

# Matthijs (Matt) van der Meer

Associate Professor  
Department of Psychological & Brain Sciences

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## Professional appointments

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Associate Professor with tenure Department of Psychological and Brain Sciences, Dartmouth College	July 2020-
Assistant Professor Department of Psychological and Brain Sciences, Dartmouth College	Jan 2015-June 2020
Assistant Professor and Canada Research Chair Department of Biology, University of Waterloo, Canada	Sept 2010-Dec 2014
Post-doctoral associate (mentor: A. David Redish) Department of Neuroscience, University of Minnesota	2007-2010

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## Education

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Ph.D. in Neuroinformatics Neuroinformatics Doctoral Training Centre, University of Edinburgh, UK Thesis title: “Neural compass or epiphenomenon? Experimental and theoretical investigations into the rodent head-direction system”. Advisors: Mark van Rossum, Emma Wood; Examiners: Neil Burgess (University College London), Mayank Dutia (Edinburgh)	2003-2007
M.Sc. in Neuroinformatics ( <i>with distinction</i> ) Neuroinformatics Doctoral Training Centre, University of Edinburgh	2002-2003
M.Sc. in Informatics ( <i>with distinction</i> ) School of Informatics, University of Edinburgh	2001-2002
B.Sc. in Science ( <i>cum laude</i> ) University College Utrecht, the Netherlands	1998-2001

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## Profile

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*Research interests:* behavioral, systems & computational neuroscience – learning and using information about places, rewards, and ways to get there – reinforcement learning – oscillations – neural data analysis methods – “replay” in the hippocampus – reward signals in the ventral striatum (nucleus accumbens)

*Approaches:* recording of neural activity in behaving rodents – large ensembles and local field potentials from multiple brain structures – advanced neural data analysis – computational modeling – optogenetics – fiber photometry

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### Manuscripts in progress

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42. Carmichael JE, Yuen MM, van der Meer MA (*in revision*) Piriform cortex provides a dominant gamma LFP oscillation in the anterior limbic system. *bioRxiv*, doi:10.1101/861021

41. van der Meer MA, Gmaz JM, Carmichael JE (*revision invited*) A comprehensive characterization of rhythmic spiking activity in the rat ventral striatum. *Journal of Neuroscience & bioRxiv*, doi:10.1101/617233

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### Publications (h = 27, 3983 Google Scholar citations)

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40. Duvelle E, Grieves RM, van der Meer MA (2023) Temporal context and latent state inference in the hippocampal splitter signal. *eLife* 12:e82357

39. Liu AA, Henin S, Abbaspoor S, Bragin A, Buffalo EA, Farrell JS, Foster DJ, Frank LM, ..., van der Meer MA, ... and Buzsáki G (2022) A consensus statement on detection of hippocampal sharp wave ripples and differentiation from other fast oscillations. *Nature Communications* 13(1):1-4

38. Gmaz JM, van der Meer MA (2022) Context coding in the mouse nucleus accumbens modulates motivationally relevant information. *PLoS Biology* 20(4): e3001338

37. Chen H, Manning JR, van der Meer MA (2021) Between-subject prediction reveals a shared representational geometry in the rodent hippocampus. *Current Biology* 31(19):4293-4304

\*Featured in a [Dispatch](#) by Stella & Treves, “Hyper-alignment: Great mice think alike”, *Current Biology* 31(19): 1138-R1140

36. Donnarumma F, Pevete R, Maisto D, Fuscone S, Irvine EM, van der Meer MA, Kemere C, Pezzulo G (2021). A framework to identify structured behavioral patterns within rodent spatial trajectories. *Scientific Reports* 11(1):1-20.

35. van der Meer MA, Kemere C, Diba K (2020) The next wave of replay: progress and issues in second-order analyses of hippocampal sequences. *Proceedings of the Royal Society B* 375:20190238.

34. Crego AC, Carmichael JE, van der Meer MA, Smith KS (2020) Complementary Control over Habits and Behavioral Vigor by Phasic Activity in the Dorsolateral Striatum. *Journal of Neuroscience* 40(10):2139-2153.

33. Carey AA, Tanaka Y, van der Meer MA (2019) Reward revaluation biases hippocampal sequence content away from the preferred outcome. *Nature Neuroscience* 22, 1450–1459

32. Gmaz JM, Carmichael JE, van der Meer MA (2018) Persistent coding of outcome-predictive cue features in the rat nucleus accumbens. *eLife* 7:e37275

31. Carmichael JE, Gmaz JM, van der Meer MA (2017) Gamma oscillations in the rat ventral striatum originate in the piriform cortex. *Journal of Neuroscience* 37(33):7962-7974  
\*Highlighted in [eNeuro editorial](#), Dec 2017
30. Riaz S, Schumacher A, Sivagurunathan S, van der Meer MA, Ito R (2017) Ventral, but not dorsal hippocampus inactivation impairs reward context memory expression and retrieval. *Hippocampus* 27(7):822-836
29. Butler WN, Smith KS, van der Meer MA, Taube JS (2017) The head direction signal plays a functional role as a neural compass during navigation. *Current Biology* 27(9):1259-1267
28. Pezzulo G, Kemere C, van der Meer MA (2017) Internally generated hippocampal sequences as a vantage point to probe future-oriented forms of cognition. *Annals of the New York Academy of Sciences* 1396: 144-165
27. van der Meer MA, Carey AA, Tanaka Y (2017) Optimizing for generalization in the decoding of internally generated activity in the hippocampus. *Hippocampus* 27(5):580-595
26. Hassani SA, Oemisch M, Balcarras M, Westendorff S, Ardid S, van der Meer MA, Tiesinga P, Womelsdorf T (2017) Alpha-2A noradrenergic agonist Guanfacine improves reinforcement learning during feature-based reversal performance: A nonhuman primate case study. *Scientific Reports* 7:40606
25. Catanese J, Carmichael JE, van der Meer MA (2016) Low and high gamma oscillations deviate in opposite directions from zero phase synchrony in the limbic corticostriatal loop. *Journal of Neurophysiology* 116(1): 5-17
24. Malhotra S, Cross RW, Zhang A, van der Meer MA (2015) Ventral striatal gamma oscillations are highly variable from trial to trial, dominated by behavioral state, and only weakly influenced by outcome value. *European Journal of Neuroscience* 42(10): 2818–2832
23. Pezzulo G, van der Meer MA, Lansink CS, Pennartz CMA (2014) Internally generated sequences in learning and executing goal-directed behavior. *Trends in Cognitive Sciences* 18(12): 647-657
22. van der Meer MA, Ito R, Lansink CS, Pennartz CMA (2014) Hippocampal projections to the ventral striatum: from spatial memory to motivated behavior. *Invited Contribution for "Space, Time & Memory in the Hippocampal Formation" (Knierim JJ and Derdikman D, eds.), Springer.*
21. Caze R, van der Meer MA (2013) Adaptive properties of differential learning rates for positive and negative outcomes. *Biological Cybernetics* 107(6): 711-719
20. Catanese J, van der Meer MA (2013) A network state linking motivation and action in the nucleus accumbens (Invited *Preview* of McGinty et al.) *Neuron* 78(5): 753-754
19. Ogawa M, van der Meer MA, Esber GR, Cerri DH, Stalnaker TA, Schoenbaum G (2013) Risk-responsive orbitofrontal neurons signal acquired salience. *Neuron* 77(2): 251-8
18. van der Meer MA, Kurth-Nelson Z, Redish AD (2012) Information processing in decision-making systems. *The Neuroscientist* 18 (4): 342-359

17. Gupta AS, van der Meer MA, Touretzky DS, Redish AD (2012) Segmentation of spatial experience by hippocampal theta sequences. *Nature Neuroscience* 15: 1032-1039
16. Malhotra S, Cross RW, van der Meer MA (2012) Theta phase precession beyond the hippocampus. *Reviews in the Neurosciences* 23(1): 39-65
15. van der Meer MA, Redish AD (2011) Ventral striatum: a critical look at models of learning and evaluation. *Current Opinion in Neurobiology* 21(3): 387-92
14. van der Meer MA, Redish AD (2011) Theta phase precession in rat ventral striatum links place and reward information. *Journal of Neuroscience* 31(8): 2843-2854
13. van der Meer MA, Johnson A, Schmitzer-Torbert NC, Redish AD (2010) Triple dissociation of information processing in dorsal striatum, ventral striatum, and hippocampus on a learned spatial decision task. *Neuron* 67(1): 25-32
12. van der Meer MA, Kalenscher T, Lansink CS, Pennartz CMA, Berke JD, Redish AD (2010) Integrating early results on ventral striatal gamma oscillations in the rat. *Frontiers in Neuroscience* 15(4): 300
11. van der Meer MA, Redish AD (2010) Expectancies in decision making, reinforcement learning, and ventral striatum. *Frontiers in Neuroscience* 15(4): 6
10. Gupta AS, van der Meer MA, Touretzky DS, Redish AD (2010) Hippocampal replay is not a simple function of experience. *Neuron* 65(5): 695-705  
 \*Spotlighted in a Preview by Derdikman and Moser, *Neuron* 65(5):582-584  
 \*Evaluated “Must Read” on *Faculty of 1000*, [www.f1000.com](http://www.f1000.com)
9. van der Meer MA, Richmond Z, Braga RM, Wood ER, Dudchenko PA (2010) Evidence for the use of an internal sense of direction in homing. *Behavioral Neuroscience* 124(1): 164-169
8. Pennartz CMA, Berke JD, Graybiel AM, Ito R, Lansink CS, van der Meer MA, Redish AD, Smith K, Voorn P (2009) Corticostriatal interactions during learning, memory processing and decision-making. *Journal of Neuroscience* 29: 12831-12838
7. van der Meer MA, Redish AD (2009b) Low and high gamma oscillations in rat ventral striatum have distinct relationships to behavior, reward, and spiking activity on a learned spatial decision task. *Frontiers in Integrative Neuroscience* 3(9): doi:10.3389/neuro.07.009.2009  
 \*Selected for *Focused Review* in *Frontiers in Neuroscience*.
6. van der Meer MA, Redish AD (2009a) Covert expectation-of-reward in rat ventral striatum at decision points. *Frontiers in Integrative Neuroscience* 3(1): doi:10.3389/neuro.07.001.2009.  
 \*Selected for *Focused Review* in *Frontiers in Neuroscience*.
5. Johnson A, van der Meer MA, Redish AD (2008) Integrating hippocampus and striatum in decision-making. *Current Opinion in Neurobiology* 17(6): 692-7
4. van Rossum MC, van der Meer MA, Xiao D, Oram MW (2008) A model for adaptive integration in the visual cortex by depressing recurrent cortical circuits. *Neural Computation* 20(7): 1847-72

3. van der Meer MA, Knierim JJ, Doreswamy Y, Wood ER, van Rossum MC (2007) Anticipation in the rodent head direction cell system can be explained by an interaction of head movements and vestibular firing properties. *Journal of Neurophysiology* 98: 1883-97
2. Ainge JA, van der Meer MA, Langston RF, Wood ER (2007) Exploring the role of context-dependent hippocampal activity in spatial alternation behavior. *Hippocampus* 17(10): 988-1002
1. van der Meer MA, van Atteveldt WH, Coopmans PH, Philip WC (2001) Subject-Object asymmetry in Dutch children's comprehension of wie-questions. *Linguistics in the Netherlands* 18(1): 167-176

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### Recent conference abstracts

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5. Gmaz JM, Carmichael JE, van der Meer MA (2019) Dynamic spike-field relationships in the rat nucleus accumbens. *Society for Neuroscience Abstracts*.
4. Carmichael JE, van der Meer MA (2019) A physiological basis for communication through coherence in the rodent striatum. *Society for Neuroscience Abstracts*.
3. van der Meer MA, Gmaz JM, Carmichael JE (2019) A comprehensive characterization of rhythmic spiking activity in the rat ventral striatum. *Society for Neuroscience Abstracts*.
2. Chen H, Manning JR, van der Meer MA (2019) Shared representational geometry as an explanation for cross-subject prediction of place cell data from the rodent hippocampus. *Society for Neuroscience Abstracts*.
1. Chen H, Manning JR, van der Meer MA (2019) Between-subject prediction reveals a shared representational geometry in the rodent hippocampus. *CoSyNe 2019*.  
\*Rated in top 6% of abstracts in a pool of over 1000 submissions.

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### Research Support

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(role: PI unless stated otherwise)

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|---|--------------|------------------|
| NIH R01 MH123466  | \$1,558,000  | 2020-2025 (June) |
| “Biases in sharp wave-ripple content as a transdiagnostic cognitive process”                            |              |                  |
| NSF CAREER IOS-1844935  | \$700,000    | 2019-2024 (May)  |
| “Content and function of hippocampal replay”  |              |                  |
| NIH UF1 (BRAIN initiative TeamBCP grant NS111695)   | \$2,987,137* | 2019-2022 (Apr)  |
| “A neural systems approach to understanding the dynamic computations underlying our sense of direction” |              |                  |
| Role: co-PI (with Jeffrey Taube, co-PI, and 3 co-Is)  |              |                  |
| (*distributed across 5 labs)  |              |                  |
| NIH R24 (MH117295, PIs: Ghosh, MIT; Halchenko, Dartmouth)   | \$1,349,674* | 2019-2022 (Jul)  |
| “DANDI: distributed archives for neurophysiology data integration”                                      |              |                  |
| Role: co-I (1 month/yr effort)  |              |                  |

*(\*distributed across 3 labs)*

*(completed)*

Whitehall Foundation “Neural Mechanisms Underlying Occasion-Setting Behavior”	\$225,000	2017-2020 (Sep)
HFSP Young Investigator Grant Collaboration with Dr. Caleb Kemere and Dr. Giovanni Pezzulo <i>(*\$350,000 allocated to each team member)</i>	\$1,050,000*	2014-2018 (Oct)
Templeton Foundation Science of Prospection Award	\$140,000	2014-2016
Ontario Early Researcher Award <i>(*Original award amount; returned because of move to USA)</i>	\$150,000*	2014
Discovery Grant National Science and Engineering Research Council (NSERC)	\$160,000	2012-2014
Canada Research Chair (Tier II, NSERC) <i>(*Used for salary support)</i>	\$500,000*	2011-2014
Canada Foundation for Innovation (CFI)	\$50,000	2011
Ontario Research Fund (ORF) Research Infrastructure	\$50,000	2012
“VENI” Innovational Research Incentive, Netherlands Organisation for Scientific Research (NWO) <i>(*Original award amount; reduced to ~€80,000 following move to Canada)</i>	€250,000*	2011-2014

### Teaching

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Department of Psychological & Brain Sciences, Dartmouth College:  
*(parentheses indicate number of times taught)*

PSYC81, Animal Cognition (new course)	Winter 2018-present (4x)
PSYC50, The Rhythmic Brain (new course)	Winter 2015-present (4x)
PSYC36, Systems Neuroscience with Lab	Fall 2015-present (5x)
PSYC175*, Current Issues in Behavioral Neuroscience	Fall 2016-present (2x)
PSYC179*, Analysis of Neural data (new course)	Winter 2016 (1x)

Department of Biology, University of Waterloo:

BIOL 377, Systems Neuroscience (new course)	Winter 2012-2014 (3x)
BIOL 678*, Current Topics in Neurophysiology	Fall 2011-2013 (2x)
BIOL 680*, Data Analysis for Neuroscience (new course)	Fall 2013-2014 (2x)

*(\*denotes graduate course)*

Co-director, Methods in Neuroscience at Dartmouth summer school 2017-present

(with Luke Chang and Jeremy Manning)

<https://mindsummerschool.org/>

Neural Systems & Behavior Summer course, faculty and module leader (2018-)	2014-present
Marine Biological Laboratory, Woods Hole, MA	
<a href="https://www.mbl.edu/nsb/">https://www.mbl.edu/nsb/</a>	
Course tutor	2009-2010
Okinawa Computational Neuroscience Course, Okinawa Institute for Science and Technology, Japan ( <a href="http://www.irlp.oist.jp/ocnc/2010/">http://www.irlp.oist.jp/ocnc/2010/</a> )	

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### Trainees mentored

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Post-doctoral:

Jeffrey Stott	2019-present
Eleonore Duvelle	2020-present
Julien Catanese ( <i>*FYSSSEN foundation fellowship award, France</i> )	2012-2014

Graduate:

Catherine Holland (PhD, co-advised with Jonathan Phillips)	2020-present
Manish Mohapatra (PhD)	2019-present
Hung-Tu Chen (PhD)	2018-present
Emily Irvine (PhD)	2015-2021
Jimmie Gmaz (PhD)	2014-2021
Youki Tanaka (MSc)	2015-2019
Eric Carmichael (PhD, now post-doc with Sylvain Williams, McGill)	2013-2019
Alyssa Carey, Biology, University of Waterloo (MSc)	2013-2015
Rob Cross, Biology, University of Waterloo (MSc)	2011-2013
Sushant Malhotra, Systems Design Engineering, Waterloo (MAsc)	2011-2013
Yan Wu, Systems Design Engineering, Waterloo (MSc; joint w/C. Eliasmith)	2010-2012

Undergraduate:

5 Senior thesis students, 6 WISP students, 2 Independent Studies students	2016-present
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*at Waterloo:*

7 full-time/single-term research assistants (NSERC USRA awards)	2011-2014
11 Honours thesis students (BIOL 499)	2011-2014

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### Invited talks, workshops (2012-present)

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46. Department of Psychology, University of Chicago	2021
45. Computational Cognitive Neuroscience workshop "Do grid codes afford generalization and flexible decision-making?"	2020
44. Department of Biology, University of Texas San Antonio	2020
43. Bridging Replay and Reactivation SfN satellite conference, Chicago, IL	2019

42. Spring Hippocampal Research Conference, Taormina, Italy	2019
41. Kavli workshop on Convergent Science of Mind and Brain, Woods Hole, MA	2019
40. EMBO Probing Neural Dynamics conference, Heidelberg	2019
39. Quantitative Life Sciences seminar series, McGill University	2019
38. Department of Neuroscience, University of Florida	2018
37. CoSyNe workshop, “Model-based cognition: Hierarchical reasoning and sequential planning”	2018
36. Winter Conference on Learning & Memory, Park City, UT	2018
35. Department of Neuroscience, Brown University	2017
34. Department of Psychology, University of Vermont	2017
33. Department of Psychology seminar series, Cornell University	2017
32. Kavli workshop on Convergent Science of Mind and Brain, Woods Hole, MA	2017
31. Spring Hippocampal Research Conference, Taormina, Italy	2017
30. Division of Neuroscience seminar, University of Dundee, UK	2017
29. Winter Conference on Brain Research (WCBR), Big Sky, Montana (panel co-chair)	2017
28. Donders Institute for Brain, Cognition, and Behavior, Nijmegen, Netherlands	2016
27. Université Pierre et Marie Curie, Paris, France	2016
26. Department of Psychology seminar series, Harvard University	2016
25. 1st Interdisciplinary Navigation Symposium, Bad Gastein, Austria	2016
24. International Neuropsychological Symposium (INS), Baiona, Spain	2016
23. Current Works in Behavior, Genetics, and Neuroscience seminar series, Yale Univ.	2016
22. SUNY Downstate Medical Center seminar series	2016
21. Department of Psychology seminar series, University of Michigan	2015
20. “Memory in action: The role(s) of the hippocampus in decisions for reward,” workshop, <i>CoSyNe</i> 2015	2015
19. Institut für Theoretische Biologie (ITB) and BCCN, Berlin, Germany	2014
18. Vespucci Institute “Brain and Space” meeting, Lisbon, Portugal	2014
17. Canadian Association for Neuroscience Annual Meeting, Montreal	2014
16. School of Informatics, Edinburgh, UK	2014
15. Psychological and Brain Sciences seminar series, Dartmouth College, NH	2013
14. Psychology & Neuroscience Seminar, Dalhousie University, Halifax, NS	2013
13. Neuroscience and Applied Cognitive Science seminar series, University of Guelph	2013
12. Donders Institute for Brain, Cognition, and Behavior, Nijmegen, Netherlands	2013
11. Neuroscience seminar series, Technion, Haifa, Israel	2013
10. Southern Ontario Neuroscience Association (SONA) annual meeting, Waterloo, ON	2013
9. Spring Hippocampal Research Conference, Taormina, Italy	2013
8. Department of Psychology seminar series, McMaster University, Hamilton, ON	2013
7. FieldTrip workshop, York University, Toronto, ON	2013
6. Participant, Cognitive Neuroscience workshop, Mathematical Biosciences Institute, Columbus, OH	2012
5. Douglas Institute for Mental Health, Montréal, QC	2012
4. Rotman Research Institute/Baycrest Hospital Rounds, Toronto, ON	2012
3. INCF Canadian Neuroinformatics Workshop, Vancouver, BC	2012
2. Swammerdam Institute for Life Sciences, University of Amsterdam, Netherlands	2012
1. Brain and Behaviour Seminar Series, University of Toronto, ON	2012

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**Service (external)**

Panel member, NIH: F01B study section

2021-current



Panel member, NIH: “Assays of Circuit Engagement” 2019

Panel member, National Science Foundation: “IOS: Modulation” and “NeuroNex” 2016-present

Evaluation Committee member, Agence Nationale de Recherche, France 2015-2016

Associate Editor, Circuits/Systems section, *Journal of Neuroscience* 2014-2019

Ad hoc manuscript reviewer for *Journal of Neurophysiology*, *Nature Neuroscience*, *Frontiers in Neuroscience*, *Neuron*, *Behavioral Brain Research*, *Hippocampus*, *Neuropsychopharmacology*, *Biological Psychiatry*, *Neuroscience*, *Cerebral Cortex*, *Behavioral Processes*, *Nature*, *Journal of Neuroscience* (\*Top Reviewer 2013), *PNAS*, *Nature Communications*, *Biological Cybernetics*, *eLife* (\*also Guest Editor), *Neurobiology of Aging*, *PLoS Computational Biology*, *PLoS Biology*, *Trends in Neurosciences*, *Behavioral Neuroscience*, *European Journal of Neuroscience*, *Philosophical Transactions of the Royal Society B*, *Journal of Experimental Psychology: Learning, Memory and Cognition*, *Neural Computation*, *Adaptive Behavior*, *Current Opinion in Neurobiology*, *eNeuro*, *Neural Networks*

Ad hoc grant application reviewer for *Natural Sciences and Engineering Research Council (NSERC, Canada)*, *Agence Nationale de Recherche (ANR, France)*, *Wellcome Trust (UK)*, *Netherlands Organisation for Scientific Research (NWO)*, *Human Frontiers Science Project*

External examiner for 5 PhD theses: Department of Psychology, McMaster University (2012); Department of Computer Science, Dalhousie University (2013); Institut for Theoretische Biologie, Humboldt Universitat Berlin, Germany (2014); Department of Psychology, University of Waterloo (2018), Department of Psychology, Brandeis University (2020)

Co-organizer, EMBO Symposium “Probing Neural Dynamics with Behavioral Genetics” (Heidelberg, Apr 2019; with Laure Rondi-Reig and Freek Hoebeek)

*Keynote speakers: Susumu Tonegawa, Carl Petersen, Dora Angelaki*

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#### Service (internal)

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Member, Integrative Neuroscience at Dartmouth (IND) Curriculum Committee 2021

Member, Neuroscience Council 2015-2018

Departmental faculty search committees (2)

Chair, Departmental Neuroscience Committee Fall 2020-present

Member, Departmental Neuroscience Committee 2018-present

Member, Departmental Graduate Committee 2016-2018

Member, Departmental Undergraduate Committee 2015-2016

Last updated March 31, 2022