

# CAITLIN SUSAN TENISON

Soar Technology, Inc.

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Citizenship: USA | Active Secret Clearance

## BIO

Dr. Caitlin Tenison has over 10 years' experience in Cognitive Neuroscience studying the neural underpinnings of higher-order cognition. Her research focuses on modeling the learning mechanisms and cognitive changes that underlie the acquisition of cognitive skill, by using a mixture of cognitive modeling, statistical modeling, and machine learning approaches. She has experience analyzing EEG, MEG, and fMRI brain imaging modalities both using traditional signal processing approaches and extending machine learning methods to detect latent cognitive states and cope with rich time-series data. Her work is characterized by the use of multi-modal data to provide convergent evidence of the state of an individual. More recently, her work has focused on expanding the scope to include diverse learner populations and using these results to develop technologies to support the learner.

**Keywords:** Cognitive Modeling, Skill Acquisition, Problem Solving, Science of Learning, Data-mining

## EMPLOYMENT

|               |  |
|---------------|--|
| 2017- Current | <b>Research Scientist</b><br><b>Soar Technology Inc</b> , Ann Arbor, MI<br>Principle Investigator on research projects spanning multiple DoD agencies. |
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## EDUCATION

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| 2016- 2017 | <b>Postdoctoral Researcher</b><br><b>Carnegie Mellon University</b> , Pittsburgh, PA<br><i>Supervisor:</i> Dr. John R. Anderson   |
| 2011- 2016 | <b>Ph.D. in Psychology</b><br><b>Carnegie Mellon University</b> , Pittsburgh, PA<br><i>Advisor:</i> Dr. John R. Anderson<br><i>Committee:</i> Dr. Robert Siegler & Dr. Marcel Just<br><i>Affiliations:</i> Program for Interdisciplinary Education Research,<br>Pittsburgh Science of Learning Center |
| 2005-2009  | <b>B.A. in Psychology and Plan II Honors</b><br><b>University of Texas</b> , Austin, TX<br>GPA 4.0 Cum Laude Ampla et Magna   |

## GRANTS and CONTRACTS

|                     |  |
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| 2019 - Present      | <b>Air Force STTR AF18B-T001 (\$149,869):</b> CogTracer Toolkit for identifying cognitive state from neuroimaging data (PI)  |
| 2018 - Present      | <b>Navy Broad Agency Announcement N6134016R0008 (\$194,614):</b> Navy Readiness for Expeditionary Surgery (PI)   |
| Sep 2018 - Apr 2019 | <b>Army SBIR A181-063 (\$99,995.):</b> Intelligent System Architecture for Autonomous Care: Trauma Diagnosis System (PI)   |
| Jun 2018 - Nov 2018 | <b>Office of Naval Research SBIR N181-076 (\$124,945)</b> Proficiency Amplified through Knowledge Sharing and Support for Informal Teaching (Co-PI with Dr. Kelly Neville)   |
| Feb 2018 - Aug 2018 | <b>Defense Health Agency STTR 17C-001 (\$149,848):</b> Griffon Test Suite for physiological data management and metric evaluation (PI)   |
| Mar 2017 - Present  | <b>Defense Advanced Research Projects Agency (DARPA) Phase 2 SBIR (\$996,680):</b> Rapid Configuration of Heterogeneous Models (Took over as PI after project start)   |
| Dec 2017 - Present  | <b>DARPA Phase 2 SBIR N13A-T024 (\$999,308):</b> Cognitive Bias in Online Communication Activity (Took over as PI after project start)   |
| 2014 - 2015         | <b>National Science Foundation, Science of Learning Centers. (\$100,000)</b> Award No. SMA-1430662. <i>Conference: A Proposal to the National Science Foundation for Support of the Seventh Annual Inter-Science of Learning Centers (iSLC) Student / Postdoctoral Scholar Conference.</i> (Co-Author with Chris MacLellan and Audrey Kittredge) |

## PUBLICATIONS

### Journal Articles

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Anderson, J. R., Borst, J. P., Fincham, J. M., Ghuman, A. S., **Tenison, C.**, & Zhang, Q. (2018). The Common Time Course of Memory Processes Revealed. *Psychological science*, 29(9), 1463-1474.

- Popov, V., Ostarek, M., & **Tenison**, C. (2018). Practices and pitfalls in inferring neural representations. *NeuroImage*, 174, 340-351.
- Tenison**, C., Fincham, J., & Anderson, J. (2016). Phases of learning: How skill acquisition impacts cognitive processing. *Cognitive Psychology*. 87,1-28.
- Jolles, D., Supekar, K., Richardson, J., **Tenison**, C., Ashkenazi, S., Rosenberg-Lee, M., Fuchs, L., & Menon, V. (2016). Reconfiguration of parietal circuits with cognitive tutoring in elementary school children. *Cortex*. 83, 231-245
- Jolles, D., Wassermann D., Chokani, R., Richardson, J., **Tenison**, C., Bammer, R., Supekar, K. Menon, V. (2016). Plasticity of left perisylvian white-matter tracts is associated with individual differences in math learning. *Brain Structure and Function*. 221(3), 1337-1351.
- Tenison**, C., & Anderson, J. (2015). Modeling the distinct phases of skill acquisition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 42(5), 749-767.
- Iuculano, T., Rosenberg-Lee, M., Richardson, J., **Tenison**, C., Fuchs, L., Supekar, K., & Menon, V. (2015). Cognitive tutoring induces widespread neuroplasticity and remediates brain function in children with mathematical learning disabilities. *Nature Communications*, 6.
- Tenison**, C., Fincham, J., & Anderson, J. (2014). Detecting math problem solving strategies. An investigation into the use of retrospective self-reports, latency and fMRI data. *Neuropsychologia*, 54, 41-52.
- Supekar, K., Swigart, A., **Tenison**, C., Jolles, D., Rosenberg-Lee, M., Fuchs, L., & Menon, V. (2013). Neural predictors of individual differences in response to math tutoring in primary-grade school children. *PNAS*. 11(20), 8230-8235.
- White, M. P., Shirer, W. R., Molfino, M. J., **Tenison**, C., Damoiseaux, J. S., & Greicius, M. D. (2013). Disordered reward processing and functional connectivity in trichotillomania: a pilot study. *Journal of Psychiatric Research*, 47(9), 1264-1272.
- Ashkenazi, S., Rosenberg-Lee, M., **Tenison**, C., & Menon, V. (2012). Weak task-related modulation and stimulus representations during arithmetic problem solving in children with developmental dyscalculia. *Developmental Cognitive Neuroscience*, 2(1), 152-166.

### Peer-Reviewed Conference Papers

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- Tenison**, C., & Anderson, J. (2017, July). *Impact of practice frequency on learning and retention*. Presented at the 39<sup>th</sup> Conference of the Cognitive Science Society, London, UK
- Popov, V., Ostarek, M. & Tenison**, C.(2017, July). *Inferential pitfalls in decoding neural representations*. Presented at the 39<sup>th</sup> Conference of the Cognitive Science Society, London, UK
- Tenison**, C. (2016, June). *Modeling the phases of skill acquisition*. Presented at the 4<sup>th</sup> annual Advances in Cognitive Systems: Students of Cognitive Systems Workshop, Evanston, IL.
- Tenison**, C., & MacLellan, C. J. (2015, June). *The Impact of Instructional Intervention and Practice on Help-Seeking Strategies within an ITS*. In Proceedings of the 8<sup>th</sup> International Conference on Educational Data Mining, Madrid, Spain.

- Tenison, C. & Anderson, J. (2014, July).** *Detecting Changes in Math Strategy During Learning.* In Proceedings of the 36<sup>th</sup> Conference of the Cognitive Science Society, Quebec City, Canada.
- Tenison, C., & MacLellan, C. J. (2014, June).** *Modeling Strategy Use in an Intelligent Tutoring System: Implications for Strategic Flexibility.* In Proceedings of the 12<sup>th</sup> International Intelligent Tutoring Systems, Honolulu, HI.
- Tenison, C., & Anderson, J. (2014, June).** *An Exploration of Two Methods for using fMRI to identify Student Problem Solving Strategies.* In Proceedings of Workshop "Utilizing EEG Input in Intelligent Tutoring Systems" at the 12<sup>th</sup> International Intelligent Tutoring Systems, Honolulu, HI.

### Conference Presentations

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- Tenison, C., & Anderson, J. (2016, August).** *From computation to automatization: How practice alters initial neural response to familiar arithmetic problems.* Presented at the 38<sup>th</sup> Conference of the Cognitive Science Society, Philadelphia, PA.
- Tenison, C., & Anderson, J. (2015, May).** *Exploring skill acquisition with cognitive and brain-based models.* Paper presented at the 8th annual Inter-Science of Learning Center Student and Post-Doc Conference, San Diego, CA.
- Tenison, C., & Anderson, J. (2013, June).** *Detecting math problem solving strategies using retrospective self-reports, latency, and fMRI data.* Presented at the Organization for Human Brain Mapping, Seattle, WA.
- Tenison, C., & Anderson, J. (2013, February).** *Assessing strategy use in a fMRI study of arithmetic training.* Presented at the Inter-Science of Learning Center Student and Post-Doc Conference, Philadelphia, PA.
- Rosenberg-Lee, M., Escovar, E., **Tenison, C.**, Khouzam, A., & Menon, V. (2012, October). *Dynamic changes in brain response and connectivity associated with arithmetic fact learning in children.* Presented at Society for Neuroscience, New Orleans, LA.
- Jolles, D., Rosenberg-Lee, M., Ashkenazi, S., Supekar, K., **Tenison, C.**, Duan, X., Uddin, L., Fuchs, L., & Menon, V. (2012, October). *Math training strengthens intrinsic connectivity of parietal cortex in children.* Presented at Society for Neuroscience, New Orleans, LA.
- Rosenberg-Lee, M., Escovar, E., **Tenison, C.**, Khouzam, A., & Menon, V. (2012, August). *How do children learn math facts?* Presented at EARLI SIG Neuroscience and Education, London, UK.
- Jolles, D., Rosenberg-Lee, M., Supekar, K., **Tenison, C.**, Ashkenazi, S., Duan, X., & Menon, V. (2012, August). *Math training changes intrinsic brain connectivity of the intraparietal sulcus.* Presented at EARLI SIG Neuroscience and Education, London, UK.
- Rosenberg-Lee, M., Young, C., **Tenison, C.**, Geary, D., & Menon, V. (2010, June). *Neural Correlates of Developmental Dyscalculia in Children: Univariate and Multivariate Analysis.* Presented at Human Brain Mapping Annual Meeting, Barcelona, SP.

Pacheco, J., Dailey, N., Olivares, M., **Tenison, C.**, & Schnyer, D. (2009, March) *An fMRI examination of the Effects of Aging on Memory Monitoring for Source and Item Recognition*. Presented at Cognitive Neuroscience Society Meeting, San Francisco, CA.

Trujillo, L., **Tenison, C.**, Dailey, D., & Schnyer, D. (2009, March). *An ERP Examination of the Differential Effects of Sleep Deprivation on Endogenously Cued and Exogenously Cued Attention*. Presented at Cognitive Neuroscience Society Meeting, San Francisco, CA.

Goldwater, M., Schnyer, D., Markman, A., Williams, V., **Tenison, C.**, & Dailey, N. (2008, April) *An Event Related Potential Analysis of Novel Denominal Verb Interpretation*. Presented at Cognitive Neuroscience Society Meeting, San Francisco, CA.

## Manuscripts in Progress

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**Tenison, C.**, Fincham, J., & Anderson, J. (In prep). From computation to automatization: How practice alters initial neural response to familiar arithmetic problems.

## RESEARCH EXPERIENCE

**2017-Present**

Intelligent Training Group

**Soar Technology Inc.**

Principle Investigator on 8 DoD funded projects. Wrote proposals, set scientific vision for projects, and led teams of engineers and scientists to successfully complete projects. Managed relationships with DoD program managers, subcontractors, and met contractual deliverables. Translated research advances into technology to solve problems faced by the modern warfighter.

**2011-2017**

ACT-R Laboratory

**Carnegie Mellon University**

Dr. John R. Anderson, Principal Investigator

Researching methods for modeling cognition by combining multiple sources of data with specific focus on detecting cognitive changes due to skill acquisition using brain and behavioral data

**2013-2015**

Interdisciplinary Independent Project

**Carnegie Mellon University**

Collaboration with Christopher MacLellan, PhD student

Developing a domain general data-mining technique that can identify strategy use and strategic flexibility using student interactions with intelligent tutoring system software

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|-----------|---|
| 2009-2011 | Stanford Cognitive and Systems Neuroscience Laboratory<br><b>Stanford University</b><br>Dr. Vinod Menon, Principal Investigator<br>Designed and conducted an NIH-funded study of the neural effects of math remediation on children with math learning disabilities   |
| 2008-2009 | Honors Program<br><b>University of Texas at Austin</b><br>Dr. Charles Holahan and Dr. David Schnyer, Advisors<br>Designed and implemented experiment investigating the interdependence between the neural networks of music and language through priming word recognition using familiar songs  |
| 2007-2009 | Schnyer Lab<br><b>University of Texas at Austin</b><br>Working with Dr. David Schnyer and Jennifer Pacheco<br>Studied the effects of aging on memory monitoring using fMRI<br><br>Working with Dr. David Schnyer and Dr. Logan Trujillo<br>Studied the differential effects of sleep deprivation on cued attention using Electrophysiology (EEG)<br><br>Working with Dr. David Schnyer and Micah Goldwater<br>Used EEG to study how people interpret and understand novel denominal verbs |

## SKILLS

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| Analysis Packages  | Matlab, R, and SPSS.   |
| Statistical Skills | Data mining techniques (e.g., hidden Markov modeling, linear discriminant analysis, principal components analysis), regression, hierarchical linear modeling, Bayesian modeling  |
| Research Methods   | Designing experiments, administering and scoring neuropsychological evaluations, working with participants between ages 7 – 80 years old, recruiting and scheduling subjects, cognitive task analysis, managing lab, overseeing and mentoring research assistants. Experience running studies in laboratory, classroom, and online environments. |

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| Brain Imaging<br>Methods | Collecting functional, structural and diffusion tensor imaging (DTI) scans using a G.E. 3.0-tesla MRI magnet<br>Collecting magnetoencephalography (MEG) data<br>Analyzing fMRI data using software packages: AFNI and FSL and SPM<br>Analyzing MEG data using MNE<br>72-channel electrophysiology (EEG) recording with the BioSemi System |
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## HONORS AND AWARDS

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| 2018      | <b>Speaker for Institute of Neuroscience Seminar Series</b><br><i>University of Oregon</i><br>Gave invited talk on my research.   |
| 2016      | <b>Conference Travel Grant</b><br><i>National Science Foundation</i><br>For attendance of the 4 <sup>th</sup> annual Advances in Cognitive Systems Conference   |
| 2016      | <b>Bobby Klatzky Graduate Student Publication Award</b><br><i>Carnegie Mellon University</i><br>Given annually for outstanding performance in scholarly research and writing.   |
| 2015      | <b>Latin American School for Education, Cognitive, and Neural Sciences</b><br><i>The James S. McDonnell Foundation</i><br>Selected to attend a two-week international meeting of students and faculty to discuss bridging between education and brain sciences. |
| 2015      | <b>Dick Hayes Graduate Student Service Award</b><br><i>Carnegie Mellon University</i><br>Given annually to the graduate student who contributes time and service to the department  |
| 2011      | <b>San Francisco Regional MENSA Scholarship</b><br><i>San Francisco Regional MENSA</i><br>Funding provided for attending graduate school  |
| 2008-2009 | <b>The Undergraduate Research Fellowship &amp; Undergraduate Honors Research Grant</b><br><i>University of Texas at Austin</i>  |

Provides research funding for undergraduate research projects

2005-2009

**Terry Scholar**

*University of Texas at Austin*

Full academic scholarship for four years of college

## SERVICE

2015-2016

**PIER Graduate Student Representative**

*Program for Interdisciplinary Education Research*

Represented the graduate students at the Steering Committee meetings

2013-2014

**Conference Organizer**

*Inter-Science of Learning Center Student and Postdoc Conference*

Organized and hosted the 7<sup>th</sup> Annual iSLC conference in Pittsburgh bringing together students from Science of Learning Centers from across the United States

2013-2014

**Organizer of Brain and Machine Learning Meetings**

*Collaboration between Psychology and Machine Learning*

Organized series of talks to foster dialogue between Machine Learning and Psychology Departments

2013-2014

**PIER Speaker Series Organizer**

*Program for Interdisciplinary Education Research*

Invited and organized guest speakers series

2012-2013

**President**

*Pittsburgh Science of Learning Center Student Group*

Organized meetings, professional development, and attended executive committee meetings as representative for graduate students of the PSLC

2011-2012

**Student Committee Member**

*Carnegie Mellon University - Human Computer Interaction Institute*

Involved in planning curricula and requirements for the Masters in Educational Technology and Applied Learning Science program