

# Ward R. Drennan, Ph. D.

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Born in Ohio, USA

## Education

Doctor of Philosophy in Speech and Hearing Science and Cognitive Science, Indiana University, December, 1998.

Bachelor of Science in Physics: Purdue University, May, 1991.

## Post Graduate Training

Postdoctoral Fellow, University of Michigan (2001-2004) Bryan E. Pfingst, mentor.

Postdoctoral Research Scientist (1998-2001). Stuart Gatehouse, mentor.

## Faculty positions held

Research Assistant Professor, Department of Otolaryngology, University of Washington (2012-present)

Adjunct Assistant Professor, Department of Speech and Hearing Sciences, University of Washington (2012-present)

Adjunct Lecturer, Department of Speech and Hearing Sciences, University of Washington (2011-2012)

Lecturer, Department of Otolaryngology, University of Washington (2007-2012)

Acting Instructor, Department of Otolaryngology University of Washington (2004-2007)

**Hospital Positions Held**--- not applicable.

**Honors**— 2005-2011 NIH Loan Repayment Program Award Recipient for Clinical Research

**Board Certifications**—not applicable

**Current Licenses to Practice**—not applicable.

## **Professional Organizations**

Association for Research in Otolaryngology  
Acoustical Society of America  
Cochlear Implant Alliance

## **Teaching Responsibilities** – mentorship and research guidance

- Chad Ruffin, MD, mentor (2006-2008) on “Discrimination of Schroeder-phase harmonic complexes by normal-hearing and cochlear-implant listeners.”
- Grace L Nimmons, MD, research volunteer prior to residency (2007), mentor on “Clinical assessment of music perception in cochlear implant listeners”
- Robert S Kang, MD (2007-2008) resident, mentor on “Development and validation of the University of Washington Clinical Assessment of Music Perception test”
- Jong Ho Won, Ph.D. Dissertation Committee, Bioengineering (2010).
- Sheli Afridi, AuD, capstone project (2012), primary mentor on “Effect of the spectral ripple discrimination task in evaluating cochlear implant (CI) candidacy: Effect of audibility on spectral ripple discrimination”
- Nikita Imennov, PhD, mentor (2011-2013) on “Detection of acoustic temporal fine structure by cochlear implant listeners: behavioral results and computational modeling”
- Zachary Douglas (summer 2015), Medical Student Research Training Program, primary mentor on “The development of behavioral diagnostics of hidden hearing loss.”
- Hillary R. Perry, AuD student (2015-2016), primary mentor on capstone project, “Incorporating effects of bilateral hearing into general quality of life measures”
- Christa Dodson, AuD student (2015-2016), primary mentor on capstone project, “Music and psychoacoustic abilities of normal-hearing listeners using simulations of a hybrid cochlear implant”
- Sophia Hannford (summer 2016), Engineering student, mentor on “Mandarin Tone Recognition in English Speakers with Normal Hearing and Cochlear Implants”
- Jesse Resnick (2017-2019), Medical student, mentor on “The role of the binaural intelligibility level difference in the early detection of noise-induced hearing loss”

## **Editorial Responsibilities** --- Regular reviewer for

Journal of the Acoustical Society of America  
Ear and Hearing  
Audiology and Neurotology  
Hearing Research  
Journal of the Association for Research in Otolaryngology  
International Journal of Audiology

**Special National Responsibilities** – none.

**Special Local Responsibilities**—University of Washington Faculty Senate from 2014-present.

## **Research Funding**

### *Current*

**Military Medical Research and Development** 7/1/2018-6/30/2021  
Department of Defense (DoD)  
Early detection of noise induced hearing loss \$1,568,560  
Role: Principal Investigator

### *Past*

**Clinical Investigations Grant** 7/1/2017-6/30/2018  
American Otological Society  
Early Detection of Noise Induced Hearing Loss \$66,000  
Role: Principal Investigator

**Themed Competition: Detect and Treat Tinnitus and Hearing Loss** 6/15/2016- 3/31/2017  
United Kingdom Ministries of Defense Centre for Defense Enterprise  
Early Detection of Noise-Induced Hearing Loss ~\$110,000  
Role: Principal Investigator

**R01 DC010148** 6/1/2010-5/31/2016  
NIH/ NIDCD  
Improved Analysis of Cochlear Implant Processing \$1,637,895  
Role: Principal Investigator

**R01 Supplement** 6/1/2012-5/31/2013  
NIH/ NIDCD  
Improved Analysis of Cochlear Implant Candidacy \$40,000  
Role: Principal Investigator

**R01 DC007525** 12/1/2005-11/30/2010  
NIH/ NIDCD  
Name: Optimized conditioned processing for cochlear implants \$1,893,855  
Role: Investigator

## Bibliography

### a) Manuscripts

1. Horn, DL, DJ Dudley, K Dedhia, K Nie, **WR Drennan**, JH Won, Rubinstein JT, Werner LA (2017). Effects of age and hearing mechanism on spectral resolution in normal hearing and cochlear-implanted listeners,” J. Acoust. Soc. Am. 141, 613-623.
2. \***Drennan, WR**, JH Won, AO Timme, JT Rubinstein (2016). “Non-linguistic outcome measures in adult cochlear implant users over the first year of implantation,” Ear Hear. 37, 354-64.
3. \***Drennan, WR**, JJ Oleson, K Gfeller, J Crosson, VD Driscoll, JH Won, ES Anderson, JT Rubinstein (2015). “Clinical evaluation of music perception, appraisal and experience in cochlear implant users,” Int. J. Audio., 54(2), 114-123.
4. Shim, HJ, JH Won, IJ Moon, ES Anderson, **WR Drennan**, NE McIntosh, E Weaver, JT Rubinstein (2014). “Can unaided non-linguistic measures predict cochlear implant candidacy?” Otology and Neurotology, 35 (8), 1345-1353.
5. **Drennan, WR**, ES Anderson, JH Won, JT Rubinstein (2014). “Validation of a clinic assessment of spectral-ripple resolution for cochlear implant users,” Ear Hear. 35(3), 92-98.
6. Imennov, NS, JH Won, **WR Drennan**, E Jameyson, JT Rubinstein (2013). “Detection of acoustic temporal fine structure by cochlear implant listeners: behavioral results and computational modeling,” Hear Res. 298, 60-72.
7. Jones GL, JH Won, **WR Drennan**, JT Rubinstein (2013). “Relationship between channel interaction and spectral-ripple discrimination in cochlear implant users,” J. Acoust. Soc. Am. 133(1), 425-433.
8. Won, JH, K Nie, **WR Drennan**, JT Rubinstein (2012). “Maximizing the spectral and temporal benefits of two clinically used sound processing strategies for cochlear implants,” Trends Amplif. 16(4), 201-210.
9. Li, X, K Nie, NS Imennov, JH Won, **WR Drennan**, JT Rubinstein, LE Atlas (2012)  
“Improved perception of speech in noise and Mandarin tones with acoustic simulations of harmonic coding for cochlear implants,” J. Acoust. Soc. Am. 132(5), 3387-98.
10. Won, JH, C Lorenzi, K Nie, X Li, EM Jameyson, **WR Drennan**, JT Rubinstein (2012). “The ability of cochlear implant users to use temporal envelope cues recovered from speech frequency modulation,” J. Acoust. Soc. Am. 132(2), 1113-1119.
11. Jung, KH, JH Won, **WR Drennan**, E Jameyson, G Miyasaki, SJ Norton, JT Rubinstein (2012). “Psychoacoustic performance and music and speech perception in prelingually deafened children with cochlear implants,” Audiol. Neurootol. 17(3), 189-197.

12. Golub JS, JH Won, **WR Drennan**, TD Worman, JT Rubinstein (2012). "Spectral a temporal measures in hybrid cochlear implant users: on the mechanism of electroacoustic hearing benefits, *Otol. Neurotol.* 33(2), 147-153.
13. Won JH, GL Jones, **WR Drennan**, EM Jameyson, JT Rubinstein (2011). Evidence of across channel processing for spectral-ripple discrimination in cochlear implant listeners," *J. Acoust. Soc. Am.* 130(4), 2088-2097
14. Won JH, **WR Drennan**, K Nie, EM Jameyson, JT Rubinstein (2011). "Acoustic temporal modulation detection and speech perception in cochlear implant listeners," *J. Acoust. Soc. Am.*, 130 (1), 376-388.
15. Won JH, CG Clinard, S Kwon, VK Dasika, K Nie, **WR Drennan**, KL Tremblay, JT Rubinstein. (2011). "Relationship between behavioral and physiological spectral-ripple discrimination." *J. Assoc. Res. Otolaryngol* 12 (3), 375-393.
16. Won JH, **WR Drennan**, RS Kang, JT Rubinstein (2010). "Psychoacoustic abilities associated with music perception in cochlear implant users," *Ear Hear.* 31, 796-805.
17. **\*Drennan WR**, JH Won, K Nie, E Jameyson, JT Rubinstein. (2010). "Sensitivity of psychophysical measures to signal processor modifications in cochlear implant users." *Hear Res.* 262, 1-8.
18. Kang, R, GL Nimmons, **WR Drennan**, J Longnion, C Ruffin, K Nie, JH Won, T. Worman, B. Yueh, JT Rubinstein. (2009). "Development and Validation of the University of Washington Clinical Assessment of Music Perception (CAMP) Test." *Ear & Hearing*, 30 (4), 411-8.
19. **\*Drennan WR**, Rubinstein JT (2008). "Music perception in cochlear implant users and its relationship with psychophysical capabilities." *J. Rehabil. Res. and Dev.*, 45(5) 779-790.
20. Won JH, Schimmel SM, **Drennan WR**, Souza PE, Atlas L, Rubinstein JT (2008). "Improving performance in noise for hearing aids and cochlear implants using coherent modulation filtering," *Hearing Research*, 239(1-2), 1-11.
21. **Drennan WR**, J Longnion, C Ruffin, JT Rubinstein (2008). "Discrimination of Schroeder-phase harmonic complexes by normal-hearing and cochlear implant listeners," *J. Assoc. Res. Otolaryngol.*, 9, 138-149.
22. Nimmons GL, Kang RS, **Drennan WR**, Longnion J, Ruffin C, Worman T, Yueh B, Rubinstein, JT (2007). "Clinical Assessment of Music Perception in Cochlear Implant Listeners," *Otol Neurotol.* 29, 149-155.
23. Won, JH, **Drennan WR**, Rubinstein, JT (2007). "Spectral-ripple resolution correlates with speech reception in noise in cochlear implant users," *J. Assoc. Res. Otolaryngol.*, 8, 384-392.
24. **Drennan WR**, Won JH, Dasika VK, Rubinstein, JT (2007). "Effects of temporal fine structure on the lateralization of speech and on speech understanding in noise," *J. Assoc. Res. Otolaryngol.*, 8, 373-383.

25. **Drennan WR** and Pfingst BE (2006) “Current-level discrimination in the context of interleaved, multichannel stimulation in cochlear implants: effects of number of stimulated electrodes, pulse rate and electrode separation,” *J. Assoc. Res. Otolaryngol*, 7, 308-316.
26. **Drennan WR**, Gatehouse S, Howell P, VanTasell D, Lund S (2005). “Localization and speech identification of hearing-impaired listeners using phase-preserving amplification,” *Ear Hear* 26, 461-472.
27. **Drennan WR**, Pfingst BE (2005) “Current-level discrimination using bipolar and monopolar electrode configurations in cochlear implants,” *Hear Res* 202, 170-179.
28. \***Drennan WR**, Gatehouse S, Lever C. (2003). “Perceptual segregation of competing speech sounds: the role of spatial location,” *J. Acoust. Soc. Am.* 114, 2178-2189.
29. **Drennan WR**, Watson CS (2001). “Sources of variation in profile analysis II. Component spacing, dynamic changes and roving level,” *J. Acoust. Soc. Am.* 110, 2498-2504.
30. **Drennan WR**, Watson CS (2001). “Sources of variation in profile analysis I. Individual differences and extended training,” *J. Acoust. Soc. Am.* 110, 2491-2497.

#### **b) Book Chapters (4)**

1. Nie KB, **Drennan WR** and Rubinstein JT. (in press). “Cochlear Implant Coding and Device Programming,” in Ballenger’s *Otorhinolaryngology Head and Neck Surgery*, J Snow and PA Wackym (Eds.), BC Decker.
2. **Drennan WR**, Svirsky M., MB Fitzgerald, Rubinstein JT. (2014). “Mimicking normal auditory functions with cochlear implant sound processing: past, present and future,” in *Cochlear Implants*. (3rd Edition). Waltzman SB, Roland JT (Eds). Thieme Medical Publications, NY. NY.
3. Nie KB, **Drennan WR** and Rubinstein JT. (2009). “Cochlear Implant Coding Strategies and Device Programming,” in Ballenger’s *Otorhinolaryngology Head and Neck Surgery*, J Snow and PA Wackym (Eds.), BC Decker.
4. **Drennan WR**, Rubinstein JT. (2006). “Sound processors in cochlear implants,” in *Cochlear Implants*. (2nd Edition). Waltzman SB, Roland JT (Eds). Thieme Medical Publications, NY. NY.

#### **c) Published software**

1. Clinical assessment of music perception for cochlear implants (CAMP)
2. Spectral-ripple resolution assessment for cochlear implant users

#### **d) Other publications—none.**

## e) Manuscripts submitted

1. Nie KB, Hannaford S., Director H., Nishigaki MC, **Drennan WR**, Rubinstein JT (2017). “Mandarin tone recognition in English speakers with normal hearing and cochlear implants” Int. J. Audiology.

## f) Conference Abstracts

1. Perry HR and **Drennan, WR** (2017) “Health Utility in unilateral vs. bilateral cochlear implant users” presented at the 2017 Conference on Implantable Auditory Prostheses, Tahoe City, CA.
2. **Drennan WR**, NE McIntosh (2016) “Early detection of noise-induced hearing loss” Talk presented at the 2016 meeting for the Northwest Auditory and Vestibular Meeting
3. **Drennan WR**, NE McIntosh, JT Rubinstein, ES Anderson (2015) “Binaural benefit in cochlear implantees: Does unilateral spectral resolution matter?” Talk presented at the American Auditory Society 42<sup>nd</sup> Annual Scientific and Technology conference, Scottsdale, AZ (A).
4. McIntosh, NE, JT Rubinstein, **WR Drennan** (2014). “Psychophysical measures show treatment effects in cochlear implant mapping,” Talk presented at the American Auditory Society 41<sup>st</sup> Annual Scientific and Technology conference, Scottsdale, AZ (A).
5. **Drennan WR**, DT Ives, JH Won, EM Jameyson; K. Nie, JT Rubinstein, C. Lorenzi (2012). “Perception of frequency-modulation patterns based on recovered- envelope cues for cochlear implant users,” Presented at the 34<sup>th</sup> Midwinter meeting of the Association for Research in Otolaryngology (A).
6. **Drennan WR**, JH Won, EM Jameyson, JT Rubinstein (2011) “Stability of Clinically Meaningful, Non-Linguistic Measures of Hearing Performance with a Cochlear Implant” Presented at the 2011 Conference on Implanted Auditory Prostheses, Asilomar, CA (A).
7. **Drennan, WR**, Nimmons GL, Kang R, Crosson J, Won JH, Rubinstein JT (2010). Music perception in cochlear implant listeners. Presented at the 11<sup>th</sup> International Conference on Music Perception and Cognition, Seattle, WA (A).
8. Jones GL, **Drennan WR**, Won JH, Rubinstein JT (2010). A model of spectral ripple discrimination by cochlear implant users. American Auditory Society, Scottsdale, AZ (A).
9. Won JH, **Drennan WR**, Jung KH, Jameyson E, Nie K, Rubinstein JT (2010). The effect of the number of channels on spectral-ripple, Schroeder-phase discrimination, and modulation detection in cochlear implant users. Presented at the 33<sup>rd</sup> midwinter meeting of the Assoc. Res. Otolaryngol., Anaheim, CA (A)
10. Rubinstein JT, **Drennan WR**, Nie K, Won JH, Imenov N, Li X, Atlas L. (2009). Spectral and temporal contributions of clinical performance. Conference on Implantable Prostheses, Tahoe City, CA.
11. Won JH, **Drennan WR**, Rubinstein JT (2009). Acoustic temporal modulation transfer function in cochlear implant users. Conference on Implantable Auditory prostheses, Tahoe City, CA. (A).

12. Miyasaki G, Won JH, Norton S, **Drennan WR**, Rubinstein JT (2009). Psychophysical and clinical outcome scores in prelingually deaf CI Children: A baseline study. 12<sup>th</sup> symposium on cochlear implants in children. (A)
13. Won JH, **Drennan WR**, Jameyson E, Rubinstein JT (2009). Single-channel Schroeder-phase discrimination as a measure of within-channel temporal fine-structure sensitivity. Presented at the 32<sup>nd</sup> midwinter meeting of the Assoc. Res. Otolaryngol, Baltimore, MD (A).
14. Won JH, **Drennan WR**, Rubinstein JT (2009). Development and validation of the acoustic temporal modulation detection test for cochlear implant users. American Auditory Society, Scottsdale, AZ (A).
15. **Drennan WR**, Won JH, Jameyson E, Rubinstein JT (2009). Improved analysis of hearing with cochlear implants. Presented at the 32<sup>nd</sup> midwinter meeting of the Assoc. Res. Otolaryngol. Baltimore, MD (A).
16. Imennov NS, Won JH, **Drennan WR**, Rubinstein JT (2009). Single-fiber population modeling of Schroeder-phase discrimination: a comparison to psychophysical results. Presented at the 32<sup>nd</sup> midwinter meeting of the Assoc. Res. Otolaryngol. Baltimore, MD. (A)
17. Won JH, Kwon S, Clinard C, **Drennan WR**, Dasika V, Tremblay K, Rubinstein JT (2008). A New Approach for Measuring Spectral-Ripple Discrimination. Presented at the 31<sup>st</sup> midwinter meeting of the Assoc. Res. Otolaryngol. Phoenix, AZ (A).
18. Clinard C, Kwon S, Won JH, **Drennan WR**, Tremblay K, Rubinstein JT (2008). Spectral-ripple Discrimination Thresholds: Relation of Behavioral and Physiological Measures. American Auditory Society, Scottsdale, AZ (A).
19. Rubinstein JT, **Drennan WR**, Crosson J., Nie K, Won JH, Kang R. (2008) "Music Perception with Cochlear Implants," Presented at the Thirty-first Annual Research Meeting of the Association for Research in Otolaryngology, Phoenix, AZ.
20. Won JH, Won S, Clinard C, **Drennan WR**, Dasika V, Tremblay K, Rubinstein (2008). "A New Approach for Measuring Spectral-Ripple Discrimination," Presented at the Thirty-first Annual Research Meeting of the Association for Research in Otolaryngology Phoenix, AZ.
21. Nie K, King B, Atlas L, Atal BS, **Drennan WR**, Rubinstein JT (2007). "Speech recognition with coherent envelopes," Presented at the 2007 Conference on Implantable Auditory Prostheses, Lake Tahoe, CA.
22. Won JH, **Drennan WR**, Kang R, Longnion J, Rubinstein JT (2007). "Relationships among music perception, speech perception in noise, Schroeder phase and spectral discrimination ability in cochlear implant listeners," Presented at the 2007 Conference on Implantable Auditory Prostheses, Lake Tahoe, CA.
23. Ruffin C.V., Longnion JK, Liu G, Won JH, **Drennan WR**, Rubinstein JT (2007). "The effect of channel-specific Hilbert phase randomization on speech perception in noise and complex tone frequency discrimination for cochlear implant users," Presented at the 2007 Conference on Implantable Auditory Prostheses, Lake Tahoe, CA.
24. Rubinstein JT, **Drennan W**, Nie K, Won JH, Dunn C, Witt S (2007). "Perception of music, speech and speech in noise: spectral and temporal contributions to performance," Presented at the 2007 Conference on Implantable Auditory Prostheses, Lake Tahoe, CA.
25. Kang R, Liu G, **Drennan W**, Longnion J, Yueh B, Rubinstein J (2007). "Development and validation of the University of Washington (UW) music test for cochlear implant users,"



- Presented at the Thirtieth Annual Midwinter Research Meeting of the Association for Research in Otolaryngology, Denver, CO.
26. Longnion J, Ruffin C, **Drennan W**, Rubinstein J (2007). "Discrimination of Schroeder-phase harmonic complexes by cochlear implant users," Presented at the Thirtieth Annual Midwinter Research Meeting of the Association for Research in Otolaryngology, Denver, CO.
  27. Ruffin C, Liu G, **Drennan W**, Won JH, Longnion J, Rubinstein J (2007). "Evidence for temporal fine structure encoding by cochlear implant subjects using envelope-modulated speech processing strategies," Presented at the Thirtieth Annual Midwinter Research Meeting of the Association for Research in Otolaryngology, Denver, CO.
  28. Won JH, **Drennan WR**, Rubinstein J (2007). "Spectral ripple resolution and speech perception in babble and speech-shaped noise by cochlear implant listeners," Presented at the Thirtieth Annual Midwinter Research Meeting of the Association for Research in Otolaryngology, Denver, CO.
  29. Ruffin CV, **Drennan WR**, Won JH, Rubinstein JT (2006). "Evidence for fine structure encoding by a cochlear implant user," Presented at the Twenty-ninth Annual Midwinter Research Meeting of the Association for Research in Otolaryngology, Baltimore, MD.
  30. **Drennan WR**, Won JH, Rubinstein JT (2005). "Effects of temporal fine-structure on the lateralization and the BMLD of spondees in babble and steady-state noise," Presented at the 2005 Conference on Implantable Auditory Prostheses, Pacific Grove, CA.
  31. **Drennan WR**, Pflugst BE (2005). "Spectral Profile Discrimination Ability in Cochlear Implant Users," Presented at the twenty-eighth midwinter meeting of the Association for Research in Otolaryngology, Daytona Beach, FL.
  32. **Drennan WR**, Pflugst BE (2004). "Spectral profile discrimination ability using cochlear implants: Effects of number of active electrodes and pulse rate", presented at the 75<sup>th</sup> anniversary meeting of the Acoustical Society of America, New York, NY.
  33. **Drennan WR**, Pflugst BE, Li X (2003). "Intensity discrimination using bipolar and monopolar electrode configurations in Nucleus ® Contour cochlear implants", presented at the 2003 Conference on Implantable Prostheses, Pacific Grove, CA.
  34. **Drennan WR**, Pflugst BE, Li X (2003). "Intensity discrimination using bipolar and monopolar electrode configurations in Nucleus ® Contour cochlear implants", presented at the 2003 Midwinter meeting of the ARO, Daytona Beach, FL.
  35. **Drennan WR**, Gatehouse S, Howell P, Van Tasell D, Lund S (2001). Localization and speech identification ability of hearing-impaired listeners using phase-preserving amplification. Presented at the 141st Meeting of the Acoustical Society of America, Chicago IL.
  36. **Drennan WR**, Gatehouse S, Lever C (1999). Perceptual segregation of competing speech sounds: the role of spatial location, *J. Acoust. Soc. Am.*, 106, 2207 (A).
  37. **Drennan WR**, Gatehouse S, Lever C (1999). Perceptual segregation of competing speech sounds: the role of spatial location. Presented at the meeting of the British Society of Audiology, Sept 1999.
  38. **Drennan WR** and Watson CS (1996). Discrimination of harmonic- and log-spaced profiles and of static and dynamic profiles by good and poor profile listeners, *J. Acoust. Soc. Am.* 99, 2565 (A).

39. Watson CS and **Drennan WR** (1995). Discrimination of static versus dynamic and log versus harmonic profiles, *J. Acoust. Soc. Am.* 97, 3272 (A).
40. Watson CS, Kidd GR, Surprenant AM, **Drennan WR** (1993) Properties of the structure of multi tone sequential patterns that determine the difficulty of perceptually isolating single target components, *J. Acoust. Soc. Am.* 93, 2315 (A).
41. Watson CS, Kidd GR, Surprenant AM **Drennan WR** (1993). Use of the psychophysical method of adjustment in tonal pattern discrimination, *J. Acoust. Soc. Am.* 93, 2315 (A).