

Curriculum Vitae and significant publications

Michael J. Frank

University Address:
Brown University
190 Thayer St Box 1821
Providence RI 02912-1821
Michael_Frank@brown.edu
<http://ski.clps.brown.edu>

Home Address:
114 Morris Ave
Providence, RI 02906

Employment:

July 2022—present	Professor of Brain Science, <i>Brown University</i>
July 2020 – present	Director, Carney Center for Computational Brain Science, <i>Brown University</i>
July 2018 – present	Edgar L. Marston Professor of Cognitive and Psychological Sciences
July 2016 – present	Professor, Cognitive & Psychological Sciences, Carney Institute for Brain Science, <i>Brown University</i>
July 2011 – June 2016	Associate Professor, Dept of Cognitive, Linguistic & Psychological Sciences, Brown Institute for Brain Science, <i>Brown University</i>
Jan 2009 – June 2011	Assistant Professor, Dept of Cognitive, Linguistic & Psychological Sciences, Brown Institute for Brain Science, <i>Brown University</i>
Jan 2006 – Dec 2008	Assistant Professor, Dept of Psychology, Program in Neuroscience, Cognitive Science Program, <i>University of Arizona</i>

Degrees:

Ph.D., Neuroscience & Psychology (joint), University of Colorado at Boulder, 2004
Thesis: "Dynamic Dopamine Modulation of Striato-Cortical Circuits in Cognition."
Randall C. O'Reilly advisor.
M.S., Electrical Engineering (biomedicine), University of Colorado at Boulder, 2000
B.Sc., Electrical Engineering, Queen's University, Canada, 1997

Research Interests:

Computational modeling of neural mechanisms underlying decision making, reinforcement learning, and cognitive control. I develop neural network and mathematical models across scales and levels of abstraction. At the neural level, I focus on interactions between basal ganglia, frontal cortex, and hippocampus, and their modulation by dopamine and other neuromodulators. I test theoretical model predictions using cognitive paradigms in tandem with various neural measurements and manipulations across species, which are used to iteratively refine and improve models.

Awards and Honors:

- National Academy of Sciences Troland Research Award, 2021
- Kavli Science Fellow, 2016
- Radboud Excellence Professorship, 2015, for “eminent researchers who have had a significant impact in their discipline and beyond” Radboud University Nijmegen, The Netherlands
- Fellow, Association for Psychological Science, 2012
- Cognitive Neuroscience Society Young Investigator Award, 2011
- Janet T Spence Award for Transformative Early Career Contributions, APS, 2010
- Neural Networks journal award for most cited article between 2006-2010
- D.G. Marquis Behavioral Neuroscience Award, best paper in Behavioral Neuroscience, 2006
- Dozier Award for outstanding scholarly record, University of Colorado, 2004
- Natural Sciences & Engineering Research Council graduate scholarship (Canada)

Significant Publications (Full publication list at end of document)

- Russin, J.L., Pavlick, E., & Frank, M.J. (2025). Parallel tradeoffs in human cognition and neural networks: the dynamic interplay between in-context and in-weight learning. *PNAS* 122: e2510270122
- Frank, M.J. (2025). Adaptive cost-benefit control fueled by striatal dopamine. *Ann Rev Neurosci* 48:1-22.
- Pagnier, G., Asaad, W.F. & Frank, M.J. (2024). Double dissociation of dopamine and subthalamic nucleus stimulation on effortful cost/benefit decision making. *Current Biology* 34, 665-660.
- Jaskir, A. & Frank, M.J. (2023). On the normative advantages of dopamine and striatal opponency for learning and choice. *eLife* 12:e85107
- Liu, R.G. & Frank, M.J. (2022). Hierarchical clustering optimizes the tradeoff between compositionality and expressivity of task structures for flexible reinforcement learning. *Artificial Intelligence* 312, 103770
- Scott, D. & Frank, M.J. (2023). Adaptive control of synaptic plasticity integrates micro- and macroscopic network function. *Neuropsychopharmacology* 48, 121–144
- Hamid, A., Frank, M.J.* & Moore, C.I.* (2021). Wave-like dopamine dynamics as a mechanism for spatiotemporal credit assignment. *Cell* 184, 2733-49 *co-senior authors; alphabetical order
- Fengler, A., Govindarajan, L., Chen, T. & Frank, M.J. (2021). Likelihood approximation networks (LANs) for fast inference of simulation models in cognitive neuroscience. *eLife* 10:e65074
- Westbrook, J.A., ..., Cools, R.* & Frank, M.J.* (2020). Dopamine promotes cognitive effort by biasing the benefits versus costs of cognitive work. *Science*, 367, 1362-1366. *co-senior authors
- Collins, A.G.E. & Frank, M.J. (2018). Within and across-trial dynamics of human EEG reveal cooperative interplay between reinforcement learning and working memory. *Proceedings of the National Academy of Sciences* 115, 2502-2507
- Nassar, M.R., Helmers, J. & Frank, M.J. (2018). Chunking as a rational strategy for lossy data compression in visual working memory. *Psychological Review* 125, 486-511.
- Collins, A.G.E., Albrecht, M.A., Waltz, J.A., Gold, J.M., & Frank, M.J. (2017). Interactions between working memory, reinforcement learning and effort in value-based choice: a new paradigm and selective deficits in schizophrenia. *Biological Psychiatry* 82, 431-439.
- Maia, T.V. & Frank, M.J. (2017). An integrative perspective on the role of dopamine in schizophrenia. *Biological Psychiatry* 81(1):52-66
- Huys, Q., Maia, T.V., & Frank, M.J. (2016). Computational psychiatry as a bridge between neuroscience and clinical applications. *Nature Neuroscience* 19, 404-413.
- Doll, B., ..., & Frank, M.J. (2016). Variability in dopamine genes dissociates model-based and model-free reinforcement learning. *Journal of Neuroscience* 36,1211-1222.
- Franklin, N.T. & Frank, M.J. (2015). A cholinergic feedback circuit to regulate striatal population uncertainty and optimize reinforcement learning. *eLife* 4:e12029.
- Frank, M.J., et al. (2015). fMRI and EEG predictors of dynamic decision parameters during human reinforcement learning. *Journal of Neuroscience*, 35, 485-494
- Cox, S.M.L., Frank, M.J., et al (2015). Striatal D1 and D2 signaling differentially predict learning from positive and negative outcomes, *NeuroImage* 109, 95-101
- Wiecki, T.V., Poland, J.S., & Frank, M.J. (2015). Model-based cognitive neuroscience approaches to computational psychiatry: clustering and classification. *Clinical Psychological Science* 3, 378-399.
- Cockburn, J., Collins, A.G.E. & Frank, M.J. (2014). A reinforcement learning mechanism responsible for the valuation of free choice. *Neuron* 83, 551-557
- Collins, A. & Frank, M.J. (2014). Opponent actor learning (OpAL): Modeling interactive effects of striatal dopamine on reinforcement learning and choice incentive. *Psychological Review* 121, 337-66
- Cavanagh, J.F. & Frank, M.J. (2014). Frontal theta as a mechanism for cognitive control. *Trends in Cognitive Sciences* 18, 414-421.
- Cavanagh, J.F., ... & Frank, M.J. (2014). Eye tracking and pupillometry are indicators of dissociable latent decision processes. *J Exp Psych: General* 143, 1476-1488
- Wiecki TV, Sofer I & Frank MJ (2013). HDDM: Hierarchical Bayesian estimation of the Drift-Diffusion Model in Python. *Frontiers of Neuroinformatics* 7:14
- Collins, A.G.E & Frank, M.J. (2013). Cognitive control over learning: Creating, clustering and generalizing task-set structure. *Psychological Review*, 120, 190-229.
- Wiecki, T.V. & Frank, M.J. (2013). A computational model of inhibitory control in frontal cortex and basal ganglia. *Psychological Review*, 120, 329-355.

- Gold, J.M., ..., & Frank, M.J. (2013). Negative symptoms in schizophrenia are associated with abnormal effort-cost computations. *Biological Psychiatry*, 74, 130-136
- Beeler, J. A*, Frank, M.J*, et al. (2012). A role for dopamine-mediated learning in the pathophysiology and treatment of Parkinson's disease. *Cell Reports* 2, 1747-1761. *joint 1st
- Badre, D., Doll, B.B., Long, N.M. & Frank, M.J. (2012). Rostrolateral prefrontal cortex and individual differences in uncertainty-driven exploration. *Neuron* 73, 595-607.
- Ratcliff, R. & Frank, M.J. (2012). Reinforcement-based decision-making in corticostriatal circuits: Mutual constraints by neurocomputational and diffusion models. *Neural Computation* 24, 1186-1229.
- Frank, M.J. & Badre, D. (2012). Mechanisms of hierarchical reinforcement learning in corticostriatal circuits I,II*. *Cerebral Cortex* 22, 509-526. (companion computational and fMRI papers)
- Gold, J.M., Waltz, J.A., ..., & Frank, M.J. (2012). Negative symptoms and the failure to represent the expected reward value of actions: Behavioral and computational modeling evidence. *Archives of General Psychiatry* 69, 129-138.
- Cavanagh J.F., Wiecki, T.V., ..., & Frank, M.J. (2011). Subthalamic stimulation reverses mediofrontal influence over decision threshold. *Nature Neuroscience* 14, 1462-67.
- Frank, M.J. (2011). Computational models of motivated action selection in corticostriatal circuits. *Current Opinion in Neurobiology* 21, 381-386.
- Doll, B.B., Hutchison, K.E. & Frank, M.J. (2011). Dopaminergic genes predict individual differences in susceptibility to confirmation bias. *Journal of Neuroscience* 31, 6188-6198.
- Maia, T.V. & Frank, M.J. (2011). From reinforcement learning models to psychiatric and neurological disorders. *Nature Neuroscience* 14, 154-162.
- Strauss, G.P.*, Frank, M.J.* et al. (2011). Deficits in positive reinforcement learning and uncertainty-driven exploration are associated with distinct aspects of negative symptoms in schizophrenia. *Biological Psychiatry* 69, 424-31 (*equal contribution)
- Frank, M.J. & Fossella, J.A. (2011). Neurogenetics and pharmacology of learning, motivation and cognition. *Neuropsychopharmacology Reviews* 36, 133-152.
- Frank, M.J., et al. (2009). Prefrontal and striatal dopaminergic genes predict individual differences in exploration and exploitation. *Nature Neuroscience* 12:1062-1068.
- Frank, M.J., Cohen, M.X. & Sanfey, A.G. (2009). Multiple systems in decision making: A neurocomputational perspective. *Current Directions in Psychological Science*, 18, 73-77.
- Frank, M.J. et al. (2007). Hold your horses: Impulsivity, deep brain stimulation and medication in Parkinsonism. *Science*, 318, 1309-1312.
- Frank, M.J., Moustafa, A.A., Haughey, H.C., Curran, T. And Hutchison, K. (2007). Genetic triple dissociation reveals multiple roles for dopamine in reinforcement learning. *Proceedings of the National Academy of Sciences*, 104, 16311-16316.
- Frank, M.J., Santamaria, A., O'Reilly, R.C. and Willcutt, E. G. (2007). Testing computational models of dopamine and noradrenaline dysfunction in attention-deficit/hyperactivity disorder. *Neuropsychopharmacology*, 32, 1583-99.
- Frank, M.J., Scheres, A. & Sherman, S.J. (2007). Understanding decision making deficits in neurological conditions: Insights from models of natural action selection. *Philosophical Transactions of the Royal Society-B*, 362, 1641-54.
- Frank, M.J. (2006). Hold your horses: A dynamic computational role for the subthalamic nucleus in decision making. *Neural Networks*, 19, 1120-1136
- Frank, M.J. and Claus, E. (2006). Anatomy of a decision: Striato-Orbitofrontal interactions in reinforcement learning, decision making and reversal. *Psychological Review*, 113, 300-326.
- Frank, M.J. and O'Reilly, R.C. (2006). A mechanistic account of striatal dopamine function in cognition: Psychopharmacological studies with cabergoline and haloperidol. *Behav Neurosci*
- O'Reilly, R.C. & Frank, M.J. (2006). Making working memory work: A computational model of learning in the frontal cortex and basal ganglia. *Neural Computation*, 18, 283-328.
- Frank, M.J. (2005). Dynamic dopamine modulation in the basal ganglia: A neurocomputational account of cognitive deficits in medicated and nonmedicated Parkinsonism. *J Cog Neurosci*, 17, 51-72.
- Frank, M.J., Woroch, B.S. & Curran, T. (2005). Error related negativity predicts reinforcement learning and conflict biases. *Neuron*, 47, 495-501.
- Frank, M.J., Seeberger, L.C. & O'Reilly, R.C. (2004). By carrot or by stick: Cognitive reinforcement learning in Parkinsonism. *Science*, 306, 1940-3

Grants (Current)

- *Computational Cognitive Neuroscience Framework for Attentional Control Traits and States*
ONR MURI Award N00014-23-1-2792 PI: Braver (Washington U St Louis)
8/1/2023 – 7/31/2028
\$2,496,839
Role: Co-PI, Computational Modeling
- *Novel treatment targets for affective disorders through cross-species investigation of approach/avoidance decision making.*
NIMH P50MH119467 PI: Pizzagalli (McLean Hospital)
4/15/20 – 3/31/25
\$1,045,633
Role: PI, Computational Core
- *Neurocircuitry of OCD: Effects of Modulation*
NIMH P50MH106435-06A1 PI: Haber (U Rochester)
4/2022 – 3/2027
\$1,130,312
Role: PI, Computational Core
- *Cognitive Neurocomputational Task Reliability & Clinical Applications Consortium*
NIMH R01 MH084840 PI: Barch (Washington University St Louis)
7/01/2019 - 6/30/2024
\$1,081,384
Role: Co-PI
- *HNDS-I: SweetPea: Automating the Implementation and Documentation of Unbiased Experimental Designs*
NSF BCS-2318549
09/2023-08/2026
\$361,441
Role: PI, with Sebastian Musslick co-PI
- *Neural and computational mechanisms of motivation and cognitive control*
NIMH R01MH124849 PI: Shenhav
03/2021 – 12/2025
\$1,991,667
Role: Co-I
- *Brown Postdoctoral Training program in Computational Psychiatry*
NIMH T32MH126388-01
7/1/2021 - 6/30/2026
\$2,322,6732
Role: PI
- *Training program for Interactionist Cognitive Neuroscience (ICoN)*
NIMH T32MH115895
7/2019 -- 6/2029
\$4,164,049
Role: Co-PI

Grants (Completed)

- *Neurocognitive characteristics of short-term risk for suicidal behavior in adolescents*
NIMH R01MH115905-01 PI: Liu (Massachusetts General Hospital)
8/1/2018 – 7/31/2023
\$402,494
Role: Co-Investigator
- *Temporal dynamics of stress, sleep, and arousal in short-term risk for adolescent suicidal behavior*
NIMH RF1MH120830-01 PI: Liu (Massachusetts General Hospital)
8/1/2019 - 7/31/2023
\$287,580
Role: Co-Investigator
- *Brain and Behavior Mechanisms of Irritability and Cognitive Flexibility in Children*
NIMH R01MH111542 PI: Dickstein (McLean Hospital)
1/12-17 – 11/30/21
\$162,241
Role: Co-I
- *Adaptive DBS in Non-Motor Neuropsychiatric Disorders: Regulating Limbic Circuit Imbalance*
NINDS UH3NS100549 PI: Goodman (Baylor College of Medicine)
9/1/2016 – 8/31/2021
\$203,326
Role: Co-Investigator
- *How Prefrontal Cortex Augments Reinforcement Learning*
NSF Proposal # 1460604
2/1/2015- 1/31/19
\$372,056 direct costs
Role:PI
- *Clinical and computational studies of dopamine function in Schizophrenia,*
NIMH R01 MH080066-01 PI: Gold (Maryland Psychiatric Research Center)
06/07/13 – 05/31/19
\$568,724 direct costs
Role: Co-Investigator
- *BIDS-Derivatives: A data standard for derived data and models in the BRAIN Initiative*
NIMH R24 MH114705-01 PI: Poldrack (Stanford University)
9/1/2017 – 8/31/2019
\$73,830 direct costs
Role: Co-Investigator
- *The Cost of Cognitive Doping: From dopamine to cognitive control via dynamic neural coding*
NWO PI: Cools (Radboud University)
\$61,924 direct costs
9/1/16 – 8/31/17
Role: Co-Investigator
- *Goal Directed Behavior and Uncertainty in Obsessive Compulsive Disorder*
Brown Institute for Brain Science Norman Prince Neuroscience Institute, New Frontiers Award
\$39,741 direct costs
7/1/2016 – 6/30/2017
Role: co-PI
- *Integrated Computational Psychiatry: Behavioral, Neurophysiological and Optogenetic Testing of Antipsychotic-Driven Aberrant Learning in the Cortico-Striatal D2 Pathway*

Brown Institute for Brain Science Innovation Award
\$100,000
7/1/14-6/30/15
Role: Co-PI

- *Electropysiological and computational studies on action monitoring.*
National Science Foundation
\$424,695 direct costs
9/1/11 – 8/31/15
Role: PI
- *The influence of stimulant therapy and co-morbidity on decisions in ADHD*
Norwegian Research Council PI: Endestand (University of Oslo)
01/07/12 – 06/30/14
Role: Co-Investigator
- *BL-OG: A Novel Minimally-Invasive and Homeostatic Method for Selective Regulation of Neural Dynamics in the Subthalamic Nucleus*
Michael J Fox Foundation PI: Moore
9/1/13-8/31/14
\$75,000
Role: Co-PI
- *Clinical and computational studies of dopamine function in Schizophrenia*
NIMH R01 MH080066-01 PI: Gold (Maryland Psychiatric Research Center)
1/01/08 – 12/31/12
\$409,521 direct costs
Role: Co-Investigator
- *Orbitofrontal and striatal mechanisms in stress and addiction*
NIDA R21 DA022630 PI: Fellows (McGill University)
9/1/06-12/31/10
\$210,000 direct costs
Role: Co-PI
- *Neurocognitive Computations in Parkinson's Disease*
Michael J Fox Foundation for Parkinson's Research
1/1/09 – 12/31/11
\$366,848 direct costs
Role: PI

***Scholarly Presentations:
Colloquia (Invited)***

- University of Connecticut Dept of Neuroscience, Farmington CT, 5/1/25
- Columbia University Neuroscience Seminar series, New York NY, 4/29/25
- University of Hamburg Cognitive Computational Neuroscience virtual seminar, 4/23/25
- Friedman Brain Institute Seminar Series at Mt Sinai, New York NY, 4/3/25
- NICHD Neuroscience Affinity Group (virtual), 4/2/25
- Center for Information and Neural Networks, Osaka Japan, 3/14/25
- University of Hamburg International Lecture Series, virtual seminar, 2/26/25
- Carnegie Mellon University brAIn (AI + neuroscience) virtual seminar, 12/11/24
- Rensselaer Polytechnic Institute Cognitive Science Lecture Series, Troy NY, 10/30/24
- MIT Simons Foundation Series in Brain and Cognitive Science, Cambridge MA, 10/16/24
- Swedish Basal Ganglia Society Webinar, 9/27/24
- Krembil Institute Computational Neuroscience Seminar, Toronto Canada, 6/28/24
- UC Davis Center for Mind and Brain “Exploring the Mind” Lecture Series, Davis CA, 3/8/24

- MindRL Hub, virtual talk <https://rldmjc.github.io/> 12/14/23
- Institute for Computational & Experimental Research on Mathematics (ICERM), Providence, 11/30/23
- Bernstein Center for Computational Neuroscience colloquium, Berlin, Germany (virtual), 6/7/23
- Precision Convergence Webinar Series, The McGill Centre for the Convergence of Health and Economics and The Pittsburgh Supercomputing Center, 11/9/22
- University College London Brain Meeting, London England (virtual), 10/14/22
- Max Planck Institute for Biological Cybernetics, Tübingen Germany (virtual), 9/30/2022
- Dresden University of Technology, Dresden Germany (virtual), 6/15/2022
- Dartmouth College Biomedical Data Sciences seminar, Lebanon NH, 5/26/2022
- University of Pennsylvania colloquium, Philadelphia PA, 11/8/2021
- Neuroeconomics Seminar series, University of Zurich, virtual, 11/4/2021
- Johns Hopkins Psychological & Brain Science colloquium, virtual, 11/3/2021
- Center for Neuroscience Studies series, Queen's University, Kingston Canada, 6/23/21
- Brain & Mind Webinar, Sharif University of Technology, Iran, 6/2/21
- Computational neuroscience seminar, UC Davis (virtual), 4/29/21
- Psychiatry seminar series, University of Cambridge (virtual), 4/29/21
- Lundbeck pharmaceuticals, Experimental Medicine seminar (virtual), 4/12/21
- Quantitative Psychology Brownbag seminar, University of Illinois (virtual), 3/10/21
- Neural Dynamics Forum seminar series, University of Bristol (UK, virtual), 10/30/20
- Rutgers-Princeton Center for Computational Cognitive Neuropsychiatry (virtual), 10/14/20
- National Institutes of Health (NIH) Neuroscience seminar, Bethesda, MD, 12/16/19
- University of Maryland, College Park, MD, 10/10/19
- NIDA/NIAAA Cutting Edge Seminar, Rockville MD, 9/27/19
- Helmholtz lecture, Utrecht University, Utrecht Netherlands, 8/30/19
- University of Amsterdam, Amsterdam Netherlands, 8/29/19
- University of Oxford, Oxford Neurotheory forum, Oxford UK, 5/8/19
- University of Surrey, Psychology department, Guildford UK, 5/7/19
- University of Colorado at Boulder, Dept of Psychology and Neuroscience, Boulder CO, 4/11/19
- University of California at Berkeley, Neuroscience seminar series, Berkeley CA 3/21/19
- University of Chicago Grossman Institute for Neuroscience, Chicago IL, 3/14/19
- Harvard University, Center for Brain Science seminar, Cambridge MA, 10/9/18
- *Van Biervliet* lecture, Center for Cognitive Neuroscience, Ghent University, Belgium, 6/21/18
- UCLA Computational Neuroscience group (webinar), 5/23/18
- Indiana University, Cognitive Science Seminar Series, Bloomington IN, 2/19/18
- University of Houston, Department of Psychology, Houston TX, 12/5/17
- Columbia University, Center for Theoretical Neuroscience seminar series, New York 11/17/17
- Columbia University Systems, Cognitive and Computational Neuroscience series 11/16/17
- Pioneers in Biomedical Research Seminar, Virginia Tech, Roanoke VA 11/3/17
- University of Massachusetts Amherst, Neuroscience & Behavior series, Amherst MA 10/25/17
- Maryland Psychiatric Research Center, Baltimore MD, 6/28/17
- Neuroeconomics Colloquium, New York University, New York NY 4/25/17
- Cognitive Science colloquium, Princeton University, Princeton NJ 3/30/17
- Bridge Webinar series: McGill U, Johns Hopkins U, Pittsburgh Supercomputing Center, 1/17/17
- University of California at San Francisco Neuroscience seminar series, San Francisco CA 3/31/16
- Johns Hopkins University Biomedical Engineering seminar series, Baltimore MD 3/28/16
- IBM TJ Watson Research Center, Computational Biology seminar, Yorktown NY 1/12/16
- Université de Montréal, Neuroscience series, Montreal Quebec Canada, 1/8/16
- American University, Special Lectures on Cognitive Neurosciences, Washington DC, 11/13/15
- University of Maryland Neuroscience and Cognitive Science series, 10/23/15
- Harvard University, Department of Psychology colloquium, Cambridge MA, 10/7/15
- University of Western Ontario, Neuroscience speaker series, London ON 9/29/15
- Yale University, Behavior, Genetics & Neuroscience seminar series, New Haven CT 9/17/15
- Donders Institute for Brain, Cognition and Behaviour, Nijmegen, the Netherlands, 6/18/15
- Google DeepMind, London UK, 5/28/15
- UCL Wellcome Trust Center for Neuroimaging "Brain Meeting", London UK, 4/17/15
- University of British Columbia, Brain Research Centre, Vancouver, Canada, 1/9/15
- University of Pennsylvania Psychology Dept, Philadelphia PA, 10/27/14

- Washington University in St. Louis: Cognitive, Computational, and Systems Neuroscience
- Invited Lecturer, St Louis, MO 10/6/14
- Carnegie Mellon University, Dept of Psychology Colloquium, Pittsburgh, PA 9/22/14
- Carnegie Mellon University, Cognitive Brown Bag, Pittsburgh, PA 9/22/14
- Columbia University Dept of Pharmacology, New York NY 5/20/14
- UCL, Affective Brain Lab Online Talk Series, London UK, 5/15/14
- Duke University, Duke Institute for Brain Science, Durham NC, 1/31/14
- Harvard University, Maclean Hospital, Boston, MA, 12/17/13
- University of Amsterdam, special seminar, Amsterdam, the Netherlands, 6/14/13
- University of Amsterdam, Brain and Cognition series, Amsterdam, the Netherlands, 6/6/13
- Harvard University, Decision-Making workshop series, Cambridge MA, 11/16/11
- New York University, Neuroeconomics seminar series, New York NY. 9/27/11
- National Institute of Neurological Disorders and Stroke (NINDS), Bethesda MD, 8/16/11
- University of Amsterdam, Cognitive Science Center Amsterdam, The Netherlands, 6/16/11
- Columbia University, Center for Theoretical Neuroscience, New York NY 5/27/11
- University of California at Davis, Perspectives in Neuroscience series, Davis CA 5/12/11
- University of Massachusetts at Amherst, Dept of Psychology, Amherst MA 4/6/11
- University of Colorado Boulder, Center for Determinants of Executive Function & Dysfunction 1/20/11
- University of Pennsylvania, Institute for Research in Cognitive Science, Philadelphia, PA 12/10/10
- New York University Center for Neural Science, Memory in Brain series, New York NY 11/5/10
- CELEST Science of Learning seminar series, Boston University, Boston MA 10/29/10
- Grand rounds, Dept of Neurology, Brown University, Providence RI 5/19/10
- National Institute on Drug Abuse (NIDA) seminar series, Baltimore MD 5/11/10
- UCLA, Center for Neurobehavioral Genetics, Los Angeles CA 5/6/10
- Yale University, Cognitive Science seminar series, New Haven CT 4/6/10
- John B Pierce Laboratory, Yale University School of Medicine, New Haven CT 4/5/10
- University College London, "Brain meeting", London UK 2/5/10
- University of Chicago, Center for Integrative Neuroscience and Neuroengineering, 1/19/10
- Donders Institute for Brain, Cognition & Behaviour, Nijmegen, The Netherlands, 7/29/09
- University of Zurich, Institute for Empirical Economics, Zurich, Switzerland, 6/4/09
- Queen's University, Centre for Neurosciences, Kingston Canada, 4/8/09
- Northwestern University, Dept of Physiology Feinberg School of Medicine, Chicago IL, 3/13/09
- Johns Hopkins University, Dept of Psychological & Brain Sciences, Baltimore Maryland, 2/11/09
- University of Waterloo, Centre for Theoretical Neuroscience, Waterloo, Canada, 12/12/08
- Tamagawa University, Tokyo, Japan, 10/15/08
- University of Colorado, Institute for Cognitive Science, Boulder, CO, 7/30/08
- Max Planck Institute, Neurocognition of Decision Making Group, Berlin Germany, 7/18/08
- Laboratoire de la Neurobiologie de la Cognition, Université de Provence, Marseille, France, 7/15/08
- Gatsby Computational Neuroscience Unit, University College London, London, UK, 6/4/08
- University of Cambridge Behavioral Neuroscience seminar series, Cambridge, UK, 6/3/08
- University of Michigan, Neurons, Brains and Models seminar series, Ann Arbor, MI, 4/10/08
- Max Planck Institute, Cologne, Germany, 3/17/08
- University of California at Davis Medical Center, MIND Institute, Davis CA, 2/28/08
- Arizona Research Laboratories Division of Neurobiology seminar, Tucson AZ, 2/25/08
- Brown University, Brain Sciences Program, Providence RI, 2/21/08
- University of Delaware, Cognition and the Brain series, 10/5/2007.
- Yale University, Swartz Initiative in Theoretical Neurobiology, New Haven, CT, 5/25/07
- UCSD Temporal Dynamics of Learning Center, San Diego, CA, 5/18/07
- Princeton University Neuroscience Institute, Princeton, NJ, 4/26/07
- Mathematics Awareness Month, 'Mathematics and the Brain', U of Arizona, 4/17/07
- Workshop on Computational Neuroscience, department of mathematics, Uof Arizona, 2/23/07
- California Institute of Technology, Neuroeconomics seminar series, Pasadena CA 01/25/07
- Ohio State University, dept of Psychology, Columbus OH 11/19/07
- UCLA Dept of Psychology, Los Angeles, CA, 7/26/06
- University of Bonn, Center for Life and Brain, Bonn Germany, 6/6/06
- Institute for Cognitive Science Science of Learning series, University of Colorado, 9/30/05
- Center for Neuroscience Supergroup, University of Colorado, 9/23/04

- Colorado State University behavioral & cognitive neuroscience brown bag, 9/24/04

Symposia and Workshops, Invited Talks

- “Linking levels of analysis from brain to behavior in computational modeling”, Neurobox: New Ideas in Translational Neuroscience, Massachusetts Institute of Technology, 7/10/25
- “The dynamic interplay between in-context and in-weight learning in humans and neural networks”, The Adaptive Brain: Development, Learning and Learning Disorders, Monté Verita Switzerland, 5/26/25
- Presentation on eLife’s model of publishing, Symposium on Scientific Publishing, Cognitive Neuroscience Society, Boston MA 3/30/25
- “From Descriptive to Normative Models of Frontostriatal Control”, Mechanisms of Brain and Mind Winter Workshop, Rusutsu, Japan, 3/10/25
- “Human Curriculum Effects Emerge with In-Context Learning in Neural Networks”, Annual Interdisciplinary Conference, Jackson Hole WY, 1/30/25
- “Adaptive Cost Benefit Control over Corticostriatal Circuitry: From Reinforcement Learning to Working Memory” Plenary lecture, Partners in Neuroscience Summit, Lisbon Portugal (virtual), 12/6/24
- “Adaptive Chunking Improves Effective Working Memory Capacity in Frontostriatal Circuits”, Control Processes Conference, Birmingham UK, 5/12/24
- “Dissecting Basal Ganglia Decision Computations”, Gordon Research Conference on Basal Ganglia, Ventura CA, 3/26/24
- “Adaptive chunking of working memory in frontostriatal neural networks”, Annual Interdisciplinary Conference, Jackson Hole WY, 1/25/24
- “Tuning striatal dopamine signals to optimize reinforcement learning across tasks”, Metaplasticity and Metalearning in Brains and Machines, Center for Mind, Brain, Computation and Technology Annual Symposium, Wu Tsai Neuroscience Institute, Stanford University, CA, 5/24/23.
- “Neural interactions between working memory and reinforcement learning”, Cortical and Brain Modeling To Understand EEG and fMRI, Cognitive Fatigue MURI Research Forum, University of Michigan (virtual), 12/13/22
- “Beyond scalar dopamine hypotheses: Computational psychiatry”, 5th Workshop on Integrating System Neuroscience, James S McDonell Foundation, Tarrytown NY, 11/3/22
- Computational Psychiatry Course, ETH Zurich, Zurich Switzerland (virtual), 9/16/22
- “Tuning striatal dopamine signals to optimize reinforcement learning across tasks”, Nobel Mini-symposium: Dopamine as a neural substrate of reward prediction and psychopathology, Nobel Forum, Stockholm Sweden, 9/8/22
- “Clustering and generalization of abstract structures in reinforcement learning”, 5th Symposium and Advanced Course on Computational Psychiatry and Ageing Research, Marbach Castle, Germany, 8/30/22
- “Clustering and generalization of abstract structures in reinforcement learning”, Brains, Minds and Machines Summer Course, Marine Biology Lab, Woods Hole MA, 8/12/22
- “Clustering and generalization of abstract structures in reinforcement learning”, Kavli Summer Institute in Cognitive Neuroscience, Santa Barbara, CA, 6/23/22
- “Striatal dopamine computations in learning about agency”, Baltic-Nordic Summer School on Neuroscience and Neuroinformatics, Stockholm (virtual), 9/24/21
- “Computational models of abstraction, composition and transfer in reinforcement learning”, Computational & Cognitive Neuroscience Summer School, Suzhou, China (virtual) 7/30/21
- “Linking across levels of analysis from brain to behavior in models of decision making”, Computational & Cognitive Neuroscience Summer School, Suzhou, China (virtual) 7/29/21
- “Drift diffusion model and beyond for linking brain to behavior in patient populations”, Methods and Primers for Computational Psychiatry and Neuroeconomics, Yale University, 3/4/21.
- “Striatal dopamine computations in learning about agency”, workshop, Terra Incognita: Diving into the Subcortex, Amsterdam (virtual presentation), 3/3/21
- “Clustering and generalization of abstract structures in reinforcement learning”, **keynote speaker**, Winter School of Mathematical Psychology, Institute for Cognitive and Brain Sciences, Shahid Beheshti University, Tehran, Iran (virtual presentation), 2/24/21.

- “Computational modeling of frontal cortex and basal ganglia during inhibitory control and decision making”, The 43rd Annual Meeting of the Japan Neuroscience Society, Kyoto Japan (virtual presentation), 7/30/20
- “Striatal dopamine computations in learning about agency”, Virtual Dopamine Conference, <http://vidaconference.com> 5/22/20
- “Corticostriatal dopamine computations in learning about agency”, Cognitive Neuroscience Society Annual Meeting, Symposium on Integrating Theory and Data: Using Computational Models to Understand Neuroimaging Data, 5/4/20
- “Spatiotemporal dynamics of corticostriatal dopamine in learning about agency”, Annual Interdisciplinary Conference, Teton Village, WY 2/9/20
- “Computational models of inhibitory control in cortical basal ganglia circuits”, Winter Conference on Brain Research, Big Sky MT, 1/28/20
- “Corticostriatal computations in learning and decision making”, Plenary lecture, Alpine Brain Imaging Meeting, Champéry Switzerland, 1/13/20
- “Beyond scalar reward prediction errors: spatiotemporal dynamics of striatal dopamine in structure learning”, International Conference on Motivation and Cognitive Control, Berlin, Germany, 9/16/19
- “Introduction to Computational Psychiatry”, Crash course in computational psychiatry, National Institute of Mental Health, Bethesda MD, 9/9/19
- “Clustering and generalization of abstract structures in human reinforcement learning”, **keynote**, 9th Joint IEEE International Conference on Development and Learning and on Epigenetic Robotics, Oslo Norway, 8/22/19
- “Dynamic dopaminergic signals underlying task state inference”, Gordon Research Conference on Catecholamines, Sunday River ME, 8/14/19
- “Corticostriatal dopamine computations in reinforcement learning and decision making”, Plenary lecture, 4th International Conference on Applications of Neuroimaging to Alcoholism (ICANA-4), Yale University, New Haven CT, 7/20/19
- “Quantifying dynamic decision processes with neural regressors”, Workshop on Integrating Neural and Behavioral Data, Midwest Cognitive Science Conference, The Ohio State University, Columbus OH, 5/24/19
- “Beyond reward prediction errors: corticostriatal mechanisms of structure learning”, symposium on the Computational and Neural Basis of Bayesian models of Reinforcement Learning, Winter Conference for Brain Research, Snowmass CO, 1/30/19
- “Methods of computational model-based analysis of brain/behavior relationships”. Computational Psychiatry: from theory to practice. San Diego CA, 11/3/18
- “Model-based EEG reveals disrupted interplay between working memory and reinforcement learning in schizophrenia”. Computational Psychiatry: from theory to practice. San Diego CA, 11/3/18
- “Computational Models and Analysis of Subthalamic function across species”. Workshop on Translational Aspects of Stopping Behavior and Cognition. San Diego CA, 11/2/18
- “Corticostriatal interactions in working memory and reinforcement learning”, workshop on Computational Properties of the Prefrontal Cortex, Nashville TN 10/13/18
- “Corticostriatal interactions in working memory and reinforcement learning”, Flexible Learning Under Stress symposium, Hamburg University, Hamburg Germany 9/20/18
- “Computational cognitive neuroscience approaches to adaptive & maladaptive learning and choice”, Translational Neuroscience and Neural Engineering Workshop for Graduate Students, Salve Regina University, Newport, RI, 6/6/18
- “Methods of computational model-based analysis of brain-behavior relationships in RL”, Computational Psychiatry Satellite Workshop @ Society for Biological Psychiatry, New York, NY, 5/9/18
- “Model-based cognitive neuroscience approaches to computational psychiatry”, American Psychiatric Association Annual Meeting, New York, NY, 5/8/18
- “Computational explorations of corticobasal ganglia function and dysfunction”, meeting on From synaptic structure to neuronal circuit dysfunction, in memory of Dominique Muller, Geneva Switzerland, 4/19/18
- “Working memory contributions to reinforcement learning”, Computational Neuroscience of Prediction, FENS BRAIN Spring meeting, Rungstedgaard, Denmark, 4/17/18
- “Computational Psychiatry”, Montreal Artificial Intelligence and Neuroscience conference, **keynote**, Montreal Que, 11/18/17

- “Optimizing working memory strategies via reinforcement learning”, Computational Psychiatry: a didactic introduction, Washington DC, 11/10/17
- “Chunking as an optimized strategy for lossy data compression in visual working memory”, Control Processes meeting, Amsterdam, The Netherlands, 10/12/17
- Computational Psychiatry Course, ETH Zurich, Zurich Switzerland, 9/1/17
- Computational Psychiatry: Opportunities and Challenges, National Institute for Mental Health, Bethesda, MD 6/26-27/17
- “Chunking as an optimized strategy for lossy data compression in visual working memory”, Reinforcement Learning and Decision Making Multidisciplinary Conference, Ann Arbor MI 6/13/17
- “Deconstructing neural mechanisms of impulsive choice”, Japanese-American Kavli Frontier of Science Symposium, National Academy of Sciences, Irvine CA, 12/2/16
- “Gating Mechanisms for Cognitive Control”, chaired symposium at Control Processes workshop, San Diego, CA 11/10/16
- “Opponency mechanisms of striatal dopamine on learning and choice”, Gatsby Computational Neuroscience Institute, workshop on dopamine. London UK, 9/30/16
- “Cognitive control over learning and action in frontostriatal circuits”, The Brain Conferences, New Insights into Psychiatric Disorders through Computational, Biological and Developmental Approaches. Copenhagen, Denmark, 9/25/16
- “Adaptive regulation of decision thresholds by basal ganglia”, Workshop on Sequential Sampling Models of Decision Making, Emmetten Switzerland, 5/10/16
- “Frontostriatal interactions at the interface between choice and learning”, The Neuroscience of Decision Making, 38th Symposium International du GRSNC, Université de Montréal, 5/3/16
- “Computational Psychiatry”, chair invited symposium, Cognitive Neuroscience Society Annual Meeting, New York NY, 4/3/16
- “Basal ganglia dynamics during active learning and choice”, Gordon Research Conference on Basal Ganglia, Ventura CA, 03/02/16
- “Frontostriatal gating mechanisms in motivated action and cognition”, Workshop on Multiregional Models of Population Coding, Simons Collaboration on the Global Brain, New York NY, 1/19/16
- “Probing for informativeness on latent states in value-based decision making”, Computational Psychiatry Course, Zurich, Switzerland, 12/12/15
- “The drift diffusion model as a tool for Computational Psychiatry and Neurology”, Computational Psychiatry Course, Zurich, Switzerland, 12/10/15
- “Probing for informativeness on latent states in value-based decision making”, International symposium on Prediction and Decision Making, Tokyo Japan, 11/1/15
- “Linking levels of analysis in computational models of corticostriatal function”, Methods in Computational Neuroscience summer school, Marine Biology Lab, Woodshole MA, 8/19/15
- “Interactive effects of striatal dopamine on reinforcement learning and choice incentive”, Gordon Research Conference on Catecholamines, Sunday River Maine, 8/10/15
- Strüngmann Forum on Computational Psychiatry, Frankfurt Germany, 6/28/15-7/3/15
- “Dopamine, reward prediction error and action selection: Is there a connection?” workshop on Computational Properties of Prefrontal Cortex, Bethesda, MD, 5/15/15
- “Probing for information about latent states during reinforcement learning”, Neurocuriosity workshop, INRIA, Bordeaux, France, 11/7/14
- “Generalization and transfer during latent structure learning”, Computational Properties of Prefrontal Cortex Workshop, Whistler, BC, Canada, 10/4/14
- “Frontal control over striatal learning and choice”, workshop on basal ganglia structure and function, Organization for Computational Neurosciences, Quebec City, Canada, 7/31/14
- “Generalization and transfer in structure learning”, workshop on Engineering and Reverse Engineering Reinforcement Learning, Massachusetts Institute of Technology, 7/18/14
- “Cognitive control over learning and action in frontostriatal circuits”, Dresden Spring School on Cognitive-Affective Neuroscience, Technical University of Dresden, Dresden Germany, 3/14/14
- “Model-based cognitive neuroscience approaches to computational psychiatry: clustering and classification”, Computational and Systems Neuroscience (CoSyne) meeting, Snowbird UT, 3/4/14
- “Interactive dynamics of corticostriatal circuits in reinforcement and motor learning”, Sackler Winter Conference on Developmental Psychobiology, Cozumel Mexico, 1/7/14
- “EEG and fMRI correlates of dynamic decision parameters during reinforcement learning”, Society for Neuroscience Annual Meeting, San Diego CA, 11/9/13

- “Computational models of aberrant learning and decision making in disease states”, Computational Psychiatry conference, Miami ,FL, 10/2/13
- “Control over learning and action in corticostriatal circuits”, Sackler Summer Institute for Developmental Psychobiology, New York, NY, 7/24/13
- “Linking levels of analysis in computational models of corticostriatal function”, The Third International Symposium on "The Biology of Decision Making", Paris France 5/29/13
- “Computational models of dopamine in learning and choice incentive”, Dopamine 2013, Alghero Italy, 5/24/13
- “Opponent processes for learning and action in frontostriatal circuits”, Meeting on dissection of direct and indirect pathways in Huntington’s Disease, CHDI Foundation, Princeton NJ, 5/9/13
- “Cognitive control over learning and action in corticostriatal circuits”, Mechanisms of Motivation, Cognition and Aging Interactions, Washington DC, 5/3/13
- “Linking levels of analysis in neurocomputational models of reinforcement learning”, Swartz symposium on Neural Circuits for Decision Making and Reinforcement Learning, Yale University, New Haven CT, 4/12/13
- “Prefrontal and striatal contributions to reinforcement learning”, 3rd International Conference on Applications of Neuroimaging to Alcoholism, Yale University, New Haven CT, 2/18/13
- “Linking levels of analysis in computational models of corticostriatal function”, Mathematical Biosciences Institute, workshop on Cognitive Neuroscience, Columbus OH, 12/11/12
- “Neurogenetic modulators of reinforcement and motor learning parameters”, Plenary Lecture, Translational Computational Motor Control meeting, New Orleans LA, 10/12/12
- “Neurogenocomputomics”, Special Symposium on Neural Foundations of Reinforcement Learning, Society for Neuroeconomics annual meeting, Key Biscayne Florida, 9/29/12
- “Interactive dynamics in corticostriatal circuits: Linking levels of computation and implications for psychiatry”, **keynote lecture**, MPS-UCL Symposium and Advanced Course on Computational Psychiatry and Ageing Research, Ringberg Castle, Bavaria, Germany 9/21/12
- "Striatal contributions to learning and choice in rodents, humans and computational models", in workshop on the Striatum, Gatsby Computational Neuroscience Unit and Sainsbury Wellcome Centre for Neural Circuits and Behaviour, London England, 5/24/12
- "Modeling decision-making deficits in fronto-striatal disorders", symposium on Computational Psychiatry, Neuroinformatics world congress, Boston MA, 9/4/11
- "Frontal control over basal ganglia in reinforcement learning and decision-making", Summer Institute on Cognitive Neuroscience, Santa Barbara CA, 6/29/11
- "Mechanisms of motivated action selection and inhibition in frontal cortex and basal ganglia". Cognitive Science Center Amsterdam, Summer Institute on Cross-Disciplinary Approaches to Impulsivity and the Inhibition of Thought and Action, Amsterdam, 6/20/11
- "Interactions Between Frontal Cortex and Basal Ganglia in Volitional Control", young investigator award lecture, Cognitive Neuroscience Society annual meeting, San Francisco CA, 4/4/2011
- "Frontal-subthalamic regulation of decision threshold", workshop on Neural Circuits of Decision-Making, Janelia Farm Research Campus, Ashburn VA, 3/8/11
- "The Role of Dopamine in Learning and Decision Making", invited address, 'Neuroscience for Social Scientists' workshop on the Foundations of Neuroeconomics, Society for Neuroeconomics annual meeting, Evanston IL, 10/15/10
- "Frontal-Subthalamic Regulation of Decision Threshold in Parkinson's Disease", Swartz Symposium on Computational Psychiatry, Yale University, 9/23/10
- "Frontal-Subthalamic Regulation of Decision Processes in Parkinson's Disease", Gordon Research Conference on the Neurobiology of Cognition, Waterville Valley NH 8/5/10
- "Neurogenetic and pharmacology of learning and executive control over learning", Symposium on dopamine and human decision making (R. Cools and M. Ullsperger, chairs), Federation of European Neurosciences annual meeting, Amsterdam, the Netherlands, 7/7/10
- "Hierarchical reinforcement learning in corticostriatal circuits", Motivation and Cognitive Control workshop, Oxford, UK, 6/4/10
- "Pharmacological and genetic modulation of decision making in corticostriatal circuits", plenary symposium, Society for Biological Psychiatry, New Orleans, LA, 5/21/10
- "Neurogenetic influences on learning and executive control over learning", symposium on dopamine and adaptive memory (D. Shohamy chair), Cognitive Neuroscience Society annual meeting, Montreal Canada, 4/20/10

- "Cortico-striatal interactions in reinforcement-based decision making: Multiple levels of modeling", UK Neuroinformatics Node Congress, Edinburgh, UK, 2/2/10
- "Neurogenetic influences on learning from experience and executive control over learning", Genetic and Experiential Influences on Executive Function meeting, Boulder CO, 1/16/10
- "Dopamine, reward processing, and decision making in aging", Aging, Motivation and Addiction meeting sponsored by NIDA and NIA, Washington DC, 10/5/09
- "Hierarchical cognitive control in prefrontal-basal ganglia circuits", symposium on computational modeling (K Norman chair), Memory Disorders Research Society, Chapel Hill NC, 9/25/09
- "Neurocomputational models of reinforcement learning: Implications for Parkinson's disease, pharmacology and genetic". Gordon Research Conference on Catecholamines, Biddeford ME 8/12/09
- "Neurocomputational models of learning and decision making: Multiple levels of analysis". **keynote address**, Mathematical Psychology annual meeting, Amsterdam, The Netherlands, 8/2/09
- "Fronto-subthalamic interactions in high conflict decisions and response inhibition: Computational and empirical studies", Symposium on neurocomputational models of speeded decision making (R Bogacz chair), Mathematical Psychology annual meeting, Amsterdam, The Netherlands, 8/2/09
- "Computational neuroscience and empirical studies of reinforcement learning", 1st Annual NIMH-Sponsored Brain Camp, Cold-Spring Harbor, NY, 5/2/09
- "The neurogenetics of exploration vs exploitation: Prefrontal and striatal dopaminergic components", workshop on Computational Role of Dopamine, (B Averbeck and M Frank, chairs) Computational and Systems Neuroscience (COSYNE) meeting, Snowbird UT, 3/2/09
- "Neurocomputational and Genetic Components to Exploration vs Exploitation", symposium on mesocorticolimbic interactions in health and disease (A Gruber chair), Winter Conference on Brain Research, Copper Mountain Colorado, 1/29/09
- "Fronto-subthalamic interactions in high conflict decisions and response inhibition: Computational and empirical studies", Symposium on the subthalamic nucleus (C Baunez chair), Winter Conference on Brain Research, Copper Mountain Colorado, 1/27/09
- "Temporal Integration of Expected Utility: Neurocomputational and Genetic Components", Open Problems in Neuroscience of Decision Making, Okinawa, Japan, 10/16/08
- "Neurogenocomputomics", symposium on Neuromodulation of Lifespan Cognition, International Congress of Psychology, Berlin, Germany, 7/21/08
- "Neurogenocomputomics", symposium on Computational Psychiatry, Lisbon, Portugal, 5/30/08
- Interactive dynamics of cortico-striatal circuits in behavioral adjustment", Workshop on "Action monitoring and behaviour adjustment", RWTH Aachen University, Aachen Germany, 3/15/08
- "Interactive dynamics of cortico-striatal circuits in reinforcement learning and decision making", Sustaining Performances Under Stress Symposium, University of Texas at Austin, Austin TX, 12/6/2007.
- "Simulating dynamics between frontal cortex and subthalamic nucleus in high-conflict decisions and response inhibition", workshop on Translational Aspects of Stopping Movement and Action, UCSD, San Diego CA, 11/2/2007
- "Neurocomputational models of frontostriatal function and dysfunction", Symposium on Computational Models of Biological Psychiatry, Computational Cognitive Neuroscience Conference, San Diego, CA, 11/1/2007
- "Dynamics of frontal cortex and subthalamic nucleus in high-conflict decisions and response inhibition", workshop on neural mechanisms of stochastic decision making, Ohio State University, Columbus, OH, 9/11/2007.
- "Interactive dynamics of cortico-striatal circuits in reinforcement learning and decision making", in K. Gurney (Chair), *"Computational Models of the Basal Ganglia: From Molecules and Membranes to Behaviour and Cognition"*. Symposium conducted at the 9th Triennial Meeting of the International Basal Ganglia Society, 9/6/2007
- "Dopamine and reward calculation", Charité conference on Emotional Neuroscience, Berlin, Germany, 9/1/2007
- "Interactive dynamics of striato-cortical circuits in reinforcement learning and decision making", in C. Holroyd (Chair) *"The Cognitive Neuroscience of Decision Making"*. **President's Symposium**, Canadian Society for Brain, Behaviour and Cognitive Science, Victoria, BC, 6/16/2007
- "Interactive dynamics of striato-cortical circuits in reinforcement learning and decision making", Perceptual Expertise Network meeting, Yale University, 4/20/07

- "The computational roles of dopamine in reinforcement learning and decision making". in J. Cohen (Chair) "*Has Reinforcement Learning Come of Age?*" Symposium conducted at the Psychonomic Society Annual Meeting, Houston TX, 11/17/06
- "Evidence for a dynamic computational role of the subthalamic nucleus in decision making", in B. Knutson (Chair) "*Motivation and Emotion: Decision-Making*" Symposium, Society for Neuroscience Annual Meeting, Atlanta Georgia, 10/15/06.
- "Interactive dynamics of striato-cortical circuits in reinforcement learning", workshop on the Role of Medial Frontal Cortex in Cognitive Control and Performance Monitoring, Amsterdam, the Netherlands, 6/10/2006
- "Dynamic Dopamine Modulation of Striato-cortical Circuits in Reinforcement learning and Decision Making", Betty Behrens Symposium on Neural Mechanisms for Regulating Behaviour, University of Cambridge, Cambridge, UK, 8/4/2005.
- "When and When Not to Use Your Subthalamic Nucleus: Lessons from a Computational Model of the Basal Ganglia", International workshop on Models of Natural Action Selection, Edinburgh, Scotland, 7/30/2005.
- "Computational Perspectives on Schizophrenia: Dysfunctional Dopamine Modulation of Striato-Cortical Circuits", Cold Spring Harbor Laboratory workshop on schizophrenia and related disorders, Cold Spring Harbor, New York, 7/16/2005.
- "Computational Models of Striato-Cortical Circuits in Cognition: Recent Advances and Converging Empirical Evidence." workshop on Basal Ganglia, Dopamine and Learning: Integrating Computational and Clinical Perspectives in Jerusalem, Israel, 6/29/2005.
- "Modeling Cognitive Deficits in Medicated and Non-medicated Parkinson's Disease." Cognitive Neuroscience of Category Learning conference, New York, NY, 10/10/2004.
- "Basal Ganglia and Dopamine in Cognition: Network Models and Behavioral Studies." John Merck Fund Summer Institute for the Biology of Developmental Disabilities, Princeton University, 7/22/2004.

Media Coverage:

- For various news articles see <http://ski.clps.brown.edu/inthenews.html>
- Radio Guest: National Public Radio (NPR) *Science Friday*, *All Things Considered*, BBC Radio 5 *live Drive*, New Hampshire Public Radio (NHPR) *Word of Mouth*
- Podcast Guest "*Science Magazine*", "*Computing Up*", "*CogNation*", "*Watercooler Neuroscience*", "*The Neural Network*", "*Scientific Sense*"

Professional Activities:

Editorial

- Senior Editor, *eLife*, 2017 - present
- Review Editor, *eLife*, 2015 – 2017
- Associate Editor, *Journal of Neuroscience*, 2015 – 2018
- Associate Editor, *Behavioral Neuroscience*, 2014 – 2020
- Consulting Editor, *Psychological Review*, 2015-2020
- Contributing Editor, *European Journal of Neuroscience*, 2008-2018
- Consulting Editor, *Journal of Mathematical Psychology*, 2010-2014
- Guest editor, *Cognition* special issue on Reinforcement Learning, 2009
- Guest editor, *Biological Psychiatry*, special issue on Computational Psychiatry, 2017
- External action editor, *PLoS Biology* 2016; *JExp Psych* 2013

Reviewing (Grants)

- NIDA Board of Scientific Counselors, 2020-2025
- NIMH Reviewer Interventions/Biomarkers panel, 2016, 2017
- NIH Reviewer Integrative, Functional and Cognitive Neuroscience panel 2012, 2013
- NSF Review Panel, 2016
- NSF Proposal Reviewer, ad-hoc
- Agence National de la Recherche (French National Agency)
- Biotechnology and Biological Sciences Research Council
- NWO (Netherlands Organisation for Scientific Research)
- Neurological Foundation of New Zealand

- NSERC Discovery Grants (Canada)
- Parkinson's Disease Society of the UK
- Swiss National Science Foundation
- The Wellcome Trust
- UK Economic and Social Research Council

Reviewing (Publications; ad-hoc)

American Journal of Psychiatry, Behavioral and Brain Sciences, Behavioural Brain Research, Behavioural Processes, Biological Psychiatry, Brain, Brain and Cognition, Brain and Language, Brain Research, Cerebral Cortex, Cognition, Cognitive Affective and Behavioral Neuroscience, Cambridge Handbook on Communications Physics, Computational Cognitive Modeling, Clinical Psychological Science, Current Biology, eLife, European Journal of Neuroscience, Handbook of Basal Ganglia Structure and Function, Hippocampus, International Journal of Neuropsychopharmacology, International Journal of Psychophysiology, JAMA Psychiatry, Journal of Cognitive Neuroscience, Journal of Computational Neuroscience, Journal of Experimental Psychology: General, Journal of Neurology, Journal of Neurophysiology, Journal of Neuroscience, Learning & Memory, Memory & Cognition, Movement Disorders, Nature, Nature Communications, Nature Human Behaviour, Nature Neuroscience, Neural Computation, Neural Networks, Neurobiology of Aging, NeuroImage, Neuron, Neuropsychologia, Neuroscience & Biobehavioral Reviews, Perception & Psychophysics, Proceedings of the National Academy of Sciences (PNAS), Psychological Review, Psychological Science, Psychonomic Bulletin & Review, Psychopharmacology, PLoS Biology, PLoS Computational Biology, PLoS ONE, Science, Science Advances, Topics in Cognitive Science, Translational Psychiatry, Trends in Cognitive Sciences

Professional Service

- Director, Carney Center for Computational Brain Science, Brown U, 2020 – present
- Director, Initiative for Computation in Brain and Mind, Brown U, 2012-2019
- Local co-chair, Multidisciplinary Conference on Reinforcement Learning and Decision Making Brown University 2021/22
- Diversity and Inclusion Subcommittee on community engagement in public schools, 2020-
- Associate Chair of Graduate Studies, Cognitive, Linguistic & Psychological Sciences 2017
- Organized and lectured at week-long summer workshops on Methods of Computational Modeling for Brain and Behavior, Brown University, 2017 – present
- Program Committee, International Convention of Psychological Science, 2013-15
- Program committee, Multidisciplinary Conference on Reinforcement Learning and Decision Making: Princeton 2013, Alberta 2015, Ann Arbor 2017, Montreal 2019
- Program Committee, Collaborative Research on Computational Neuroscience (CRCNS) conference, Brown University 2017
- Cognitive Neuroscience Society Young Investigator Award Committee, 2015-present
- Co-organized first Computational Psychiatry Conference, Miami FL. 10/22–23, 2013
- Co-organized computational psychiatry workshop satellite to Biological Psychiatry conference, San Diego CA 5/17/17
- Co-organized workshop “Towards an objective function for computational psychiatry”, The Banbury Center, Cold Spring Harbor Lab, Feb3-6, 2019
- Organized symposium on “Computational models of basal ganglia physiology and function”, International Basal Ganglia Society, Eilat Israel, 3/5/2013
- Co-chair in symposium on “Individual Differences in Dopamine Signaling: Role in Learning, Risk Taking, and Impulsivity”, Dopamine 2013, Alghero Italy, 5/24/13
- Co-organized workshop on "The computational role of dopamine", Computational and Systems Neuroscience (Cosyne 2009), Snow Bird Utah, 3/2/2009
- Organized symposium on "Computational models of biological psychiatry" at the Computational Cognitive Neuroscience Conference, San Diego, 11/2/2008
- Provide assistance to researchers using neural modeling software for simulating basal ganglia interactions in learning and associated neurological dysfunction (2005 – present)
- Panel member, Cognitive Neuroscience Treatment Research for Improving Cognition in Schizophrenia (CNTRICS)

- Participated in Deep Brain Stimulation (DBS) Consensus Conference to provide recommendations for patients with medically intractable Parkinson disease to patients and physicians. Advised on cognitive disturbances of medication and DBS. 4/2 – 4/3, 2009, New York, NY.
- Academic Advisor for freshman students, Brown University, 2010-2012

Teaching

- Computational Cognitive Neuroscience, 2007- present
- Doing Bayesian Data Analysis 2013
- Mechanisms of Motivated Decision making, Spring 2011, 2017, 2022
- Cognitive Control Functions of the Prefrontal Cortex, Spring 2010
- Reinforcement Learning, graduate seminar, Fall 2007
- Seminar on Computational Approaches to Cognitive Neuroscience, Fall 2006
- Computational Cognitive Functions of the Prefrontal Cortex, graduate seminar, Spring 2006

Guest Lecturer (recurring)

- Systems Neuroscience
- Advanced Cognitive Neuroscience
- Foundations in Cognitive Psychology
- Neural Dynamics
- Cognition core graduate course
- Introduction to Computational Neuroscience

Supervision (current)

Postdoctoral advisor

- Alexander Fengler, 2023 – present
- Nadja Ging-Jehli, 2022 – present
- Jake Russin, 2023 – present

PhD advisor

- Krishn Bera, 2021 – present
- Joonhwa Kim (co-advisor with Matt Nassar), 2024 – present
- Aalok Sathe (co-advisor with Ellie Pavlick), 2024 – present
- Pranavan Chanthrakumar, 2024 – present

Supervision (completed)

Postdoctoral advisor

- Rex Liu, 2019 – 2024, now PI at National Center for AI, Santiago Chile
- Andrew Westbrook, 2016 – 2023, now Asst Prof, Rutgers University
- Peter Hitchcock, 2019 – 2023, now Asst Prof, Emory University
- Andra Geana, 2016 – 2023, now Asst Prof, Providence College
- Rachel Rac-Lubashevsky, 2018-2023, now U Calgary
- Cristian Buc Calderon, 2019 – 2021, now PI at National Center for AI, Santiago Chile
- Arif Hamid, 2016 – 2021, now Asst Prof University of Minnesota
- Matthew Nassar, 2013 – 2018, mentor for K99/R00, now Asst Prof Brown U
- Mads Pedersen, postdoctoral 2017 – 2019, now postdoc U Oslo
- Anne Collins, 2010 – 2015, now Assoc Prof UC Berkeley
- Daniel Dillon, co-mentor for K99/R00, 2012- 2014 now Assoc Prof McLean Hospital, Harvard
- Nathan Vierling-Claasen, 2013 – 2016, now data scientist Wayfair
- Jim Cavanagh, 2010 – 2014, now Assoc Prof U New Mexico
- Michael X. Cohen, 2008-2009, now Assoc Prof, Donders Center for Neuroscience (Netherlands)
- Ahmed Moustafa, 2006-2007, now Assoc Prof Univ W Sydney Australia

PhD advisor

- Aneri Soni, 2019 – 2024

- Alana Jaskir, 2018-2024, now postdoc at NYU
- Guillaume Pagnier (co-mentor), 2018-2024, now postdoc at McLean (Harvard Medical School)
- Alexander Fengler, 2018-2022, now postdoc at Brown U
- Daniel Scott, 2016 – 2022, now postdoc at Brown U
- Harrison Ritz (co-mentor), graduate student, 2016 – 2022 , now postdoc at Princeton
- Amrita Lamba (co-mentor), 2016 – 2023, now postdoc at MIT
- Lucas Lehnert (co-mentor with Michael Littman), 2018 – 2021, now Asst Prof at U Saskatchewan
- Nicholas Franklin, 2011 – 2017, now data scientist HyperScience
- Prannath Moolchand (co-mentor with Dr. Stephanie Jones), 2012 – 2019, now postdoc U Sydney
- Jeff Cockburn, 2009 – 2015, now Asst Prof at U Iowa
- Thomas Wiecki, 2010 – 2014, VP of data science at Quantopian Inc; Founder, PyMC labs
- Bradley Doll, 2006-2011, now senior data scientist, Spotify
- Jim Cavanagh, Ph.D. co-advisor, 1/07 – 8/10, now Assoc Prof U. New Mexico

Other Work Experience:

Prediction Company

June 2001 - June 2003

Software Developer and Research Consultant

- Designed and developed neural network software for detecting stock market patterns

Santa Fe, New Mexico

(consultant office in Boulder, CO)

Uniden San Diego R&D Center

October 1997- August 1998

Staff engineer

- Systems Integration and Test Engineer, hardware and software design for cellular phone.

San Diego, CA

Montreal Neurological Institute

May 1996 - August 1996

Biomedical engineering research assistant

- Developed software to manipulate magnetic resonance images (MRI) for analysis of epileptic brain anatomy and to map electroencephalogram (EEG) activity on the MR images.

Montreal, Quebec

Personal Information:

Born: November 22, 1974 in Montreal, Quebec, Canada

Full Publication List

- Russin, J.L., Pavlick, E., & Frank, M.J. (2025). Parallel tradeoffs in human cognition and neural networks: the dynamic interplay between in-context and in-weight learning. *Proceedings of the National Academy of Sciences* 122: e2510270122
- Westbrook, J.A., van den Bosch, R., Hofmans, L., Papadopetraki, D., Määttä, J. Collins, A.G.E, Frank, M.J. & Cools, R. (2025). Striatal dopamine can enhance both fast working memory, and slow reinforcement learning, while reducing implicit effort cost sensitivity. *Nature Communications* 16:6320.
- Hitchcock, P.F., Kim, J. & Frank, M.J. (in press). How working memory and reinforcement learning interact when avoiding punishment and pursuing reward concurrently. *Journal of Experimental Psychology: General*.
- Frank, M.J. (2025). Adaptive cost benefit control fueled by striatal dopamine. *Annual Review of Neuroscience* vol 48: 1-22.
- Scott, D.N. & Frank, M.J. (2025). Beyond gradients: Factorized, geometric control of interference and generalization. *eLife* 13:RP103701
- Ging-Jehli, N.R., Cavanagh, J.F, Ahn, M., Segar, D.J., Asaad, W.F.. & Frank, M.J. (2025). Basal ganglia components have distinct computational roles in decision-making dynamics under conflict and uncertainty. *PLoS Biology* 23 (1): e3002978.
- Hewson, J.T.S, Jaskir, A. & Frank. M.J. (2025). Many roads to minimizing regret: A comparison of Wang et al (2024) and OpAL* models of adaptive striatal dopamine. *PLoS Computational Biology* 21(4): e1012920
- Halassa, M.M., Frank, M.J. et al. (in press). Developing algorithmic psychiatry via multi-level spanning computational models. *Cell Reports Medicine*
- Kuhn, M., et al. (2025). Computational phenotyping of effort-based decision making in unmedicated adults with remitted depression. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*.
- Soni, A. & Frank, M.J. (2024) Adaptive chunking improves effective working memory capacity in a prefrontal cortex and basal ganglia circuit. *eLife* 13:RP97894
- Herz, D.M., Frank, M.J., Tan, H. & Groppa, S. (2024). Subthalamic control of impulsive actions: insights from deep brain stimulation in Parkinson's disease. *Brain* 147, 3651-3664
- Lamba, A., Frank, M.J. & FeldmanHall, O. (2024). Keeping an eye out for change: Anxiety disrupts adaptive resolution of policy uncertainty. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging* 9, 1188-1198.
- Pan, W., Geng, H., Zhang, L., Fengler, A., Frank, M.J., Zhang, R-Y. & Chuan-Peng, H. (2025). dockerHDDM: A user-friendly environment for Bayesian Hierarchical Drift-Diffusion Modeling. *Advances in Methods and Practices sin Psychological Science* 8(1)
- Hitchcock, P.F. & Frank, M.J. (2024). The challenge of learning adaptive mental behavior. *Journal of Psychopathology and Clinical Science* 33(5), 413-426
- Monosov, I., Zimmermann, J., Frank, M.J., Mathis, M.W. & Baker, J. T. (2024). Ethological computational psychiatry: challenges and opportunities. *Current Opinion in Neurobiology* 86:102881
- Rasanan, A.H.H. et al. (2024). Beyond discrete-choice options. *Trends in Cognitive Sciences* 28:857-870.

Russin, J.L., McGrath, S.W. Pavlick, E. & Frank, M.J. (2024). Is human compositionality meta-learned? Commentary on Binz N, et al., Meta-Learned Models of Cognition. *Behavioral and Brain Sciences* 47, e162

Erickson, M. et al. (2024). Dysfunctional alpha modulation as a mechanism of working memory impairment in serious mental illness. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging* 9, 1271-1280.

Ging Jehli, N.R.* , Kuhn, M.* , Blank, J.M., Chanthrakumar, P., Steinberger, D.C., Yu, Z., Herrington, T.M., Dillon, D.G., Pizzagalli, D.A.** & Frank, M.J.** (2024). Cognitive signatures of depressive and anhedonic symptoms, and affective states, using computational modeling and neurocognitive testing. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging* 9, 726-737. *co-first authors; **co-senior authors.

Pagnier, G., Asaad, W.F. & Frank, M.J. (2024). Double dissociation of dopamine and subthalamic nucleus stimulation on effortful cost/benefit decision making. *Current Biology* 34, 665-660

Hitchcock, P.F. & Frank, M.J. (2024). From Tripping and Falling to Ruminating and Worrying: A Meta-Control Account of Repetitive Negative Thinking. *Current Opinion in Behavioral Sciences* 56: 101356

Culbreth, A.J., Moran E.K., Mahaphanit, W., Erickson M.A., Boudewyn, M.A., Frank M.J., Barch, D.M., MacDonald III, A.W., Ragland, J.D., Luck, S.J., Silverstein S.M., Carter C.S., Gold, J.M. (2024). A Transdiagnostic Study of Effort-Cost Decision-Making in Psychotic and Mood Disorders. *Schizophrenia Bulletin* 50, 339-348

Jaskir, A. & Frank, M.J. (2023). On the normative advantages of dopamine and striatal opponency for learning and choice. *eLife* 12:e85107

Rac-Lubashevsky, R., Cremer, A., Collins, A.G.E., Frank, M.J.* & Schwabe, L* (2023). Neural index of reinforcement learning predicts improved stimulus-response retention under high working memory load. *Journal of Neuroscience* 43(17):3131–3143 *co-senior authors

Rouhani, N., Niv, Y., Frank, M.J. & Schwabe, L. (2023). Multiple routes to enhanced memory for emotionally relevant events. *Trends in Cognitive Sciences* 27, 867-882.

Liu, R.G. & Frank, M.J. (2022). Hierarchical clustering optimizes the tradeoff between compositionality and expressivity of task structures for flexible reinforcement learning. *Artificial Intelligence* 312, 103770

Scott, D. & Frank, M.J. (2023). Adaptive control of synaptic plasticity integrates micro- and macroscopic network function. *Neuropsychopharmacology* 48, 121–144

Culbreth, A.J., Schwartz, E.K., Frank, M.J., Brown, E.C., Xu, Z., Chen, S., Gold, J.M. & Waltz, J.A. (2023). A computational neuroimaging study of reinforcement learning and goal-directed exploration in schizophrenia spectrum disorders. *Psychological Medicine*.

Hitchcock, P., Britton, W., Mehta, K. & Frank, M.J. (2022) Self-judgment Dissected: A Computational Modeling Analysis of Self-Referential Processing and its Relationship to Trait Mindfulness Facets and Depression Symptoms. *Cognitive, Affective and Behavioral Neuroscience*

Brown, V.M., Hallquist, M.N., Frank, M.J. & Dombrovski, A.Y. (2022). Humans adaptively resolve the explore-exploit dilemma under cognitive constraints: Evidence from a multi-armed bandit task. *Cognition* 229

Fengler, A., Bera, K., Pedersen, M.L. & Frank, M.J. (2022). Beyond Drift Diffusion Models: Fitting a broad class of decision and RL models with HDDM. *Journal of Cognitive Neuroscience* 34, 1780-1805

Moolchand, P., Jones, S.R. & Frank, M.J. (2022). Biophysical and Architectural Mechanisms of Subthalamic Theta under Response Conflict. *Journal of Neuroscience* 42:4470-87

- Calderon, C.B., Verguts, T. & Frank, M.J. (2022). Thunderstruck: The ACDC model of flexible sequences and rhythms in recurrent neural circuits. *PLoS Computational Biology* 18(2): e1009854.
- Hamid, A., Frank, M.J.* & Moore, C.I.* (2021). Wave-like dopamine dynamics as a mechanism for spatiotemporal credit assignment. *Cell* 184, 2733-49 *co-senior authors; alphabetical order
- Hitchcock, P., Fried, E. & Frank, M.J. (2022). Computational psychiatry needs time and context. *Annual Reviews of Psychology* 73:243-270.
- Geana, A., Barch, D.M., Gold, J.M., Carter, C.S., MacDonald, A.W., Ragland, J.D., Silverstein, S.M. & Frank, M.J. (2022). Using computational modelling to capture schizophrenia-specific reinforcement learning differences and their implications on patient classification. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging* 7(10):1035-1046.
- Westbrook, J.A., Frank, M.J. & Cools, R. (2021). A mosaic of cost-benefit control over cortico-striatal circuitry. *Trends in Cognitive Sciences* 25, 710-721.
- Fengler, A., Govindarajan, L., Chen, T. & Frank, M.J. (2021). Likelihood approximation networks (LANs) for fast inference of simulation models in cognitive neuroscience. *eLife* 10:65074
- Rac-Lubashevsky, R. & Frank, M.J. (2021). Analogous computations in working memory input, output and motor gating: Electrophysiological and computational modeling evidence. *PLoS Computational Biology* 17, e1008971.
- Pedersen, M.L., Ironside, M., Amemori, K.-I., McGrath, C.M., Kang, M.S., Graybiel, A.M., Pizzagalli, D. A., & Frank, M.J. (2021). Computational phenotyping of brain-behavior dynamics underlying approach-avoidance conflict in major depressive disorder. *PLoS Computational Biology* 17(5):e1008955
- Nassar, M.N., Waltz, J.A., Albrecht, M.A., Gold, J.M. & Frank, M.J. (2021). All or nothing belief updating in patients with schizophrenia reduces precision and flexibility of beliefs. *Brain* 144, 1013-1029.
- Huys, Q.J.M., Browning, M., Paulus, M. & Frank, M.J. (2021). Advances in the computational understanding of mental illness. *Neuropsychopharmacology Reviews* 46, 3-19.
- Provenza, N.R., et al. (2022). Honeycomb: a template for reproducible psychophysiological tasks for clinic, laboratory, and home use. *Brazilian Journal of Psychiatry* 44(2), 147–155
- Umbrecht, D., et al. (2021). Proof-of-Mechanism Study of the PDE10 Inhibitor RG7203 in Patients with Schizophrenia and Negative Symptoms. *Biological Psychiatry: Global Open Science*
- Lehnert, L., Littman, M.L. & Frank, M.J. (2020). Reward-predictive representations generalize across tasks in reinforcement learning. *PLoS Computational Biology* 16(10): e1008317.
- Westbrook, J., van den Bosch, R., Maatta, J.I., Hofmans, L., Papadopetraki, D., Cools, R.* & Frank, M.J.* (2020). Dopamine promotes cognitive effort by biasing the benefits versus costs of cognitive work. *Science*, 367, 1362-1366. *co-senior authors
- Franklin, N T. & Frank, M. J. (2020). Generalizing to generalize: humans flexibly switch between compositional and conjunctive structures during reinforcement learning. *PLoS Computational Biology* 16(4): e1007720
- Pedersen, M.L. & Frank, M. J. (2020). Simultaneous hierarchical Bayesian parameter estimation for reinforcement learning and drift diffusion models: a tutorial and links to neural data. *Computational Brain & Behavior* 3, 458-471
- Browning, M., et al. (2020). Realizing the Clinical Potential of Computational Psychiatry: Report From the Banbury Center Meeting, February 2019. *Biological Psychiatry* 88(2):e5-e10

Waltz, J. A.*, Wilson, R. C. *, Albrecht, M. A. , Frank, M. J. & Gold, J. M. (2020). Differential effects of psychotic illness on directed and random exploration. *Computational Psychiatry* 4, 18-39. *equal contributions

Culbreth, A., Waltz, J.A., Frank, M.J. & Gold, J.M. (2020). Retention of Value Representations Across Time in People with Schizophrenia and Healthy Control Subjects. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*.

Lamba, A., Frank, M.J. and FeldmanHall, O. (2020). Anxiety Impedes Adaptive Social Learning Under Uncertainty. *Psychological Science* 31, 592-603

Piray, P., Dezfouli, A., Heskes, T., Frank, M. J. & Daw, N. D. (2019). Hierarchical Bayesian inference for concurrent model fitting and comparison for group studies. *PLoS Computational Biology* 15(6): e1007043.

Nassar, M.R., Bruckner, R. and Frank, M.J. (2019). Statistical context dictates the relationship between feedback-related EEG signals and learning. *eLife* 8:e46975.

Frey, A.-L., Frank, M.J. and McCabe, C. (2019). Social reinforcement learning as a predictor of real-life experiences in individuals with high and low depressive symptomatology. *Psychological Medicine*

Ironside, M*, Amemori, K*, McGrath, C.L., Lund Pedersen, M., Kang, M.S., Amemori, S., Frank, M.J., Graybiel, A.M., Pizzagalli, D.A. (2020). Approach-avoidance conflict in major depression: Congruent neural findings in human and non-human primates. *Biological Psychiatry* 87(5), 399-408. *Joint 1st

Poldrack, R.A., Feingold, F., Frank, M.J. *et al.* (2019). The importance of standards for sharing of computational models and data. *Computational Brain & Behavior* 2, 229-232

Lawlor, V. M., Webb, C. A., Wiecki, T. V., Frank, M. J., Trivedi, M., Pizzagalli, D. A. & Dillon, D. G. (2020). Dissecting the impact of depression on decision-making. *Psychological Medicine* 50, 1613-1622.

Cavanagh, J.F., Bismark, A., Frank, M.J. and Allen, J.J.B. (2019). Multiple dissociations between comorbid depression and anxiety on reward and punishment processing: Evidence from computationally-informed EEG. *Computational Psychiatry* 3, 1-17.

Franklin, N.T. & Frank, M.J. (2018). Compositional clustering in task structure learning. *PLOS Computational Biology* 14(4): e1006116.

Collins, A.G.E. & Frank, M.J. (2018). Within and across-trial dynamics of human EEG reveal cooperative interplay between reinforcement learning and working memory. *Proceedings of the National Academy of Sciences* 115, 2502-2507

Nassar, M.R., Helmers, J. & Frank, M.J. (2018). Chunking as a rational strategy for lossy data compression in visual working memory. *Psychological Review* 125, 486-511.

Swart, J., Frank, M.J., Määttä, J.I., Jensen, O., Cools, R. & den Ouden, H.E.M. (2018). Frontal network dynamics reflect neurocomputational mechanisms for reducing maladaptive biases in motivated action. *PLOS Biology* 16(10): e2005979.

Hernaus, D., Xu, Z., Brown, E. C., Ruiz, R., Frank, M.J., Gold, J.M. & Waltz, J.A. (2018). Motivational deficits in schizophrenia relate to abnormalities in cortical learning rate signals. *Cognitive, Affective and Behavioral Neuroscience*.

Patel, S., Herrington, T.M., Sheth, S.A., Mian, M.K., Bick, S.K., Yang, J.C., Flaherty, A.W., Frank, M.J., Widge, A.S., Dougherty, D., & Eskandar, E.N. (2018). Intermittent subthalamic nucleus deep brain stimulation induces risk-averse behavior in human subjects. *eLife* 7:e36460

Ritz, H., Nassar, M., Frank, M.J. & Shenhav, A. (2018). A control theoretic model of adaptive behavior in dynamic environments. *Journal of Cognitive Neuroscience* 30, 1405-1421.

Boehm, U., Annis, J., Frank, M.J., et al., (2018). Estimating Across-Trial Variability Parameters of the Diffusion Decision Model: Expert Advice and Recommendations. *Journal of Mathematical Psychology* 87, 46-75.

Jahfari, S., Ridderinkhof, R.R., Collins, A.G.E., Knapen, T., Waldorp, L.I., & Frank, M.J. (2019). Cross-task contributions of fronto-basal ganglia circuitry in response inhibition and conflict-induced slowing. *Cerebral Cortex* 29: 1969–1983

Broadway, J.M., Frank, M.J. & Cavanagh, J.F. (2018). Dopamine D2 agonist affects visuospatial working memory distractor-interference depending on individual differences in baseline working memory span. *Cognitive, Affective, and Behavioral Neuroscience* 18, 509-520.

Kasanova, Z., Ceccarini, J., Frank, M.J., van Amelsvoort, T., Booij, J., Heinzl, A., Mottaghy, F.M., Myin-Germeys, I. (2018). Daily-Life Stress Differentially Impacts Ventral Striatal Dopaminergic Modulation of Reward Processing in First-degree Relatives of Individuals with Psychosis. *European Neuropsychopharmacology* 28(12):1314-1324.

Hernhaus, D., Gold, J.M., Waltz, J.A. & Frank, M.J. (2018). Impaired expected value computations coupled with overreliance on stimulus-response learning in schizophrenia. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging* 3(11):916-926.

Waltz, J.A., Xu, Z., Brown, E.C., Ruiz, R.R., Frank, M.J. & Gold, J.M. (2018). Motivational deficits in schizophrenia are associated with reduced differentiation between gain and loss-avoidance feedback in the striatum. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, 3, 239-247

Westbrook, J.A. & Frank, M.J. (2018). Dopamine and proximity in motivation and cognitive control. *Current Opinion in Behavioral Sciences* 22, 28-34.

Collins, A.G.E., Albrecht, M.A., Waltz, J.A., Gold, J.M., & Frank, M.J. (2017). Interactions between working memory, reinforcement learning and effort in value-based choice: a new paradigm and selective deficits in schizophrenia. *Biological Psychiatry* 82, 431-439.

Kasanova, Z., Ceccarini, J., van Amelsvoort, T., Frank, M.J., Booij, J., Vaessen, T., Steinhart, H., Duin, E., Heinzl, A., & Mottaghy, F. (2017). Intact striatal dopaminergic modulation of reward learning and daily-life reward-oriented behavior in first-degree relatives of individuals with psychotic disorder. *Psychological Medicine* 1-6.

Kasanova, Z., Ceccarini, J., Frank, M.J., van Amelsvoort, T., Booij, J., Heinzl, A., Mottaghy, F., & Myin-Germeys, I. (2017). Striatal Dopaminergic Modulation of Reinforcement Learning Predicts Reward-Oriented Behavior in Daily Life. *Biological Psychology* 127, 1-9.

Swart, J., Cook, J.L., Geurts, D.E.M., Frank, M.J., Cools, R. & den Ouden, H.E.M. (2017). Catecholaminergic challenge uncovers distinct Pavlovian and instrumental mechanisms of motivated (in)action. *eLife* 6:e22169

Collins, A.G.E., Ciullo, B., Frank, M.J. & Badre, D. (2017). Working memory load strengthens reward prediction errors. *Journal of Neuroscience* 37, 4332-4342.

Pedersen, M.L., Frank, M.J. & Biele, G. (2017). The drift diffusion model as the choice rule in reinforcement learning. *Psychonomic Bulletin & Review*. 24, 1234-1251.

Schutte, I., Slagter, H., Collins, A.G.E., Frank, M.J. & Kenemans, J.L. (2017). Stimulus discriminability may bias value-based probabilistic learning. *PLoS ONE* 12(5): e0176205

Voon, V., Napier, C., Frank, M.J., Sgambato-Faure, V., Grace, A.A., Rodriguez-Oroz, M., Obeso, J., Bezard, E. & Fernagut, P.O. (2017). Impulse control disorders and dyskinesias in Parkinson's disease: an update. *The Lancet Neurology* 16: 238-250

Werchan, D., Collins, A.G.E., Frank, M.J. & Amso, D. (2016). Role of prefrontal cortex in learning and generalizing hierarchical rules in 8-month-old infants. *Journal of Neuroscience* 36, 10314-10322

Maia, T.V. & Frank, M.J. (2017). An integrative perspective on the role of dopamine in schizophrenia. *Biological Psychiatry* 81(1):52-66

Dowd, E.C., Frank, M.J., Collins, A.G.E., Gold, J.M. & Barch, D.M. (2016). Probabilistic reinforcement learning in schizophrenia: Relationships to anhedonia and avolition. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging* 1(5):460-473

Moustafa, A.A., Chakravarthy, S., Phillips, J. Gupta, A., Keri S, Polner, B., Frank, M. J. & Jahanshahi, M. (2016). Motor symptoms in Parkinson's disease: A unified framework. *Neuroscience & Biobehavioral Reviews* 68:727-40.

Albrecht, M.A., Waltz, J.A., Frank, M.J. & Gold, J.M. (2016). Probability and magnitude evaluation in schizophrenia. *Schizophrenia Research: Cognition* 5, 41-46.

Nassar, M.R. & Frank, M.J. (2016). Taming the beast: extracting generalizable knowledge from computational models of cognition. *Current Opinion in Behavioral Sciences* 11, 49-54.

Collins, A.G.E. & Frank, M.J. (2016). Neural signature of hierarchically structured expectations predicts clustering and transfer of rule sets in reinforcement learning. *Cognition* 152, 160-169

Wiecki, T.V., Antoniaes, C.A., Stevenson, A. Kennard, C., Borowsky, B., Owen, G., Leavitt, B., Roos, R., Durr, A., Tabrizi, S.J. & Frank, M.J.* (2016). A computational cognitive biomarker for early-stage Huntington's disease. *PLoS ONE* 11:e0148409.

Huys, Q., Maia, T.V., & Frank, M.J. (2016). Computational psychiatry as a bridge between neuroscience and clinical applications. *Nature Neuroscience* 19, 404-413.

Collins, A.G.E. & Frank, M.J. (2016). Motor demands constrain cognitive rule structures. *PloS Computational Biology* 12: e1004785.

Albrecht, M.A., Waltz, J.A., Cavanagh, J.F., Frank, M.J. & Gold, J.M. (2016). Reduction of Pavlovian bias in schizophrenia: Enhanced effects in clozapine-administered patients. *PLOS ONE* 11:e0152781

Doll, B.B., Bath, K.G., Daw, N.D*. & Frank, M.J.* (2016). Variability in dopamine genes dissociates model-based and model-free reinforcement learning. *Journal of Neuroscience* 36,1211-1222. * equal contribution

Franklin, N.T. & Frank, M.J. (2015). A cholinergic feedback circuit to regulate striatal population uncertainty and optimize reinforcement learning. *eLife* 4:e12029.

Badre, D., Frank, M.J., & Moore, C.I. (2015). Interactionist Neuroscience. *Neuron*, 88, 855-860.

Kayser, A.S., Op de Macks, Z., Dahl, R. & Frank, M.J. (2016). A neural correlate of exploratory behavior at the onset of adolescence. *Journal of Cognitive Neuroscience* 28, 199-209.

Stephan, K.E., Bach, D.R., Fletcher, P.C., Flint, J., Frank, M.J., Friston, K.J., Heinz, A., Huys, Q.M., Owen, M.J., Binder, E.B., Dayan, P., Johnstone, E., Meyer-Lindenberg, A., Montague, P.R., Schnyder, U., Wang, X.J. & Breakspear, M. (2016). Charting the landscape of priority problems in Psychiatry - Part I: Nosology and diagnosis. *The Lancet Psychiatry* 3, 77-83

Stephan, K.E., Binder, E.B., Breakspear, M., Dayan, P., Johnstone, E., Meyer-Lindenberg, A., Schnyder, U., Wang, X.J. , Bach, D.R., Fletcher, P.C., Flint, J., Frank, M.J., Heinz, A., Huys, Q.M., Montague, P.R.,

- Owen, M.J., & Friston, K.J. (2016). Charting the landscape of priority problems in Psychiatry - Part II: Pathogenesis and aetiology. *The Lancet Psychiatry* 3, 84-90
- Moustafa, A.A., Chakravarthy, S., Phillips, J., Crouse, J., Gupta, A., Frank, M. J., Hall, J. M., Jahanshahi, M. (2016). Interrelations between cognitive dysfunction and motor symptoms of Parkinson's disease: Behavioral and neural studies, *Reviews in the Neurosciences* 27(5):535-48
- Solomon, M., Ragland, J.D., Niendam, T.A., Lesh, T.A., Beck, J.S., Matter, J.C., Frank, M.J., Carter, C.S. (2015). Atypical learning in autism spectrum disorders: An fMRI study of transitive inference. *Journal of the American Academy of Child and Adolescent Psychiatry* 54: 947-955.
- Morris, L., Baek, K., Kundu, P., Harrison, N., Frank, M.J., & Voon, V. (2016). Biases in the explore-exploit tradeoff in addictions: the role of avoidance of uncertainty. *Neuropsychopharmacology* 41(4):940-8.
- Slagter, H.A., Georgopoulou, K. & Frank, M.J. (2015). Spontaneous eye blink rate predicts learning from negative, but not positive, outcomes. *Neuropsychologia* 71:126-32.
- Gold, J.M., Waltz, J.W. & Frank, M.J. (2015). Effort cost computation in schizophrenia: A commentary on the recent literature. *Biological Psychiatry* 78: 747-753.
- Frank, M.J., Gagne, C., Nyhus, E., Masters, S., Wiecki, T.V., Cavanagh, J.F. & Badre, D. (2015). fMRI and EEG predictors of dynamic decision parameters during human reinforcement learning. *Journal of Neuroscience*, 35, 485-494
- Cox, S.M.L., Frank, M.J., Larcher, K., Fellows, L.K., Clark, C.A., Leyton, M., Dagher, A (2015). Striatal D1 and D2 signaling differentially predict learning from positive and negative outcomes, *NeuroImage* 109, 95-101
- Frank, M.J. and Badre, D. (2015). How cognitive theory guides neuroscience. *Cognition*, 135, 14-20 (special issue on influences of cognitive science on other domains).
- Wiecki, T.V., Poland, J.S., & Frank, M.J. (2015). Model-based cognitive neuroscience approaches to computational psychiatry: clustering and classification. *Clinical Psychological Science* 3, 378-399.
- Werchan, D., Collins, A.G.E, Frank, M.J. & Amso, D. (2015). Eight-Month-Old Infants Spontaneously Learn and Generalize Hierarchical Rules. *Psychological Science* 26, 805-815
- Cavanagh, J.F., Masters, S.E., Bath, K.G., and Frank, M.J. (2014). Conflict acts as an implicit cost in reinforcement learning. *Nature Communications* 5:5394
- Cockburn, J., Collins, A.G.E. and Frank, M.J. (2014). A reinforcement learning mechanism responsible for the valuation of free choice. *Neuron* 83, 551-557
- Collins, A.G.E., Brown, J., Gold, J.M., Waltz, J.A., Frank, M.J. (2014). Working memory contributions to reinforcement learning impairments in schizophrenia. *Journal of Neuroscience* 34, 13747-56.
- Kayser, A., Mitchell, J., Weinstein, D. & Frank, M. J. (2015). Dopamine, Locus of Control, and the Exploration-Exploitation Tradeoff. *Neuropsychopharmacology* 40, 454-462
- Bell, P., Gilat, M., O'Callaghan, C., Copland, C., Frank, M.J., Lewis, S. & Shine, J. (2015). Dopaminergic basis for impairments in functional connectivity across subdivisions of the striatum in Parkinson's Disease. *Human Brain Mapping*, 36(4):1278-91
- Collins, A.G.E. and Frank, M.J. (2014). Opponent actor learning (OpAL): Modeling interactive effects of striatal dopamine on reinforcement learning and choice incentive. *Psychological Review* 121, 337-366
- Cavanagh, J.F. and Frank, M.J. (2014). Frontal theta as a mechanism for cognitive control. *Trends in Cognitive Sciences* 18, 414-421.

Solomon, M., Frank, M.J., Ragland, J.D., Smith, A.C., Niendam, T.A., Lesh, T.A., Grayson, D., Beck, J.S., Matter, J.C. & Carter, C.S. (2015). Feedback-driven trial-by-trial learning in autism spectrum disorders. *American Journal of Psychiatry* 172, 173-181.

Collins, A.G.E., Cavanagh, J.F. and Frank, M.J. (2014). Human EEG uncovers latent generalizable rule structure during learning. *Journal of Neuroscience* 34, 4677-4685

Chatham, C., Frank, M.J. and Badre, D. (2014). Corticostriatal output gating during selection from working memory. *Neuron* 81, 930-942

Cavanagh, J.F., Wiecki, T.V., Kochar, A., and Frank, M.J. (2014). Eye tracking and pupillometry are indicators of dissociable latent decision processes. *Journal of Experimental Psychology: General* 143, 1476-1488

Cavanagh, J.F., Sanguinetti, J. L., Allen, J.J.B., Sherman, S.J. and Frank, M.J. (2014). The subthalamic nucleus contributes to post-error slowing. *Journal of Cognitive Neuroscience* 26, 2637-3644

Doll, B.B., Waltz, J.A., Cockburn, J., Brown, J.K., Frank, M.J. & Gold, J.M. (2014). Reduced susceptibility to confirmation bias in schizophrenia. *Cognitive, Affective & Behavioral Neuroscience* 14, 715-728

Moustafa, A.A., Krishna, R., Frank, M.J., Eissa, A., Hewedi, D. (2014). Cognitive correlates of psychosis in patients with Parkinson's disease. *Cognitive Neuropsychiatry* 19, 381-398

Narayanan, N.S., Cavanagh, J.F., Frank, M.J. and Laubach, M. (2013). Common medial frontal mechanisms of adaptive control in humans and rodents. *Nature Neuroscience*, 16, 1888-95

Guitart-Masip, M., Economides, M., Huys, Q., Frank, M.J., Chowdhury, R., Duzel, E., Dayan, P., and Dolan, R. (2014). Differential, but not opponent, effects of L-DOPA and citalopram on action learning with reward and punishment. *Psychopharmacology* 231, 955-966

Wiecki TV, Sofer I and Frank MJ (2013). HDDM: Hierarchical Bayesian estimation of the Drift-Diffusion Model in Python. *Frontiers of Neuroinformatics* 7:14

Collins, A.G.E and Frank, M.J. (2013). Cognitive control over learning: Creating, clustering and generalizing task-set structure. *Psychological Review*, 120, 190-229.

Wiecki, T.V. and Frank, M.J. (2013). A computational model of inhibitory control in frontal cortex and basal ganglia. *Psychological Review*, 120, 329-355.

Cavanagh, J.F., Eisenberg, I., Guitart-Masip, M., Huys, Q., and Frank, M.J. (2013). Frontal theta overrides Pavlovian learning biases. *Journal of Neuroscience*, 33, 8541-8548.

Gold, J.M., Strauss, G.P., Waltz, J.M., Robinson, B.M., Brown, J.K., and Frank, M.J. (2013). Negative symptoms in schizophrenia are associated with abnormal effort-cost computations. *Biological Psychiatry*, 74, 130-136

Gold, B., Frank, M.J., Bogert, B. and Brattico, E. (2013). Pleasurable music affects reinforcement learning according to the listener. *Frontiers in Auditory Cognitive Neuroscience* 4, 1-19.

Shine, J., Matar, E., Ward, P., Frank, M.J., Moustafa, A., Pearson, M., Naismith, S. and Lewis, S. (2013). Freezing of gait in Parkinson's disease is associated with functional de-coupling between the Cognitive Control Network and the basal ganglia. *Brain* 136, 3671-3681.

Shine, J., Moustafa, A. A., Matar, E., Frank, M.J., and Lewis, S. (2013). The role of frontostriatal impairment in freezing of gait in Parkinson's disease. *Frontiers in Systems Neuroscience* 7:61, 1-7

- Beeler, J. A*, Frank, M.J*, McDaid, J*, Alexander, E., Turkson, S., Bernandez, M.S., McGehee, D.S., & Zhuang, X. (2012). A role for dopamine-mediated learning in the pathophysiology and treatment of Parkinson's disease. *Cell Reports* 2, 1747-1761. *Joint first author
- Berghorst, L. H., Bogdan, R., Frank, M. J. & Pizzagalli, D. A. (2013). Acute stress selectively reduces reward sensitivity. *Frontiers in Neuroscience*, 7, 1-15
- Brown, J., Waltz, J.A., Strauss, G.P., McMahon, R.P., Frank, M.J. & Gold, J.M. (2013). Hypothetical decision making in schizophrenia: The role of expected value computation and "irrational" biases". *Psychiatry Research* 209, 142-149
- Cavanagh, J.F. and Frank, M.J. (2013). Stop! Stay tuned for more information. Commentary on Alegre et al. *Experimental Neurology* 247, 289-91.
- Jahfari, S., Verbruggen, F., Frank, M.J, Waldorp, L., Colzato, L., Ridderinkhof, K.R., and Forstmann, B. (2012). How preparation changes the need for top-down control of the basal ganglia when inhibiting premature actions. *Journal of Neuroscience*, 32, 10870-8.
- Collins, A.G.E. and Frank, M.J. (2012). How much of reinforcement learning is working memory, not reinforcement learning? A behavioral, computational, and neurogenetic analysis. *European Journal of Neuroscience* 35, 1024-1035.
- Cavanagh, J.F., Figueroa, C. M., Cohen, M.X., and Frank, M.J. (2012). Frontal theta reflects uncertainty and unexpectedness during exploration and exploitation. *Cerebral Cortex* 22, 2575-86.
- Lighthall, N., Gorlick, M. A., Schoeke, A., Frank, M. J. and Mather, M. (2013). Stress Modulates Reinforcement Learning in Younger and Older Adults. *Psychology & Aging* 28, 35-46
- Whitmer, A., Frank, M.J. and Gotlib, I.H. (2012). Sensitivity to reward and punishment in major depressive disorder: The effect of rumination. *Cognition and Emotion* 26, 1475-85.
- Badre, D., Doll, B.B., Long, N.M. and Frank, M.J. (2012). Rostrolateral prefrontal cortex and individual differences in uncertainty-driven exploration. *Neuron* 73, 595-607.
- Ratcliff, R. and Frank, M.J. (2012). Reinforcement-based decision-making in corticostriatal circuits: Mutual constraints by neurocomputational and diffusion models. *Neural Computation* 24, 1186-1229.
- Frank, M.J. and Badre, D. (2012). Mechanisms of hierarchical reinforcement in corticostriatal circuits I: Computational analysis. *Cerebral Cortex* 22, 509-526.
- Badre, D. and Frank, M.J. (2012). Mechanisms of hierarchical reinforcement learning in corticostriatal circuits II: Evidence from fMRI. *Cerebral Cortex* 22, 527-536.
- Gold, J.M., Waltz, J.A., Matveeva, T.M., Kasanova, Z., Strauss, G.P., Herbener, E.S., Collins, A., & Frank, M.J. (2012). Negative symptoms and the failure to represent the expected reward value of actions: Behavioral and computational modeling evidence. *Archives of General Psychiatry* 69, 129-138.
- Cavanagh J.F., Wiecki, T.V., Cohen, M.X., Figueroa, C., Samanta, J., Sherman, S.J., and Frank, M.J. (2011). Subthalamic stimulation reverses mediofrontal influence over decision threshold. *Nature Neuroscience* 14, 1462-67.
- Cavanagh, J.F., Bismark, A., Frank, M.J. and Allen, J.J.B. (2011). Larger error signals in major depression are associated with better avoidance learning. *Frontiers in Cognition* 2, 1-6.
- Wietzikoski, E.C., Boschen, S.L., Miyoshi, E., Bortolanza, L.M, Frank, M.J., Brandao, M.L., Winn, P., Da Cunha, C. (2012). Roles of D1-like dopamine receptors in the nucleus accumbens and dorsolateral striatum in conditioned avoidance responses. *Psychopharmacology* 219, 159-169.

- Ragland, J.D., Cohen, N.J., Cools, R., Frank, M.J., Hannula, D.E., Ranganath, C. (2012). CNTRICS Imaging Biomarkers Final Task Selection: Long-term Memory and Reinforcement Learning. *Schizophrenia Bulletin* 38, 62-72.
- Frank, M.J. (2011). Computational models of motivated action selection in corticostriatal circuits. *Current Opinion in Neurobiology* 21, 381-386.
- Doll, B.B., Hutchison, K.E. and Frank, M.J. (2011). Dopaminergic genes predict individual differences in susceptibility to confirmation bias. *Journal of Neuroscience* 31, 6188-6198.
- Maia, T.V. and Frank, M.J. (2011). From reinforcement learning models to psychiatric and neurological disorders. *Nature Neuroscience* 14, 154-162.
- Strauss, G.P.*, Frank, M.J.*, Waltz, J.A., Kasanova, Z., Herbener, E.S., Gold, J.M. (2011). Deficits in positive reinforcement learning and uncertainty-driven exploration are associated with distinct aspects of negative symptoms in schizophrenia. *Biological Psychiatry* 69, 424-31 (*authors contributed equally to this work).
- Cavanagh, J.F., Frank, M.J., & Allen, J.J.B. (2011). Social stress reactivity alters reward and punishment learning. *Social, Cognitive and Affective Neuroscience* 6, 311-320.
- Strauss, G.P., Robinson, B.M., Waltz, J.A., Frank, M.J., Kasanova, Z., Herbener, E.S., Gold, J.M. (2011). Patients with schizophrenia demonstrate inconsistent preference judgments for affective stimuli. *Schizophrenia Bulletin* 37, 1295-1304.
- Solomon, M., Frank, M.J., Smith, A.C., Ly, S. and Carter, C.S. (2011). Transitive inference in adults with autism spectrum disorders. *Cognitive, Affective and Behavioral Neuroscience* 11, 437-449.
- Solomon, M., Smith, A.C., Frank, M.J., Ly, S. and Carter, C.S. (2011). Probabilistic reinforcement learning in adults with autism spectrum disorders. *Autism Research* 4, 109-120.
- Kasanova Z, Waltz J.A., Strauss G.P., Frank M.J., Gold J.M. (2011). Optimizing vs. matching: Response strategy in a probabilistic learning task is associated with negative symptoms of schizophrenia. *Schizophrenia Research* 127, 215-222.
- Frank, M.J. and Fossella, J.A. (2011). Neurogenetics and pharmacology of learning, motivation and cognition. *Neuropsychopharmacology Reviews* 36, 133-152.
- Waltz, J. A., Frank, M.J., Wiecki, T.V. & Gold, J.M. (2011). Altered probabilistic learning and response biases in schizophrenia: Behavioral evidence and neurocomputational modeling. *Neuropsychology* 25, 86-97.
- Cavanagh, J.F., Frank, M.J., Klein, T.J., & Allen, J.J.B. (2010). Frontal theta links prediction errors to behavioral adaptation in reinforcement learning. *NeuroImage* 49, 3198-3209.
- Wiecki, T.V. and Frank, M.J. (2010). Neurocomputational models of motor and cognitive deficits in Parkinson's disease. *Progress in Brain Research* 183, 275-297.
- Cavanagh, J.F., Gruendler, T.O., Frank, M.J., & Allen, J.J.B. (2010). Altered cingulate sub-region activation accounts for task-related dissociation in ERN amplitude as a function of obsessive-compulsive symptoms. *Neuropsychologia* 48:2098-2109.
- Robinson, O.J., Frank, M.J., Sahakian, B.J. and Cools, R. (2010). Dissociable responses to punishment in distinct striatal regions during reversal learning. *NeuroImage* 51, 1459-1467.
- Samson, R.D., Frank, M.J., and Fellous, J.-M. (2010). Computational models of reinforcement learning: The role of dopamine as a reward signal. *Cognitive Neurodynamics* 4, 91-105.

- Chang, L.J., Doll, B.B., van 't Wout, M., Frank, M.J. and Sanfey, A.G. (2010). Seeing is believing: Trustworthiness as a dynamic belief. *Cognitive Psychology* 61, 87-105.
- Hazy, T.E., Frank, M.J. and O'Reilly, R.C. (2010). Neural mechanisms of acquired phasic dopamine responses in learning. *Neuroscience & Biobehavioral Reviews* 34, 701-720.
- Chase, H.W., Frank, M.J., Albert, M., Bullmore, E.T., Sahakian, B.J. and Robbins, T.W. (2010). Approach and avoidance learning in patients with major depression and healthy controls: Relation to anhedonia. *Psychological Medicine* 40:433-440.
- Frank, M.J., Doll, B.B., Oas-Terpstra, J. and Moreno, F. (2009). Prefrontal and striatal dopaminergic genes predict individual differences in exploration and exploitation. *Nature Neuroscience* 12:1062-1068.
- Frank, M.J. and Hutchison, K. (2009). Genetic contributions to avoidance-based decisions: Striatal D2 receptor polymorphisms. *Neuroscience* 164:131-140.
- Doll, B.B., Jacobs, W.J., Sanfey, A.G. and Frank M.J. (2009). Instructional control of reinforcement learning: A behavioral and neurocomputational investigation. *Brain Research* 1299:74-94
- Chatham, C., Frank, M.J. and Munakata, Y. (2009). Pupillometric and behavioral markers of a developmental shift in the temporal dynamics of cognitive control. *Proceedings of the National Academy of Science*, 106, 5529-33
- Wiecki, T.V., Riedinger, K., Meyerhofer, A., Schmidt, W.J. and Frank, M.J. (2009). A neurocomputational account of catalepsy sensitization induced by D2-receptor-blockade in rats: Context-dependency, extinction and renewal. *Psychopharmacology*, 204, 265-77
- Frank, M.J., Cohen, M.X. and Sanfey, A.G. (2009). Multiple systems in decision making: A neurocomputational perspective. *Current Directions in Psychological Science*, 18, 73-77.
- Gründler, T.O.J., Cavanagh, J.F., Frank, M.J. and Allen, J.J.B. (2009). Task related dissociation in ERN amplitude as a function of obsessive-compulsive symptoms. *Neuropsychologia* 47, 1978.
- Cools, R., Frank, M.J., Gibbs, S.E., Miyakawa, A., Jagust, W. and D'Esposito, M. (2009). Striatal dopamine predicts outcome-specific reversal learning and its sensitivity to dopaminergic drug administration. *Journal of Neuroscience* 29, 1538-1543.
- Cohen, M.X. and Frank, M.J. (2009). Neurocomputational models of basal ganglia function in learning, memory and choice. *Behavioural Brain Research*, 199, 141-156.
- Ragland, J.D., Cools, R., Frank, M.J., Pizzagalli, D.A., Preston, A., Ranganath, C. And Wagner, A.D. (2009). Cognitive neuroscience treatment research to improve cognition in schizophrenia (CNTRICS) final task selection: Long-term memory. *Schizophrenia Bulletin*, 35, 197-212
- Santesso, D.L., Evins, A.E., Frank, M.J., Cowman, E.M. and Pizzagalli, D.A. (2009). Single dose of a dopamine agonist impairs reinforcement learning in humans: Converging evidence from electrophysiology and computational modeling of striatal-cortical function. *Human Brain Mapping* 30, 1963-1976.
- Moustafa, A.A., Cohen, M.X., Sherman, S.J. and Frank, M.J. (2008). A role for dopamine in temporal decision making and reward maximization in Parkinsonism. *Journal of Neuroscience*, 28, 12294-12304.
- Frank, M.J. (2008). Schizophrenia: A computational reinforcement learning perspective. *Schizophrenia Bulletin*, 34, 1008-1011.
- Moustafa, A.A., Sherman, S.J. and Frank, M.J. (2008). A dopaminergic basis for working memory, learning, and attentional shifting in Parkinsonism. *Neuropsychologia*, 46, 3144-56.

- Frank, M.J., O'Reilly, R.C. and Curran, T. (2008). Midazolam, hippocampal function, and transitive inference: Reply to Greene. *Behavioral and Brain Functions*, 4:5.
- Frank, M.J. and Kong, L. (2008). Learning to avoid in older age. *Psychology and Aging*, 23: 392
- Pizzagalli, D.A., Evins, A.E., Schetter Cowman, E., Frank, M.J., Pajtas, P.E., Santesso, D.L., and Culhane, M. (2008). Single dose of a dopamine agonist impairs reinforcement learning in humans: Behavioral evidence from a laboratory-based measure of reward responsiveness. *Psychopharmacology* 196, 221–232.
- Frank, M.J., Samanta, J., Moustafa, A.A. and Sherman, S.J. (2007). Hold your horses: Impulsivity, deep brain stimulation and medication in Parkinsonism. *Science*, 318, 1309-1312.
- Frank, M.J., Moustafa, A.A., Haughey, H.C., Curran, T. And Hutchison, K. (2007). Genetic triple dissociation reveals multiple roles for dopamine in reinforcement learning. *Proceedings of the National Academy of Sciences*, 104, 16311-16316.
- Frank, M.J., D'Lauro, C., and Curran, T. (2007). Cross-task individual differences in error processing: Neural, electrophysiological, and genetic components. *Cognitive, Affective, and Behavioral Neuroscience* 7, 297-308.
- Aron, A.R., Behrens, T.E., Smith, S. Frank, M.J. and Poldrack, R.A. (2007). Triangulating a cognitive control network using diffusion-weighted MRI and functional MRI. *Journal of Neuroscience*, 27, 3743-52.
- Frank, M.J., Santamaria, A., O'Reilly, R.C. and Willcutt, E. G. (2007). Testing computational models of dopamine and noradrenaline dysfunction in attention-deficit/hyperactivity disorder. *Neuropsychopharmacology*, 32, 1583-99.
- Frank, M.J., Scheres, A. and Sherman, S.J. (2007). Understanding decision making deficits in neurological conditions: Insights from models of natural action selection. *Philosophical Transactions of the Royal Society-B*, 362, 1641-54.
- Hazy, T., Frank, M.J. and O'Reilly, R.C. (2007). Toward an executive without a homunculus: Computational models of the prefrontal cortex/basal ganglia system. *Philosophical Transactions of the Royal Society-B*, 362, 1601-13.
- O'Reilly, R.C., Frank, M.J., Hazy, T. and Watz, B. (2007). PVLV: The Primary Value and Local Value Pavlovian Learning Algorithm. *Behavioral Neuroscience*, 121, 31-49.
- Waltz, J., Frank, M.J., Robinson, B. and Gold, J. (2007). Selective reinforcement learning deficits in schizophrenia support predictions from computational models of striato-cortical dysfunction. *Biological Psychiatry*, 62, 756-764.
- Frank, M.J. (2006). Hold your horses: A dynamic computational role for the subthalamic nucleus in decision making. *Neural Networks*, 19, 1120-1136
- Frank, M.J. and Claus, E. (2006). Anatomy of a Decision: Striato-Orbitofrontal Interactions in Reinforcement Learning, Decision Making and Reversal. *Psychological Review*, 113, 300-326.
- Frank, M.J. and O'Reilly, R.C. (2006). A mechanistic account of striatal dopamine function in cognition: Psychopharmacological studies with cabergoline and haloperidol. *Behavioral Neuroscience*, 120, 497-517.
- Frank, M.J., O'Reilly, R.C. and Curran, T. (2006). When memory fails, intuition reigns: Midazolam enhances implicit inference in humans. *Psychological Science*, 17, 700-707.
- O'Reilly, R.C. and Frank, M.J. (2006). Making working memory work: A computational model of learning in the frontal cortex and basal ganglia. *Neural Computation*, 18, 283-328.

Hazy, T., Frank, M.J. and O'Reilly, R.C. (2006). Banishing the homunculus: Making working memory work. *Neuroscience*, 139, 105-118.

Frank, M.J. (2005). Dynamic dopamine modulation in the basal ganglia: A neurocomputational account of cognitive deficits in medicated and nonmedicated Parkinsonism. *Journal of Cognitive Neuroscience*, 17, 51-72.

Frank, M.J., Worocho, B.S. & Curran, T. (2005). Error related negativity predicts reinforcement learning and conflict biases. *Neuron*, 47, 495-501.

Frank, M.J., Rudy, J.W., Levy, W.B. & O'Reilly, R.C. (2005) When logic fails: Implicit transitive inference in humans. *Memory and Cognition*, 33, 742-50.

Frank, M.J., Seeberger, L.C. and O'Reilly, R.C. (2004). By carrot or by stick: Cognitive reinforcement learning in Parkinsonism. *Science*, 306, 1940-3.

Atallah, H.E., Frank, M.J. and O'Reilly, R.C. (2004). Hippocampus, cortex and basal ganglia: Insights from computational models of complementary learning systems. *Neurobiology of Learning and Memory*, 82, 253-67.

Frank, M.J., Rudy, J.W., & O'Reilly, R.C. (2003). Transitivity, flexibility, conjunctive representations and the hippocampus: II: A computational analysis. *Hippocampus*, 13, 341-354.

Frank, M. J., Loughry, B. & O'Reilly, R. C. (2001) Interactions between frontal cortex and basal ganglia in working memory: A computational model. *Cognitive, Affective, and Behavioral Neuroscience*, 1 137-160.

Books

O'Reilly, R. C., Munakata, Y., Frank, M. J., Hazy, T. E., and Contributors (2024). *Computational Cognitive Neuroscience*. Wiki Book, 5th Edition (2024). URL: <https://compcogneuro.org/>

Commentaries/Editorials/Book Chapters/Conference Proceedings:

Hazy, T.E., Frank, M.J. & O'Reilly, R.C. (2023). Computational Neuroscience Models of Working Memory. Chapter in Run, R. Ed. *The Cambridge Handbook on Computational Cognitive Sciences*. 2nd ed. Cambridge Handbooks in Psychology. Cambridge University Press; 2023:611-663. doi:10.1017/9781108755610.023 611-663.

Westbrook, A., Cools, R. & Frank, M.J. Dopamine and reward: Implications for neurological and psychiatric disorders. in *The Cognitive Neurosciences, 6th Edition* (eds. Poeppel, D., Mangun, G. R. & Gazzaniga, M. S.) 651–664 (2020).

Albrecht, M.A., Waltz, J.A., Frank, M.J. & Gold, J.M. (2018). Modeling negative symptoms in schizophrenia. Chapter in Anticevic, A., Murray, J.D. Eds. *Computational Psychiatry: Mathematical Modeling of Mental Illness*, Elsevier, Academic Press, 219-246.

Maia, T.V, Huys, Q.J.M., & Frank, M.J. (2017). Theory-based computational psychiatry. *Biological Psychiatry* 82, 382-384.

Bhandari, A., Badre, D. & Frank, M.J. (2017). Learning cognitive control. Chapter in Egner, T. ed. *The Wiley Handbook of Cognitive Control*, John Wiley & Sons Ltd. Chichester, West Sussex, UK pp 376-391

Collins, A.G.E. & Frank, M.J. (2016). Surprise! Dopamine signals mix action, value and error. *News & Views, Nature Neuroscience* 19, 3-5

Frank, M.J. (2016). Computational cognitive neuroscience approaches to deconstructing mental function and dysfunction. In: *Computational Psychiatry: New Perspectives on Mental Illness*, ed. A. D. Redish and J. A. Gordon. Strüngmann Forum Reports, vol. 20, J. Lupp series editor. Cambridge, MA: MIT Press.

Kurth-Nelson, Z., O'Doherty, J. P., Barch D. M., Denève, S., Durstewitz, D., Frank, M.J., Gordon, J.A., Mathew, S. J., Niv. Y., Ressler, K. & Tost, H. (2016). Computational Approaches for Studying Mechanisms of Psychiatric Disorders. In: Computational Psychiatry: New Perspectives on Mental Illness, ed. A. D. Redish and J. A. Gordon. Strüngmann Forum Reports, vol. 20, J. Lupp series editor. Cambridge, MA: MIT Press.

Frank, M.J. (2015). Linking across levels of computation in model-based cognitive neuroscience. Chapter in Forstmann, B. U. & Wagenmakers, E.-J., eds. *An introduction to model-based cognitive neuroscience*. Springer, pp 163-181.

Frank, M.J., Scheres, A. & Sherman, S.J. (2012). Understanding decision making deficits in neurological conditions: Insights from models of natural action selection. Chapter in Seth, A., Prescott, T., & Bryson, J., eds, *Modeling Natural Action Selection*, Cambridge University Press, pp330-362.

Hazy, T., Frank, M.J., & O'Reilly, R.C. (2012). Towards an executive without a homunculus: Computational models of the prefrontal cortex/basal ganglia system. Chapter in Seth, A., Prescott, T., & Bryson, J., eds, *Modeling Natural Action Selection*, Cambridge University Press, pp239-263.

Cockburn, J. and Frank, M.J. (2011). Reinforcement learning, conflict monitoring and cognitive control: An integrative model of cingulate-striatal interactions and the ERN. Chapter in R. Mars, J. Sallet, M. Rushworth, and N. Yeung. (eds), *Neural Basis of Motivational and Cognitive Control*, MIT Press, pp. 311-331.

Daw, N.D. and Frank, M.J. (2009) Reinforcement learning and higher level cognition: Introduction to special issue. *Cognition*, 113, 259-261

Frank, M.J. and Surmeier, D.J. (2009). Do substantia nigra dopaminergic neurons differentiate between reward and punishment? *Journal of Molecular Cell Biology (JMCB)*, 1 15-16.

Frank, M.J. (2009). Slave to the striatal habit: Commentary on Tricomi et al. *European Journal of Neuroscience*, 29, 2223-4.

Doll, B.B. and Frank, M.J. (2009). The basal ganglia in reward and decision making: Computational models and empirical studies. Chapter in J.-C. Dreher and L. Tremblay, eds, *Handbook of Reward and Decision Making*, Oxford:Academic Press, pp399-425.

Frank, M.J. (2005). When and when not to use your subthalamic nucleus: Lessons from a computational model of the basal ganglia. *Modelling Natural Action Selection: Proceedings of an International Workshop*, 53-60.

Popular Press (non-peer reviewed):

Frank, M.J. (2007). "Go" and "NoGo" Learning and the Basal Ganglia. *Cerebrum* (<http://www.dana.org/news/cerebrum/detail.aspx?id=10376>)

Frank, M.J. and O'Reilly, R.C. (2005). Cognitive processes in Parkinson's disease: From dopamine to behavior. *Colorado Neurological Institute Review*, Fall 2005, pp. 3-9.