily associated with hearing loss. They should understand that hyperacusis is an abnormal intolerance of sounds (not necessarily loud sounds) and understand the phenomenon of hyperacusis as distinct from the loudness recruitment associated with sensory loss.

Vertigo

Students should understand that vertigo is an hallucination of movement. They should understand the ear's importance in maintaining balance.

Students should be aware of the common causes of vertigo (labyrinthitis, barotrauma, drug side effects, blast trauma, acoustic neuroma, fistula, iatrogenic causes and Menière's Disorder).

Students should have an awareness of the possible treatments including medical and surgical treatments.

Pain

Students should have knowledge of the common local causes of pain (otitis externa, otitis media, mastoiditis, herpes zoster, furunculosis and trauma). They should have knowledge of the common referred causes of pain (neuralgia, toothache, sore throat, temporo-mandibular joint disorders).

Examination of the ear

Safe use of the otoscope (auriscope):

Students should understand and demonstrate safe otoscopic procedures. This includes arranging suitable seating for himself and the client, laying out the required equipment in a clean and hygienic manner and handling equipment with

proper attention to hygiene (*see BSA Procedure on Disinfection*). They must give clear instructions to the client and handle the otoscope safely whilst performing a thorough examination of the ear.

The client's comfort and safety should be maintained at all times.

Normal appearance of the healthy ear and surrounding area:

Students should be able to recognise and describe the appearance of a normal, healthy outer ear as seen from an external examination.

They should be able to recognise and describe the appearance of a normal, healthy external auditory meatus and ear drum as seen from an otoscopic examination.

Signs of ear disorders:

The candidate should be able to recognise and describe abnormal conditions of the outer ear, including excessive wax, stenosis, skin disorders, swellings and growths.
They should be able to recognise and describe the abnormal appearance of the tympanic membrane as a result of otitis media, current or healed perforations and retraction pockets.

They should be able to recognise and describe the appearance of typical post-surgical conditions arising from previous mastoid surgery.

Referral to a medical practitioner, as laid down in the Code of Practice

Students should understand, practise and demonstrate the need for referral to a medical practitioner, as laid down in the Code of Practice.

Acoustics

The physical properties of sound:

Students should understand that sound in air travels by successive pressure changes, i.e. compressions and rarefactions. They should understand it is a longitudinal wave, and the relevance of its graphical representation as a transverse wave. They should understand that the speed at which the wave front travels is the speed of sound, approximately 330 m/s in air. They should be aware of sound propagation in solids and liquids.

Students should understand the following terms:

Periodic or Tonal:	Sounds causing regular repeating pressure changes. Aperiodic or atonal sounds do not have a regular repeating pressure change.
Amplitude:	The amount of displacement of particles in the medium, the greater the sound pressure the greater the amplitude.
Frequency:	The number of repetitions or cycles per second (hertz) of a periodic sound.
Cycle:	A single compression and its associated rarefaction.
Period:	The time taken to complete one cycle.
Phase:	Is determined by whether the pressure is above (+ve phase) or below (-ve phase) atmospheric pressure at a point in space and time.
Wavelength:	The distance between wave fronts or the length of a repeating cycle or periodic sound.
Pure Tone:	A single frequency causing regular repeating pressure changes that can be described as a sine wave.

Warble Tone:	A frequency modulated sine wave signal.
Complex Sound:	A combination of two or more pure tones.
Noise:	An aperiodic or random complex sound and is often unwanted sound (see below).
Frequency Analysis:	Students should understand that all complex sounds could be broken down into their constituent frequencies by a method known as Fourier analysis.
White Noise:	A complex sound that contains all audible frequencies with equal energy at each frequency.
Pink Noise:	A complex sound that contains all audible frequencies with equal energy per octave.
Narrow Band Noise:	NBN contains a limited range of frequencies; third-octave NBN has a bandwidth of one third of the centre frequency. Octave band NBN has a bandwidth equal to the centre frequency. The critical band is the narrowest bandwidth that can mask a pure tone.
Speech-shaped Noise:	A random non-repeating waveform based on the long-term average speech spectrum, containing all the frequencies from 250Hz-4000Hz in the proportions found in speech.
Impedance:	The resistance to movement of vibrations through a mechanism or medium.

Absorption:	Sound energy can be absorbed when a sound wave hits a surface, and by friction as it travels through the air. This effect is more noticeable as frequency increases.
Reflection:	On hitting a surface a sound wave will be partly reflected and partly absorbed, reflection being greater from a hard surface. Reflections can lead to echoes, reverberation and standing waves.
Standing Waves:	Can occur when a pure tone is reflected from a surface and the incident and reflected wave interact to form a wave that appears stationary. Constructive or destructive interaction occurs.
Reverberation:	The measure of the amount of reflected sound in a room. Factors affecting reverberation include absorption and reflection when sound hits a boundary. Reverberation Time is the time taken for the sound level in a room to drop by 60dB when the sound source has stopped. Candidates should understand the beneficial and detrimental effects of reverberation on communication.
Diffraction:	Occurs when a sound wave hits an object. Generally frequencies with wavelengths longer than the object size will pass around the object more readily than those with a shorter wavelength.
Distortion:	A sound or noise unintentionally introduced into the output signal that might adversely affect the desired signal in audiometry and hearing aid use.

Harmonics:	Additional tones that occur at frequencies that are whole number multiples of the original frequency.

Decibel Scales

Sound Pressure is expressed in decibels sound pressure level (dBSPL). Given by the formula dBSPL = 20log P/P_{ref} Where P is the pressure of a sound wave, measured in pascals, and P_{ref} the reference pressure of 0.00002 pascals.

Students should understand that the dBHL scale is used in pure-tone threshold audiometry and allows a patient's hearing thresholds to be compared with normal. 0dBHL is defined as the normal threshold of hearing at a frequency, although the actual value in dBSPL varies with frequency and is given by the Reference Equivalent Threshold Sound Pressure Level values (RETSPL).

Students should understand that the dB(A) scale is a single, weighted average decibel scale that approximates to the sensitivity of the human ear across frequency, based on the 40 phon equal loudness contour. They should understand its use in sound measurement.

Students should be familiar with the use of sound level meters using both the dB(A) and dBSPL scales.

Students should understand Signal to Noise Ratio (SNR) as the difference in decibels between the levels of the desired signal and the unwanted noise. Students must understand the relevance of SNR to communication for normal and hearing-impaired people.

Perception of Sound (psycho-acoustics)

Subjective and objective measures:

Students should understand the differences between objective and subjective measures, their advantages and disadvantages.

Intensity resolution:

See Anatomy and Physiology section.

Frequency resolution:

See Anatomy and Physiology section.

Students should understand the travelling wave theory to include critical bands and auditory filters. They should understand the role of psycho-acoustical tuning curves in describing cochlear function.

Temporal resolution:

Students should understand that temporal resolution is the ability to detect changes in stimuli over time, and that this is a very important dimension in hearing as much of the information is carried in the changes themselves rather than the relatively stable parts of speech.

Relationship between frequency and pitch:

Students should understand that pitch is the subjective quality primarily associated with frequency. As frequency increases pitch typically increases although this is not a linear relationship and can be further affected by frequency.

Relationship between intensity and loudness:

Students should understand that loudness is the subjective quality primarily associated with intensity. As intensity increases loudness typically increases although this is not a linear relationship and is further affected by frequency. Equal loudness contours or phons curves can be plotted showing this relationship.

Measurement of threshold:

Students should understand that absolute threshold is the minimum detectable level of sound in the absence of any other external sounds. They should understand that two methods have been used to measure the intensity of a minimum audible

stimulus over the audible frequency range: minimum audible pressure (MAP) and minimum audible field (MAF). They should understand the methods used to determine MAP and MAF.

Students should understand that an individual's sensitivity thresholds are not absolute; they tend to vary from trial to trial and can be affected by bias and motivation.

Students should be aware that there is a threshold of detectability and a threshold of intelligibility, such that speech does not become intelligible until it is significantly above the threshold of detectability.

Auditory masking:

Students should know that auditory masking is the process by which the threshold of audibility for one sound is raised by the presence of another sound. The amount by which the threshold is raised is given in decibels. They should understand that the masking effect is greater for sounds of similar frequency. They should understand the upward spread of masking and physiological reason why this occurs.

Recruitment:

Students should understand that recruitment refers to an abnormally rapid growth of loudness as the intensity level of the sound increases. They should understand that this is a cochlear phenomenon, as a result of hair cell damage.

The audiogram and dynamic range:

Students should understand that thresholds are usually specified relative to young healthy listeners with 'normal' hearing, and are usually plotted on an audiogram. The levels at which sounds become uncomfortably loud can also be measured and plotted on an audiogram. Students should understand that the area between threshold and uncomfortable loudness levels is known as the dynamic range.

Binaural hearing:

Students should understand the acoustic benefits of binaural hearing to include:

Sound localization: students should understand the basic principles behind our ability to localize sounds by time and intensity differences at the two ears, changes in the spectral composition of the sounds due to head shadow and pinna effects, and changes in all these cues by head or sound source movements.

Squelch effect: students should understand that binaural listening could improve hearing in noise due to the squelch effect, due to differences in the phase and intensity of the signal between the two ears and not the noise.

The precedence effect: students should understand that binaural hearing enables us to fuse two sounds in close succession into one, for example sound arriving from the direct path and reverberant path, such that you are able to localize sounds in a reverberant environment and are often not aware of echoes.

Binaural summation: students should understand that due to binaural summation thresholds are improved by 3 – 6 dB.

Students should also understand other benefits of binaural hearing to the individual to include safety issues, lack of head shadow effect in background noise, improved comfort of listening and confidence in social environments.

Speech Production and Perception

Students should understand the human speech production mechanisms, to include the acoustic properties of vowels, consonants, voiced and non-voiced sounds. They must understand the roles of the organs of the vocal tract including the pharynx, larynx, mouth, tongue, teeth, lips, hard and soft palates, nose and paranasal sinuses.

Students should be able to draw and explain the long-term average speech spectrum.

Students should be able to explain its significance in interpreting the degree of hearing difficulty likely to be experienced from a given set of audiometric results.

Using the long-term average speech spectrum, they should be able to predict the likely benefit of amplification applied to a given set of audiometric results.

They should understand the acoustic properties of different speech sounds (phonemes) including formants and their production.

Students should understand the role of phonemes, words, syntax, context, linguistic redundancy, intonation, stress, prosody, pronunciation and accent in comprehension.

Students should be aware that speech reading may be either the sole means of communication for a hearing-impaired person or an adjunct to hearing aid use. They should understand the limitations and potential confusions when communication relies on speech reading alone. They should understand that the risk of confusion can be minimized by the addition of supplementary auditory and non-auditory cues.

Students should understand the likely effects of pre-lingual and post-lingual conductive and sensorineural hearing impairment on the development and maintenance of language skills.

Students should understand why the conductive hearing loss sufferer perceives a significant loss of intensity (but not a loss of clarity) when listening to other people's speech but perceives an apparent increase in the intensity of his or her own speech. They should also understand why the sensorineural hearing loss sufferer perceives a significant loss of intensity and clarity when listening to other people's speech as well as his or her own speech.

Pure-Tone Audiometry and Masking

Students should understand the mechanisms of hearing by air and bone conduction. They should understand how hearing thresholds can be determined through audiometry, understand the sources of error in audiometry and identify situations where results may be inaccurate. They should understand the process of transcranial transmission leading to cross hearing and be able to identify where cross hearing may have occurred. They must understand the principles of masking to obtain accurate test results in these circumstances.

They should be able to perform air and bone conduction audiometry and masking, on adults, in accordance with current BSA recommended procedures, including the use of earphones and insert phones. They should be familiar with the use of masking charts. They should be aware of different techniques used to obtain results with young children.

Students should understand the need for an appropriate acoustical environment for testing (as required by BSA procedures) and be able to instigate appropriate full assessment of the environment as well as carrying out simple tests of ambient noise. They should be aware of methods to control the test environment and understand safety and hygiene issues associated with audiometry.

Students should be able to carry out daily subjective tests of audiometer function and calibration and to instigate appropriate full objective calibration in accordance with current BSA and HAC guidelines. They should be aware of calibration procedures, the use of couplers including artificial mastoids and tolerances for output levels, frequency, distortion etc.

Students should be able to interpret and report test results, including the degree and type of loss, dynamic range, likely effect on speech perception and aid selection and use.

Speech Discrimination Tests

Students should know what equipment is needed for speech testing through headphones or in sound-field situations. They must be aware of the variety of test methods and materials available, to include tests in quiet and noise, types of speech material (phonemes, syllables, words and sentences), methods of scoring.

Students should have a basic understanding of the usual procedure for speech audiometry using isophonemic word lists for adults, to include requirements for speech materials, test conditions, use of masking, test instructions, method of scoring and reporting results. They should understand the importance of the results in diagnosis and as a guide to likely aid benefit.

Students should be aware of factors affecting results, to include test type, test conditions, language, motivation and memory. Candidates should be aware of the limitations of speech audiometry due to the sensitivity and reliability of the tests.

Sound Field Testing

Students should understand the uses of sound field testing in threshold audiometry and as a functional test of aid performance. They should understand the requirements of the test environment (*as required by BSA procedures*) and types of stimulus for threshold and speech discrimination testing.

They should be able to describe and set up a suitable facility for a sound-field speech discrimination test.

Other measurements of hearing and ear function

Students should understand and be able to perform tests of middle-ear function including Tympanometry and Acoustic Reflex tests. They should be familiar with test procedures and interpretation of results (*as described in BSA Recommended Procedure on Tympanometry*).

Students should understand and be able to perform tests of recruitment including Loudness Scaling, ULL tests and Acoustic Reflex tests. They must understand safety issues associated with subjecting patients to high stimulus levels.

Students should be aware of the measurement of otoacoustic emissions and its use in audiology including paediatrics.

Students should be aware of tests for non-organic hearing loss including Stenger, Lombard, Delayed Auditory Feedback, Acoustic Reflex tests and Evoked Response Audiometry.

Students should be aware of self-recording and automated threshold audiometry as used in screening tests, particularly in industrial settings.

Students should be aware of Evoked Response Audiometry and its use with adults and children.

Students should be aware of other tests relevant to babies and children, including visual reinforcement audiometry, conditioned play audiometry and distraction testing.

HEARING AIDS

It is essential that students keep up to date with current developments in aid technology and applications, even when new techniques do not appear in the syllabus.

Hearing Aid Systems

Students should understand the definitions and applications of behind the ear (BTE), body-worn (BW), in the ear (ITE), in the canal (ITC), completely in the canal (CIC) and modular air conduction aids, including their relative characteristics and merits.

They should understand the rationale of CROS AND BI-CROS systems, the different types available and their uses.

They should understand the use and fitting of air conduction spectacle aids.

They should understand the use of remote microphone systems particularly in relation to feedback problems and to improve SNR, they should also understand their use with FM radio systems.

They should understand the use and fitting of remote control systems.

They should understand the applications of bone conduction aids including bone conduction spectacles and bone-anchored aids.

They should be aware of the use and fitting of cochlear implants. They should be aware of middle ear implants.

They should be familiar with the use of noise generators as part of a management strategy for tinnitus.

Students should understand the basic operation of electret microphones, directional microphones and microphone arrays. They should understand the basic operation of receivers, induction pick-up coils and classes of analogue amplifier in current use.

They should understand the principles of analogue to digital conversion and the basic operation of digital amplifiers.

Students should understand the types of battery currently available, current drain and battery life and the factors affecting it.

Aid Selection and Fitting

Students should understand the concepts of linear and non-linear amplification and their application to maximise speech intelligibility for the wearer. They should understand linear prescription methods including Lybarger's half-gain rule, POGO, Berger and NAL, and where such methods should be applied.

They should understand principles of compression ratio, knee point or compression threshold, and output limiting and wide dynamic range compression in relation to non-linear amplification. They should be familiar with strategies to set appropriate compression parameters for particular patients.

They should be familiar with non-linear prescription methods including DSL, Fig6, and NAL-NL etc.

Students should understand the concepts of multi-channel and multi-band systems and their programming to maximise the benefit for the wearer.

They should understand and be able to program multi-memory or multi-program systems. Where these systems are appropriate students should be able to select and program the best options for particular clients and give clear instructions on how the different programs can be used to maximise benefit.

They should be familiar with and be able to apply digital noise suppression and feedback suppression strategies in appropriate cases.

They must understand the range of audiological, physical and other factors affecting aid selection and demonstrate the ability to select appropriate hearing aid systems for particular patients. They must understand and be able to explain the relative merits and disadvantages of different options in relation to a particular client's needs.

Students should understand and be able to demonstrate the use of NOAH and other software in the selection and programming of a range of digital aids from different manufacturers via computer. They should be able to maintain a computer system, arrange back-up copies of records and install new software.

Hearing Aid Evaluation

Students must understand and be able to demonstrate the measurement of aid performance in a test box (to current UK and European Standards, *see BSA Hearing Aid Handbook part 1*) to include measurements of full-on gain, maximum power output, reference test gain, telecoil sensitivity and distortion.

They should be able to produce and interpret frequency charts and input-output charts. They should be able to interpret data sheets supplied by aid manufacturers.

Students should be able to adjust the performance of programmable and non-programmable aids and assess the subjective and objective outcomes of these adjustments.

Students should understand and be able to perform probe microphone measurements, including real ear unaided response (REUR), real ear aided response (REAR) and real ear insertion gain (REIG). They should be aware of the use of real-ear coupler differences (RECD). They should understand the role of probe microphone measurements in the selection and fitting of hearing aids.

Students must also understand the principles behind and use of benefit assessments such as questionnaires (including GHABP, COSI and APHAB) and sound-field speech testing.

Students must understand basic hearing aid fault-finding techniques (*see BSA Procedures*). Students should be able to perform simple maintenance procedures including retubing, cleaning and replacing wax traps.

Students should understand the concept of feedback in a hearing aid system, factors affecting it and strategies to reduce it including physical and electrical methods.

Aural Impressions

Students must understand and demonstrate safe methods for otoscopic examination as covered in the Medical Aspects section of this syllabus.

Students must understand and demonstrate correct and safe procedures for impression taking, as described in the BSA Recommended Procedure for Impression Taking, using open jaw and closed jaw techniques. They must be able to take good impressions on a range of different ears.

They must understand and apply correct procedures for handling impressions and be aware of current regulations for handling potentially contaminated items.

Earmoulds

Students should be familiar with the relative properties and merits of different earmould materials including acrylics and silicons. They must understand the use of hypoallergenic materials with ITE and BTE aids.

They should be familiar with the range of earmould styles available, including open, skeleton, shell and solid moulds etc.

They should understand the acoustical properties of earmoulds including the effects of vents, tubing dimensions, horn effects, filters and meatal depth. They should understand how these properties compare for ITE and BTE aids.

They must demonstrate the ability to select correct earmoulds for a client, taking into consideration acoustical, physical and practical requirements.

Students must be aware of methods to modify earmoulds and the shells of ITE aids in order to alter their acoustical properties and optimise fit. They must be aware of health and safety issues associated with undertaking such modifications.

Students must understand the properties and use of earplugs for swimming and noise exclusion.

Students must understand and demonstrate appropriate advice to patients on aid use, including cleaning and maintenance, insertion and removal, battery replacement and acclimatisation.

They should understand the psychological and sociological, economic and educational implications of hearing loss in adults and children.

They should understand the relevance of age, domestic circumstances, employment, socio-economic status and physical problems.

They should understand the effects of hearing loss on significant others and understand public attitudes to hearing loss and hearing aids.

Students should understand the concept of Deaf Culture and the preferred use of sign language by many people.

They should understand the importance of pre- and post-fitting counselling, hearing and communication tactics.

They should understand the role of routine follow-up visits.

They should understand the principles and use of a wide range of assistive listening devices, including loop systems, and where these are used to supplement or replace conventional hearing aids.

They should be aware of lip-reading, the needs for auditory training and understand the role of Hearing Therapists.

They should understand NHS provision of hearing aids and other services for hearing-impaired people. They should also understand the role of charity and other organisations with hearing-impaired adults and children.

THE HEARING AID COUNCIL, CODE OF PRACTICE AND STANDARD OF COMPETENCE

Students must understand the roles of the Hearing Aid Council and its committees.

They must understand both the Code of Practice and Standard of Competence in full as well as their implications

They must demonstrate adherence to the requirements of the Code in all their activities.

They must also understand the Registration Rules.

It is essential that students keep up to date both with changes to the Code and with Advisory Notes issued from time to time by the Hearing Aid Council.

They must also keep up to date with those changes in BSA Recommended Procedures that apply to Hearing Aid Audiology.

BUSINESS ISSUES

Students should be aware of financial issues involving personal taxation, national insurance and VAT.

They should be aware of accounting methods, profit and loss and financial planning.

They should be aware of marketing strategies and pricing policies.

Students must be able to use a computer for record keeping.

They should understand issues surrounding ethical business practice.

Basic Texts

Graham J & Martin M (eds)	*Ballantyne's Deafness (6th Edition)* Whurr, 2001 ISBN 1–86156–170–9
*Brooks D N (ed)	*Adult Aural Rehabilitation (1st Edition)* Chapman and Hall, 1989 ISBN 0–412–33290–6
Browning G G	*Clinical Otology and Audiology (2nd Edition)* Butterworth, Heinemann, 1999 ISBN 0–7506–3373–5
Dillon H	*Hearing Aids* Boomerang Press 2001 ISBN 1–58890–052–5
Hawke M and McCombe A	*Diseases of the Ear – a pocket atlas* Starkey, 1995 ISBN 1–896251–02–1
Tate-Maltby M	*Principles of Hearing Aid Audiology (2nd Edition)* Whurr, 2002 ISBN 1–86156–257–8
Venema T H	*Compression for Clinicians* Singular Publishing Group, Inc ISBN 1–56593–973–5
Volanthen A	*Hearing Instrument Technology for the Hearing Healthcare Professional (2nd Edition)* Singular Publishing, 2000 ISBN 0–7693–0072–3

Wormald P J and Browning G G — *Otoscopy – a structured approach*
Arnold, 1996
ISBN 0–340–61376–9

**[Brooks is currently out of print but is worth borrowing and reading.]*

Other References

Appropriate BSA Recommended Procedures
BSA Hearing Aid Handbook
Web sites for RNID, NDCS, HAC, BSHAA, Aid Manufacturers etc.

There will also be relevant articles in such journals as The International Journal of Audiology (formerly the British Journal of Audiology) and The Hearing Journal. These may be found by either a manual or electronic literature search.

HAC

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