

COURSE OUTLINE

CSD 9526a Modern Practices in Assistive Hearing Technologies: Hearing Aids

The University of Western Ontario, Fall Semester, 2018

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Overview and Purpose of Course:

This course will support advanced clinical practice in prescribing and verifying hearing aids, with an emphasis on evidence-based use of procedures and technologies. Advanced knowledge of the scientific foundations underlying current clinical practice will be supported and expected. Reading and discussion of evidence and modern protocols will critically evaluate advanced procedures in real ear measurement, prescription, digital signal processing (DSP) features, and outcome measurement.

Required Textbook:

Ricketts, T. A., Bentler, R., & Mueller, H. G. (2019). *Essentials of Modern Hearing Aids: Selection, Fitting, and Verification..* San Diego, CA: Plural Publishing.

Popelka, G. R., Moore, B. C. J., Fay, R. R., & Popper, A. N. (Eds.). (2016). *Hearing aids*. Retrieved from <https://ebookcentral.proquest.com> . Link to the ebook from the Library website: (<http://alpha.lib.uwo.ca/record=b6838686~S20>)

Grading Scheme:

Test #1	30%	October 24, 2018, 11:30 am – 1 pm	Required element.
Test #2	30%	November 21, 2018, 11:30 am – 1 pm	Required element.
Final Exam	40%	During the exam period.	Required element.

NOTE: You are required to attend all sessions and to contribute effectively to your group's work, and to integrate knowledge from ongoing and past coursework and practica into your work on this course.

Required Statements:

1. On attendance: We follow the CSD Attendance Policy for MCISc students.
2. On passing requirements: This course contains specific pass requirements (required elements), as specified above. To pass this course you must attain a grade of at least 60% according to the grade weighting given above AND attain at least the passing grade for each required element. If you do not pass all of the required elements, your submitted grade will be the lower of: a) 59% and b) your grade calculated as usual according to the grade weighting given above. That is, the highest grade possible if not all required elements are passed would be 59%. The policy of the CSD program is that the assigned course grade is the instructor's final assessment of a student's performance and already includes any and all grade rounding an instructor has chosen to implement. Assigned grades "close to" 60% or other letter-grade boundaries will not be further rounded up, with the

exception that grades submitted with decimal percentages are rounded up or down to the nearest integer by the Registrar before appearing on the student's record.

3. On academic offenses, from Western: Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following website:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

4. For the Policy on Accommodation for Illness and a downloadable SMC see:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_illness.pdf

[downloadable Student Medical Certificate (SMC):

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf

Electronic devices: Active pagers, cell phones, laptops, and/or internet connections including email are not allowed in class unless instructors indicate they are to be used in a specific classroom activity.

Accessibility: Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at <http://www.sdc.uwo.ca/ssd/> or 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

Support Services:

Office of the Registrar, <http://www.registrar.uwo.ca/>

Student Development Centre, <http://www.sdc.uwo.ca/>

USC Student Support Services, <http://westernusc.ca/services/>

Students who are in emotional/mental distress should refer to Mental Health @ Western, http://www.health.uwo.ca/mental_health/, for a complete list of options about how to obtain help.

Graduate Course Health and Wellness Insert for Graduate Course Outlines

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western's Campus Recreation Centre. Numerous cultural events are offered throughout the year. Please check out the Faculty of Music web page <http://www.music.uwo.ca/>, and our own McIntosh Gallery <http://www.mcintoshgallery.ca/>. Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at http://www.health.uwo.ca/mental_health/resources.html

To help you learn more about mental health, Western has developed an interactive mental health learning module, found here: http://www.health.uwo.ca/mental_health/module.html. This module is 30 minutes in length and provides participants with a basic understanding of mental health issues and of available campus and community resources. Topics include stress, anxiety, depression, suicide and eating disorders. After successful completion of the module, participants receive a certificate confirming their participation.

Timetable of Topics in this Course and Related Activities:

Colour key indicates primary instructor:

Susan Scollie	Vijay Parsa
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CSD 9526 room 2510 Mondays 1:30 to 4:30 PM		
Lecture Date	Lecture Topic	Reading Material
Sept. 10	Hearing aid components & DSP review	Popelka et al. (2016) Chapter 4, pp 93 - 102 Ricketts et al. (2019) Chapter 10, pp 327 - 343
	Level-dependent processing I – Basics	Ricketts et al. (2019), Chapter 10, pp 364 – 380 Banerjee (2006) Souza (2002)
Sept. 17	Level-dependent processing II (multichannel WDRC, Channel-Free & ADRO)	Woods et al (2006) Blamey (2005)
	Wireless & Remote Mic Technologies	Wolfe Chapter in Tharpe & Seewald Kuk (2010) Primer
Sept. 24	Prescriptive methods I	Ricketts, Bentler, & Mueller, (2019) Chapter 14 Or Bentler, Mueller & Ricketts (2016) Chapter 4
	Prescriptive methods II: Infant fitting, conductive corrections, venting corrections	Readings as listed
Oct. 1	Open Fitting, Venting, Occlusion effect. CROS & BiCros	Pumford (2005); Hayes (2006) Ricketts, Bentler, & Mueller, (2019) 258-266; 685-705 Or Bentler, Mueller & Ricketts (2016) Chapter 7 pp 322-342.
	Profound hearing losses including safety of hearing aid fitting. Hearing Aid orientation.	Souza (2002) sections on severe to profound losses. Bentler, Mueller, & Ricketts (2016) Chapter 8 OR Ricketts, Bentler & Mueller (2019) Chapter 19.
Oct. 8	Thanksgiving	No Class.

Oct. 15	Case discussions, candidacy, fine tuning, troubleshooting	<p>Bagatto & Scollie (2011) Ricketts, Bentler, & Mueller, (2019) Chapter 3 (free esample available)</p> <p>Other readings as listed</p>
	Frequency lowering Guest: Danielle Glista	Readings as listed
Oct. 22	Outcomes Assessment in Adults	<p>Bentler, Mueller, & Ricketts (2016) Chapter 10 OR Ricketts, Bentler & Mueller (2019) Chapter 19.</p> <p>Other readings as listed</p>
	Outcomes Assessment Guest: Marlene Bagatto	Readings as listed
Oct. 29	Directional technologies – I	<p>Popelka et al. (2016) Chapter 4, 110 -115</p> <p>Ricketts et al. (2019) Chapter 10, pp 343 – 354</p> <p>Ricketts (2001)</p>
	Directional technologies – II	<p>Moore (2007)</p> <p>Ricketts et al. (2019) Chapter 11, pp 403 – 426</p> <p>Other readings as listed</p>
Nov. 5	Adaptive noise reduction	<p>Popelka et al. (2016) Chapter 4, 115 -118</p> <p>Ricketts et al. (2019) Chapter 11, pp 389 – 403</p> <p>Bentler & Chiou (2006)</p>
	Feedback control	<p>Popelka et al. (2016) Chapter 4, 118 -122</p> <p>Ricketts et al. (2019) Chapter 12, pp 440 – 445</p>
Nov. 12	Environment Classifiers	<p>Popelka et al. (2016) Chapter 4, 122 -124</p> <p>Ricketts et al. (2019) Chapter 11, pp 384 – 389</p>

	OTC & PSAPs	Chan & McPherson (2015) Johnson, Xu, & Cox (2016) Humes et al. (2017)
Nov. 19	Hearing Aid Apps Master Hearing Aid	Kayser (2017)
	Clinical protocols for remote microphone and phone fitting. Venting review.	AAA CPG for FM fitting Other readings as listed
Nov. 26	Music and hearing aids. Guest: Jonathan Vaisberg	Readings as listed
	Tinnitus maskers and therapeutic sound	Readings as listed
Dec.3	Case presentations	Cases from 9528 will be discussed in class.
Final exam period	Final exam (cumulative)	

COMPETENCIES RELEVANT TO THIS COURSE:

CASLPA COMPETENCY COVERAGE:

1.7 INSTRUMENTATION

Demonstrate basic knowledge of:

i. The instrumentation relevant to clinical practice and its operation (e.g., amplification and assistive devices, audiometers, audio and video recorders, voice and speech synthesizers and analyzers).

1.7.i Advanced knowledge of certain aspects (The instrumentation relevant to clinical practice and its operation (eg, amplification and assistive devices, audiometers, audio and video recorders, voice and speech synthesizers and analyzers))

1.9 RESEARCH METHODOLOGY

Demonstrate basic knowledge of:

i. The scientific method.

ii. Basic statistical concepts and theories.

iii. Commonly used research designs.

iv. How to critically evaluate research.

v. Systematic evaluation of the reliability and validity of assessment procedures, and of treatment efficacy.

1.9 Application of concepts from 1.9 Research Methodology (basic knowledge) as they pertain to the evidence-based evaluation of signal processing efficacy/effectiveness, especially 1.9.iv and v.

AND: 2.4 Reporting

UNIT THREE: CLIENT MANAGEMENT

3.2 AMPLIFICATION AND ASSISTIVE LISTENING DEVICES

Demonstrates knowledge in the following areas:

ii. Current Principles and Methods of Selection and Fitting:

d) Verification strategies, including real ear measurements and sound field evaluation.

e) Validation of hearing aid benefits (outcome measures, self-assessment questionnaires).

3.2.d and e: Verification and validation of hearing aid fittings

4, 5 Modification of procedures to allow accurate and timely client management for the infant/neonatal, and preschool/school-aged populations, throughout and particularly:

UNIT FOUR: NEONATAL AND INFANT POPULATIONS

4.3 COUNSELLING

Demonstrates the ability to:

i. Communicate diagnostic information, its implications, and resulting habilitative recommendations to caregivers and referral sources.

ii. Understand the effects of hearing loss in daily life and of emotional reactions to hearing handicap.

4.4 (RE)HABILITATION

Demonstrates knowledge of:

vi. Special considerations for selection, evaluation, and monitoring of hearing devices

4.3, 4.4 Counselling and habilitation, especially 4.4.vi – special considerations for device fitting.

Updated required chapters and articles (harmonized with CSD 9528) (Sections requiring or suggesting chapters from textbooks are highlighted)

Hearing aid components & DSP review:

Review materials from last year's course and/or read ahead as you wish. This lecture is intended as a refresher, and is based on:

1. Chapter 10, Ricketts et al. (2019) book. The first part of this chapter has a good review of microphones, receivers, and digital signal processing.
2. Popelka et al. (2016), Chapter 4, pp 93 - 102. Gives an overview of signal processing features in hearing aids. Covers time-domain and frequency-domain analysis.

Level-dependent processing:

Ricketts et al. (2019), Chapter 10, pp 364 – 380, covers the basics of level-dependent processing. Souza (2002) and the Compression Handbook by Banerjee contain overlapping and some complementary information.

Woods et al. (2006) and Blamey (2005) support lecture content, remainder are needed for 9528 Unit 3 Assignment.

1. Souza P. (2002). Effects of compression on speech acoustics, intelligibility, and speech quality. *Trends in Amplification*, 6:131-165.
2. Banerjee, S. *The Compression Handbook*, Third Edition.
3. Woods WS, Van Tasell DJ, Rickert ME, Trine TD (2006). SII and fit-to-target analysis of compression system performance as a function of number of compression channels. *International Journal of Audiology*, 45(11):630-44.
4. Blamey PJ (2005). Adaptive dynamic range optimization (ADRO): A digital amplification strategy for cochlear implants and hearing aids. *Trends in Amplification* 9(2): 77-98.
5. Bisgaard, N, Vlaming, M, Dahlquist, M. (2010). Standard Audiograms for the IEC 60118-15 Measurement Procedure. *Trends in Amplification* 14: 113-120.
6. Holder, J. T., Picou, E. M., Gruenwald, J. M., & Ricketts, T. A. (2016). Do Modern Hearing Aids Meet ANSI Standards?. *Journal of the American Academy of Audiology*, 27(8), 619-627.

Candidacy and Selection:

1. Chapter 2, Understanding the Hearing Aid Candidate in: Mueller, Bentler, and Ricketts, *Modern Hearing aids, Pre-fitting and Selection Considerations*. **This chapter is freely available if you download the sample e-book:** https://play.google.com/store/books/details/H_Gustav_Mueller_Modern_Hearing_Aids?id=EtszBwAAQBAJ&hl=en
2. Goal-setting sections of Chapter 5 of Bentler, Mueller, & Ricketts (2016)

The readings below give a “big picture” overview of amplification, selection, and benefit in modern hearing aid prescription and dispensing.)

1. Hickson L, Meyer, C., Lovelock, K., Lampert, M. & Khan, A. (2015). "Factors associated with success with hearing aids in older adults" *International Journal of Audiology* 53:sup1, S18-27.
2. Abrams, H., & Kihm, J. (2015). An introduction to MarkeTrack IX: A new baseline for the hearing aid market: *Hearing Review*, 22(6): 16. Accessed from: <http://www.hearingreview.com/2015/05/introduction-marketrak-ix-new-baseline-hearing-aid-market/>
3. Poost-Foroosh, L., Jennings, M.B., Cheesman, M.F. (2015). Comparisons of Client and Clinician Views of the Importance of Factors in Client-Clinician Interaction in Hearing Aid Purchase Decisions. *J Am Acad Audiolog* 26: 247-259.
4. Gioia et al, (2015) Case Factors Affecting Hearing Aid Recommendations by Hearing Care Professionals *J Am Acad Audiolog* 26: 229-246.

Prescription, programming, fit to targets, and infant prescription:

1. Bentler, Mueller & Ricketts, Chapter 4
2. Bagatto, M. & Scollie, S. (2011). Current Approaches to the Fitting of Amplification to Infants and Young Children. In: *Comprehensive Handbook of Pediatric Audiology*. Edited by: R. Seewald and A. M. Tharpe. Plural Publishing, pp. 527- 552.
 - a. UWO PedAMP resources for fit to targets and SII worksheets are also handy for 9528 assignments in this topic area, and may be freely downloaded from: www.dslio.com
3. Keidser G, Dillon H, Flax M, Ching T, Brewer S (2011). The NAL-NL2 prescription procedure. *Audiology Research* 1 (e24), 88-90.
 - a. This reading is supplemental to the coverage offered in Bentler, Mueller & Ricketts Ch 4
4. Polonenko et al (2010) Fit to targets, preferred listening levels, and self-reported outcomes for the DSL v5.0a hearing aid prescription for adults. *International Journal of Audiology*, 49 (8), 550-560.
 - a. This is listed as a course resource for your Unit Two requirement in 9528 and does not need to be "studied" for exams.
5. Programming hearing aids guide posted to OWL.

Occlusion, venting, and RECD applications in real ear measurement:

1. Bentler, Mueller, & Ricketts cover verification of this in chapter 7, starting about page 302, and Figure 7-8 is key. These concepts are also discussed in:
 - a. Mueller, G. (2003) There is less talking in barrels, but the occlusion effect is still with us. *The Hearing Journal*, 56 (8), 10- 16.
 - b. Stender, T. & Appleby, R. (2009). Occlusion effect measures: Are they all created equal? *The Hearing Journal*, 62(7), pp. 21-25.
 - c. Winkler et al (2016). Open Versus Closed Hearing-Aid Fittings: A Literature Review of Both Fitting Approaches. *Trends in Hearing*, 20: 1-13.

Hearing Aid Orientation & Troubleshooting

1. Bentler, Mueller & Ricketts, Chapter 8 OR Ricketts, Bentler, & Mueller Chapter 19.
2. Seewald & Tharpe, Chapter 29
3. Discussion articles at the following links:
 - <http://aja.pubs.asha.org/article.aspx?articleid=2629894&resultClick=1>
 - <http://aja.pubs.asha.org/article.aspx?articleid=2443236&resultClick=1>
 - <http://aja.pubs.asha.org/article.aspx?articleid=1757461&resultClick=1>

- <http://www.tandfonline.com/doi/full/10.1080/14992027.2017.1282632>
- <http://www.tandfonline.com/doi/full/10.1080/14992027.2016.1253877>
- <http://www.ingentaconnect.com/contentone/aaa/jaaa/2016/00000027/00000004/art00005>

Frequency Lowering:

1. For 9526, this article provides a good explanation of the differences between various types of frequency lowering signal processors and how they work – we are including it for that reason and less so for the specific experiments presented in the article: Alexander, J. M. (2013). Individual variability in recognition of frequency-lowered speech. *Seminars in Hearing*, 34, 86-109.
2. Relevant sections of your textbook chapters are helpful but use different stimuli than our local protocols – it is worth understanding why we don't use these stimuli any more:
 - a. Bentler et al: begins on page 343
3. Protocols that we will use in 9528:
 - a. Child Amplification Laboratory (2014). Protocol for the Provision of Amplification version 2014.01. M Bagatto & S Scollie (eds). Report developed for: Ministry of Children and Youth Services. November 17, 2014. Downloadable from: http://www.dslio.com/?page_id=166
 - b. Glista, D., Hawkins, M., and Scollie, S. (2016). An update on modified verification approaches for frequency lowering devices. *AudiologyOnline*, Article 16932. 5/2/2016 from <http://www.audiologyonline.com/>.
 - The publication describing the development of stimuli used in this protocol is: Scollie, S., Glista, D., Seto, J., Dunn, A., Schuett, B., Hawkins, M., Pourmand, N., and Parsa, V. (2016). Fitting frequency-lowering signal processing applying the American Academy of Audiology Pediatric Amplification Guideline: Updates and protocols. *Journal of the American Academy of Audiology*, 27(3): 219-236.

Fitting Unilateral/asymmetrical hearing losses:

1. Pumford (2005) Benefits of probe-mic measures with CROS/BiCROS fittings. *The Hearing Journal*, 58(10), 34-40.
2. Hayes (2006) A practical guide to CROS/BiCROS fittings. http://www.audiologyonline.com/articles/article_detail.asp?article_id=1632
3. AAA Draft Guideline for adults with unilateral hearing loss

Outcome measures for adults and children:

1. Bentler, Mueller, & Ricketts (2016) cover this topic in Chapter 10 or Chapter 19 in the Ricketts et al (2019) textbook.
1. See also Hickson et al (2010) from week 1 for info on factors affecting outcome).
2. Bagatto et al (2011) The University of Western Ontario Pediatric Audiological Monitoring Protocol (UWO PedAMP). *Trends in Amplification*, 15 (1-2), 57-76.

The readings below are references for specific tests that will be covered in 9526/9528. Practical knowledge of test administration and interpretation is required, memorization is not.

1. Bagatto, M. (2012). 20Q: Baby Steps Following Verification - Outcome Evaluation in Pediatric Hearing Aid Fitting, AudiologyOnline. http://www.audiologyonline.com/articles/article_detail.asp?article_id=2414).
2. Johnson, J., Cox, R., and Alexander, G. (2010). Development of APHAB norms for WDRC hearing aids and comparisons with original norms. *Ear & Hearing*, 31(1):47-55.
3. Killion MC, Niquette PA, Gudmundsen GI, Revit LJ, Banerjee S.(2004) Development of a quick speech-in-noise test for measuring signal-to-noise ratio loss in normal-hearing and hearing-impaired listeners. *J Acoust Soc Am* 116(4):2395–2405. [note Erratum]
4. Ng, S., Meston, C., Scollie, S., & Seewald, R. (2011). Adaptation of the BKB-SIN Test for Use as a Pediatric Aided Outcome Measure. *Journal of the American Academy of Audiology*. 22:375–386.
5. Scollie, S., Glista, D., Tenhaaf Le Quelenec, J., Dunn, A., Malandrino, A., Keene, K., Folkeard, P. (2012). Ling 6 Stimuli and normative data for detection of Ling-6 sounds in Hearing Level, *American Journal of Audiology*.
6. Glista, D. and Scollie, S. (2012). Development and Evaluation of an English Language Measure of Detection of Word-Final Plurality Markers: The University of Western Ontario Plurals Test. *American Journal of Audiology*, 21: 76-81.

[This marks the end of readings that are included in Test 1 of CSD 9526]

ANR, Directionality, and Feedback cancellation:

Verification of: (these will orient you to measures used in CSD 9528)

1. The Bentler, Mueller, & Ricketts textbook provides an excellent overview in Chapter 7, starting on page 338. These procedures are also discussed in:
 - a. Smriga, D. J. (2004). How to measure and demonstrate four key digital hearing aid performance features. *Hearing Review*, 11(11).
 - b. McReery, R. (2011). Pediatric Hearing Aid Fittings: Selection and Verification of Features, AudiologyOnline, http://www.audiologyonline.com/articles/article_detail.asp?article_id=2399
2. Bisgaard, N, Vlaming, MSMG, Dahlquist, M. (2010). Standard Audiograms for the IEC 60118-15 Measurement Procedure. *Trends in Amplification* 14: 113-120.
3. Cox, R. (2009a). Verification and what to do until your probe-mic system arrives (Part 1 of 2). *The Hearing Journal*, 62, 9, pp 10,12-14,16. http://journals.lww.com/thehearingjournal/Fulltext/2009/09000/Verification_and_what_to_do_until_your_probe_mic.3.aspx
4. Cox, R. (2009b). Verification and what to do until your probe-mic system arrives: (The second of two parts). *The Hearing Journal*, 62, 10, pp 10 – 14. http://journals.lww.com/thehearingjournal/Fulltext/2009/10000/Verification_and_what_to_do_until_your_probe_mic.3.aspx

How directional mics work, and evidence:

1. Ricketts et al. (2019), Chapter 10, pp. 343 – 354, and Chapter 11, 407 – 426.
2. Popelka et al. (2016), Chapter 4, 110 -115.
3. Ricketts, TA (2001). Directional Hearing Aids. *Trends in Amplification*, 5(4): 139 - 176.

4. Bentler, RA (2005). Effectiveness of Directional Microphones and Noise Reduction Schemes in Hearing Aids : A Systematic Review of the Evidence. *Journal of the American Academy of Audiology*, 16: 473 - 484.

In part-II, we will look at recent evidence surrounding binaural beamforming technologies. Relevant articles and information:

1. Ricketts et al. (2019), Chapter 11, 407 – 426 covers some of the evidence on bilateral beamformers.
2. Chapter 4 from Popelka et al. (2016) has some information on this.
3. Moore, BCJ (2007). Binaural sharing of audio signals: Prospective benefits and limitations. *The Hearing Journal*, 60:46 - 48.
4. Other recent articles discussed in class.

How ANRs work, and evidence:

1. Ricketts et al. (2019), Chapter 11, pp 389 – 403.
2. Popelka et al. (2016), Chapter 4, 115 -118
3. Book chapter from Dillon (2012) (posted to OWL).
4. Bentler, RA, Chiou, L.(2006). Digital Noise Reduction : An Overview. *Trends in Amplification*, 10:67 – 82.
5. Bentler, RA, Wu, Y., Kettel, J., Hurtig, R. (2008). Digital noise reduction: Outcomes from laboratory and field studies. *International Journal of Audiology*, 47:447 – 460.
6. Scollie, S., Levy, C., Pourmand, N., Abbasalipour, P., Bagatto, M., Richert, F., ... & Parsa, V. (2016). Fitting Noise Management Signal Processing Applying the American Academy of Audiology Pediatric Amplification Guideline: Verification Protocols. *Journal of the American Academy of Audiology*, 27(3), 237-251.

Environmental Classifiers:

1. Ricketts et al. (2019), Chapter 11, pp 384 – 389.
2. Popelka et al. (2016), Chapter 4, 122 -124.
3. Banerjee, S. (2011). Hearing aids in the real world: Typical automatic behavior of expansion, directionality, and noise management. *Journal of the American Academy of Audiology*, 22(1), 34-48.
4. Searchfield, G. D., Linford, T., Kobayashi, K., Crowhen, D., & Latzel, M. (2018). The performance of an automatic acoustic-based program classifier compared to hearing aid users' manual selection of listening programs. *International journal of audiology*, 57(3), 201-212.

Feedback Cancellers:

1. Ricketts et al. (2019), Chapter 12, pp 440 – 445.
2. Popelka et al. (2016), Chapter 4, 118 -122.
3. Chung, K. (2004). Challenges and Recent Developments in Hearing Aids, Part II : Feedback and Occlusion Effect Reduction Strategies, Laser Shell Manufacturing Processes, and Other Signal Processing Technologies. *Trends in Amplification*, 8:125 -161.

Wireless and Remote Microphone Technologies:

1. Chapter 27: Wolfe, Lewis, & Eiten. Remote Microphone Systems and Communication Access for Children. in Tharpe, A. M., & Seewald, R. (Eds.). (2016). *Comprehensive Handbook of Pediatric Audiology*. Plural Publishing. PDF will be posted to OWL site.

2. Kuk, F., Crose, B., Korhonen, P., Kyhn, T., Mørkebjerg, M., Rank, M., ... & Ungstrup, M. (2010). Digital wireless hearing aids: Part 1: A primer. *Hearing Review*, 17(3), 54-67.

OTCs, PSAPs, and MHA:

1. Chan, Z. Y. T., & McPherson, B. (2015). Over-the-counter hearing aids: a lost decade for change. *BioMed research international*, 2015.
2. Johnson, J. A., Xu, J., & Cox, R. M. (2016). Impact of hearing aid technology on outcomes in daily life II: Speech understanding and listening effort. *Ear and hearing*, 37(5), 529-540.
3. Kayser, H. (2017). Open community platform for hearing aid algorithm research. *Medizinische*, 6, 26.
4. Humes et al., (2017). The effects of service-delivery model and purchase price on hearing-aid outcomes in older adults: A randomized double-blind placebo-controlled clinical trial. *American Journal of Audiology*, Vol 26, 53-79. doi:10.1044/2017_AJA-16-0111

[This marks the end of readings that are included in Test 2 of CSD 9526]

Clinical protocols for remote microphone and phone fitting:

1. AAA Clinical practice guidelines (2011) Remote Microphone hearing assistance technologies for Children and Youth from Birth to 21 years. Downloaded from: [https://audiology-
web.s3.amazonaws.com/migrated/HAT_Guidelines_Supplement_A.pdf_53996ef7758497.5441900
0.pdf](https://audiology-
web.s3.amazonaws.com/migrated/HAT_Guidelines_Supplement_A.pdf_53996ef7758497.5441900
0.pdf)

Hearing aids and Telephones: (See mobile phone compatibility section in Dillon text)

1. Palmer, C. (2001). Ring, ring! Is anybody there? Telephone solutions for hearing aid users. *The Hearing Journal*, 54(9), 10-18.
2. Valente, M. (2013). The Telecoil: The Lonely Transducer that Can Be a Big Producer. *AudiologyOnline* course #22765. Available at: [http://www.audiologyonline.com/audiology-
ceus/course/telecoil-lonely-transducer-that-can-22765](http://www.audiologyonline.com/audiology-
ceus/course/telecoil-lonely-transducer-that-can-22765)
3. Bentler, Mueller, & Ricketts (2016) offer a specific section on telephone verification starting on page 350, and offer a good review of legislation on phones and hearing aid compatibility in chapter 2.
4. *We will show you this protocol in 9528:* Folkeard, P., Pumford, J., Narten, P., & Scollie, S. (2017). Verifying monaurally and binaurally linked telephone programs. *Canadian Audiologist*, 4(2).

Products for special populations: (tinnitus maskers, personal amplification systems, and OTC hearing aids)

Tinnitus Maskers (overview & evidence):

Please review the international consensus materials on assessment and outcome measurement at: http://www.tinnitusresearch.org/en/consensus/consensus_en.php

Henry, J. A., McMillan, G., Dann, S., Bennett, K., Griest, S., Theodoroff, S., . . . Saunders, G. (2017). Tinnitus Management: Randomized Controlled Trial Comparing Extended-Wear Hearing Aids, Conventional Hearing Aids, and Combination Instruments. *Journal of the American Academy of Audiology*, 28(6), 546-561. doi: 10.3766/jaaa.16067

Schmidt, C. & Henry, J. (2018). Behavioral Intervention in Tinnitus Management. Downloaded from: <https://www.nationalregister.org/pub/the-national-register-report-pub/journal-of-health-service-psychology-winter-2018/behavioral-intervention-in-tinnitus-management/>.

We will review the following sample programs and tools:

- http://journals.lww.com/ear-hearing/Abstract/2012/03000/The_Tinnitus_Functional_Index_Development_of_a.2.aspx
- http://www.ncrar.research.va.gov/Education/Documents/TinnitusDocuments/Triage_Guide.pdf

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