

**SUSAN A. MURPHY**

(617) 495 5497, samurphy@fas.harvard.edu

<http://people.seas.harvard.edu/~samurphy/>

Mallinckrodt Professor of Statistics and of Computer Science,  
Radcliffe Alumnae Professor at the Radcliffe Institute and  
Harvard University  
Cambridge, MA 02138-2901

**RESEARCH INTERESTS:**

Experimental design and causal inference to inform sequential decision making, particularly with regards to sequencing treatments in health and in mobile health intervention development. Inference for high dimensional models.

**EDUCATION:**

Ph.D., Statistics (1989), “Time-Dependent Coefficients in a Cox-Type Regression Model”  
(P.K. Sen, advisor) University of North Carolina, Chapel Hill, NC

B.S., Mathematics (1980), Louisiana State University, Baton Rouge, LA

**PROFESSIONAL POSITIONS SINCE 2001:**

Fall, 2021-	Mallinckrodt Professor of Statistics and of Computer Science Harvard Univ.
Fall, 2017-	Radcliffe Alumnae Professor at the Radcliffe Institute, Harvard Univ.
Fall, 2017-2021	Professor of Statistics and Professor of Computer Science at the Harvard John A. Paulson School of Engineering and Applied Sciences Harvard Univ.
Fall, 2014-2017	H.E. Robbins Distinguished University Professor of Statistics, Dept of Statistics, Univ. of Michigan
Fall, 2005 -2017	Professor of Psychiatry, Univ. of Michigan
Fall, 2004 - 2014	H.E. Robbins Professor of Statistics, Dept. of Statistics, Univ. of Michigan
Fall, 2001 - 2004	Professor of Statistics, Dept. of Statistics, Univ. of Michigan
Fall, 2001 - 2017	Research Professor, Institute for Social Research, Univ. of Michigan

**HONORS since 2000:**

**2021:** Van Wijngaarden Award 2021, Centrum Wiskunde & Informatica, The Netherlands

**2019:** Royal Statistical Society Guy Medal in Silver

**2018:** Australian Mathematical Sciences Institute-Statistical Society of Australia 2018 Lecturer

**2018:** R.A. Fisher Award and Lectureship

**2018:** Precision Medicine World Conference 2018 Luminary Award

**2016:** Elected a member of the National Academy of Sciences of the US National Academies

**2014:** Elected a member of the National Academy of Medicine (formerly the Institute of Medicine)  
of the US National Academies

**2014:** Elected a Fellow of the College on Problems in Drug Dependence.

**2014-2018:** MacArthur Fellow.

**2011:** Elected a Member of the International Statistical Institute.

**2007-8:** Invited Fellow at the Center for Advanced Study in the Behavioral Sciences, Stanford University

**2002:** Elected a Fellow of the American Statistical Association.

**2000:** Elected a Fellow of the Institute of Mathematical Statistics.

**Keynote, Plenary and Distinguished Lectures since 2010:**

**2021:** 2021 Myles Hollander Distinguished Lecture, Florida State University

**2021:** Keynote, Uncertainty in Artificial Intelligence 2021, (Virtual Presentation)

**2020:** Keynote, Joint Conference of the GMDS & CEN-IBS 2020, Berlin (Virtual Presentation)

**2020:** Keynote, 13th International Conference on Health Policy Statistics, San Diego

**2019:** Plenary Lecture at the Statistics and the Life Sciences: Creating a Healthier World, University of Boston Dean's Symposium

**2019:** Challis Lectures, University of Florida

**2019:** Duncan Lecture in Applied Mathematics & Statistics, Johns Hopkins University

**2019:** Keynote at "3rd NorthEast Computational Health Summit," Providence, RI

**2019:** Distinguished Visitor Lecture Series Speaker at IMS, Singapore (3 lectures)

**2019** Keynote at "Big Data for Better Science: Technologies for Measuring Behaviour" meeting. The Royal Scientific Society, London, UK

**2018:** 2018 Distinguished Lecture in Statistical Sciences, Fields Institute for Research in Mathematical Sciences

**2018:** Keynote, COLT 2018 in Stockholm, Sweden

**2018:** Opening Keynote, 2018 Modern Modeling Methods Conference, Storrs CT

**2018:** Harvard Award and Lecture in Psychiatric Epidemiology and Biostatistics, Harvard Program in Brain Health.

**2017:** Keynote Lecture at the Machine Learning in Health Care Workshop, NIPS.

**2017:** David Sprott Distinguished Lecture, Department of Statistics and Actuarial Science, University of Waterloo; Waterloo, Canada.

**2017:** Vice Chancellor for Research Distinguished Lecture, University of Tennessee Health Center; Memphis, TN.

**2017:** Keynote Lecture, Centre for Behaviour Change's 3rd Digital Health Conference; UCL, London

**2016:** Plenary Talk, CLAPEM, San José, Costa Rica

**2016:** Keynote Lecture, IMPACT Symposium IV

**2016:** Keynote Lecture, IEEE Wireless Health

**2016:** Lecture in the NSF Distinguished Lecture Series in Mathematical and Physical Sciences, Washington, DC

**2016:** Plenary Talk, Conference on Statistical Learning and Data Science, Chapel Hill

**2016:** Presented the Henry Seeley White Lectures at Vassar College, NY

**2016:** Association for the Advancement of Artificial Intelligence 2016 Invited Talk, Phoenix, AR (one of 6 invited talks)

**2015:** Plenary Lecturer, ASA Biopharmaceutical 2015 Workshop

**2015:** IMS Wald Lecturer, JSM, Seattle

**2015:** Invited Speaker at the International Conference on Machine Learning (ICML), Lille, Paris (one of three invited speakers)

**2015:** Presented the Keynote Lecture at the Joint ICSA/Greybill Symposium, Ft. Collins  
**2015:** Presented the Bernard G. Greenberg Lecture Series, UNC, Chapel Hill  
**2015:** Keynote Speaker at the 2015 Doctoral Hooding Ceremony, UNC, Chapel Hill  
**2015:** Presented the Bradley Lecture, University of Georgia, Athens  
**2014:** Presented the 12th Annual Armitage Lecture, Medical Research Council Biostatistics Unit, Cambridge  
**2014:** Presented the G. Snedecor Memorial Lecture, Department of Statistics, Iowa State University  
**2014:** Presented the P. Porcelli Lectures, Department of Mathematics, Louisiana State University  
**2014:** Presented the R.R. Bahadur Memorial Lectures, Department of Statistics, University of Chicago

**SERVICE TO THE SCIENTIFIC COMMUNITY (mostly since 2010):**

2021	Member, External Review Committee of the Data Science Institute, Columbia University
2020	Co-Organizer and Chair, American Academy of Addiction Psychiatry Workshop on “Trials and Tribulations in Optimizing mHealth Interventions in Addictions” at the 31st AAAP annual meeting.
2018-2021	President-Elect, President, Past President, Institute of Mathematical Statistics
2015-2021	President-Elect, President, Past President, Bernoulli Society
2017-	External Advisory Board; MIT Institute for Data, Systems and Society
2016-2017	SAMSI Director Search Committee
2016-2017	Local Organizing Committee, 3rd Multi-disciplinary Conference on Reinforcement Learning and Decision Making
Fall, 2015	External Review Committee Member; UC, Berkeley Statistics Dept.
2015	Reviewer for ICML, AAAI (computer science conferences)
2015- 2017	Member, Committee on National Statistics, The National Academies
2015	Member, Organizing Committee for The Multi-disciplinary Conference on Reinforcement Learning and Decision Making (RLDM)
2013-2016	Member, IMS Council
2012	Member, Organizing Committee for Workshop on Future Research Directions in Statistics
2012-2015	SAMSI National Advisory Committee Co-Chair
2011-12	Chair, Committee to Select Editors, AOS
2011	Member, Joint IMS/BS Publications Management Committee
2010	Member of the Scientific Organizing Committee for International Conference on Health Policy Statistics 2011
2009-2010	Member of the NAS Oversight Committee on the Handling of Missing Data in Clinical Trials
2009-2011	Member of the NIMH Interventions Committee for Adult Disorders
2009-2011	Member of the Columbia University HIV Center for Clinical and Behavioral Studies’s external PSMB.
2008-2015	Member of the SAMSI National Advisory Council
2007-2009	Editor of <i>The Annals of Statistics</i> (with B. Silverman)

**PUBLICATIONS AND MANUSCRIPTS:**Articles in Refereed Journals and Refereed Proceedings

(129) Qian, T., Walton, A., Collins, L.M., Klasnja, P., Lanza, S., Nahum-Shani, I., Rabbi, M., Russell, M., Walton, M.A., Yoo, H. and Murphy, S.A. The Micro-Randomized Trial for Developing Digital Interventions: Experimental Design and Data Analysis Considerations *To appear in Psychological Methods*

(128) K. Zhang, L. Janson and Murphy, S.A. Statistical Inference with M-Estimators on Adaptively Collected Data. *To appear in NeurIPS 2021.*

(127) Nahum-Shani, I., Potter, L.N., Lam, C.Y., Yap, J., Moreno, A., Stoffel, R., Wu, Z., Wan, N., Dempsey, W., Kumar, S., Ertin, E., Murphy, S.A., Rehg, J., Wetter, D.W. The Mobile-Assistance for Regulating Smoking (MARS) Micro-Randomized Trial Design Protocol. *To appear in Contemporary Clinical Trials*

(126) A. M. Psihogios, M. Rabbi, A. Ahmed, E. R. McKelvey, Y. Li, J. Laurenceau, S P Hunger, L Fleisher, A Pai, L. A. Schwartz, S.A. Murphy & L. P. Barakat. Ecological Momentary Assessment to Understand Adolescent and Young Adult 6-mercaptopurine Adherence and mHealth Engagement during Cancer Treatment: A Protocol Paper. *To appear in JMIR Research Protocols* DOI: 10.2196/preprints.32789

(125) Yao, J., Brunskill, E., Pan, W., Murphy, S.A., Doshi-Velez, F., Power Constrained Bandits. Machine Learning in Health Care 2021. *To appear in Proceedings of Machine Learning Research.*

(124) Tomkins, S., Liao, P., Klasnja, P. and Murphy, S.A., Intelligent Pooling: Practical Thompson Sampling for mHealth. *Mach Learn.* (2021). PMID:PMC849236

(123) Nahum-Shani, I., Rabbi, M., Yap, J., Philyaw-Kotov, M.L., Klasnja, P., Bonar, E.E., Cunningham, R.M., Murphy, S.A. and M.A. Walton., Translating Strategies for Promoting Engagement in Mobile Health: A Proof-of-Concept Micro-Randomized Trial. *To appear in Health Psychology.*

(122) Zhang, K.W., Janson, L. and Murphy, S.A., Inference for Batched Bandits. *34th Conference on Neural Information Processing Systems (NeurIPS 2020)*, Vancouver, Canada

(121) Qian, T., Yoo, H., Klasnja, P., Almirall, D. and Murphy, S.A. (2020). Estimating Time-Varying Causal Excursion Effects in Mobile Health with Binary Outcomes with discussion. *Biometrika* Volume 108, Issue 3, September 2021, Pages 507-527. Rejoinder: *Biometrika* Volume 108, Issue 3, September 2021, Pages 551-555.

(120) Bidargaddi, N., Schrader, G., Klasnja, P., Licinio, J. and S.A. Murphy. Designing m-Health interventions for precision mental health support. *Translational Psychiatry* (2020)10:222 <https://doi.org/10.1038/s41398-020-00895-2>

(119) Kroska, E.B., Hoel, S., Victory, A., Murphy, S.A., McInnis, M.G., Stowe, Z.N. and A. Cochran. Optimizing Acceptance and Commitment Therapy Microintervention via a Mobile App with Two Cohorts: Protocol for Micro-Randomized Trials, *JMIR Res Protoc* (forthcoming). doi:10.2196/17086

(118) Liao, P., Klasnja, P. and Murphy, S.A., Off-Policy Estimation of Long-Term Average Outcomes with Applications to Mobile Health. *To appear in Journal of the American Statistical Association.*

- (117) Liao, P., Greenewald K., Klasnja, P. and Murphy, S.A., Personalized HeartSteps: A Reinforcement Learning Algorithm for Optimizing Physical Activity. Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies March 2020 Article No.: 18. <https://doi.org/10.1145/3381007>
- (116) Rabbi, M., Li, K., Yan, H.Y., Hall, K., Klasnja, P. and Murphy, S.A., ReVibe: A context-assisted evening recall approach to improve self-report adherence. Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies December 2019 Article No.: 149. <https://doi.org/10.1145/3369806>. PubMed Central PMCID: PMC8218636.
- (115) Dempsey, W., Liao, P., Kumar, S. and Murphy, S.A., The stratified micro-randomized trial design: sample size considerations for testing nested causal effects of time-varying treatments *Annals of Applied Statistics* (2020) 14 (2): 661-684 .
- (114) Qian, T., Klasnja, P. and Murphy, S.A., Linear mixed models under endogeneity: modeling sequential treatment effects with application to a mobile health study. *Statistical Science with Discussion*. (2020) 35, (3): 375-390. Rejoinder pgs: 400-403. PMCID: PMC7596885
- (113) Seewald, N., Smith S., Lee A., Klasnja P. and Murphy, S.A., Practical Considerations for Data Collection and Management in Mobile Health Micro-randomized Trials. *Statistics in Biosciences*. Published online 01.05.2019. <https://doi.org/10.1007/s12561-018-09228-w>
- (112) Liao, P., Dempsey, W., Sarker, H., Hossain S.M., alAbsi, M., Klasnja, P., and Murphy, S.A., Just-in-Time But Not Too Much: Determining Treatment Timing in Mobile Health, *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.*, Vol. 2, No. 4, Article 179. December 2018. PMCID: PMC6380673
- (111) Klasnja, P., Smith, S., Seewald, N.J., Lee, A., Hall, K., Luers, B., Hekler, E.B. and Murphy, S.A. Efficacy of contextually-tailored suggestions for physical activity: A micro-randomized optimization trial of HeartSteps *Annals of Behavioral Medicine*. 2018 Sep 5. [Epub ahead of print] PubMed PMID: 30192907; PubMed Central PMCID: PMC6401341
- (110) Bidargaddi N, Almirall D, Murphy, S.A., Nahum-Shani I, Kovalcik M, Pituch T, Maaieh H and Strecher V. To prompt or not to prompt? A micro-randomized trial of time-varying push notifications to increase proximal engagement with a mobile health application *JMIR mHealth and uHealth*;6(11):e10123 DOI: 10.2196/10123
- (109) Rabbi M, Philyaw-Kotov M, Cunningham R, Bonar EE, Nahum-Shani I, Klasnja P, Walton M, **Murphy**, S.A., Towards increasing engagement in substance use data collection: Development of the SARA app and protocol for a micro-randomized trial with adolescents and emerging adults. *JMIR Res Protoc* 2018;7(7):e166 URL: <https://www.researchprotocols.org/2018/7/e166>. doi:10.2196/resprot.9850 <http://dx.doi.org/10.2196/resprot.9850>
- (108) Walton, A, Nahum-Shani, I, Crosby, L, Klasjna, P and **Murphy**, S.A., (2018). Optimizing Digital Integrated Care via MicroRandomized Trials. *Clinical Pharmacology & Therapeutics*, 104 (1), 53-58. <http://doi.org/10.1002/cpt.1079> NIHMS ID 956009 PMCID: PMC5995647
- (107) Luers, B., Klasnja P. and **Murphy**, S.A., Standardized effect sizes for preventive mobile health interventions in micro-randomized trials. *Prevention Science*. 2018 Jan 9. doi: 10.1007/s11121-017-0862-5.PMCID: PMC6037616
- (106) Greenewald, K., Tewari A., Klasnja P. and **Murphy**, S.A. Action Centered Contextual Bandits. *Adv Neural Inf Process Syst*. 2017 Dec; 30: 59735981, PMC5719505

- (105) Dempsey, W.H., Moreno, A., Scott, C.K., Dennis, M.L., Gustafson, D.H., **Murphy, S.A.** and Rehg, J.M., iSurvive: An Interpretable, Event-time Prediction Model for mHealth, Proceedings of the 34th International Conference on Machine Learning, Sydney, Australia, PMLR 70, 2017. NIHMS922395. PMC6430609.
- (104) Boruvka, A., Almirall, D., Witkiewitz, K. & **Murphy, S.A.**. Assessing Time-Varying Causal Effect Moderation in Mobile Health, *Journal of the American Statistical Association*, 113:523, 1112-1121, Accepted author version posted online: 31 Mar 2017  
<http://dx.doi.org/10.1080/01621459.2017.1305274>
- (103) Nahum-Shani, I., Smith, S.N. Spring, B.J., Collins, L.M., Witkiewitz, K., Tewari, A., & **Murphy, S.A.**. (2018). Just-in-Time Adaptive Interventions (JITAs) in Mobile Health: Key Components and Design Principles for Ongoing Health Behavior Support. *Ann Behav Med*. 2018 May 18;52(6):446-462. doi: 10.1007/s12160-016-9830-8. PMCID: PMC5364076
- (102) Bekiroglu, K., Lagoa, C., **Murphy, S.A.** & S. T. Lanza, S.T. Control Engineering Methods for the Design of Robust Behavioral Treatments, (2016) *IEEE Transactions on Control Systems Technology*. Vol 25(3):979-990. Epub 2016 Jun 28. PMCID: PMC5362168
- (101) Dempsey, W., Liao, P., Klasnja, P., Nahum-Shani, I., **Murphy, S.A.** (2015). Randomized trials for the Fitbit generation, *Significance*. 12(6):20-23. PMCID: PMC4721268
- (100) Liao,P., Klasnja, P., Tewari, P., **Murphy, S.A.**, (2015) Micro-Randomized Trials in mHealth, *Statistics in Medicine*. Dec 28. doi: 10.1002/sim.6847. [Epub ahead of print] PubMed PMID: 26707831
- (99) Klasnja, P., Hekler, E.B., Shiffman, S., Boruvka, A., Almirall, D., Tewari, A. and **Murphy, S.A.** (2015). Micro-randomized trials: An experimental design for developing just-in-time adaptive interventions, *Health Psychology*. Vol 34(Suppl):1220-1228. doi: 10.1037/hea0000305. PubMed PMID: 26651463; PubMed Central PMCID: PMC4732571
- (98) Lu, X., Lynch, K.G., Oslin, D.W. and **Murphy, S.A.** (2015) Comparing Treatment Policies with Assistance from the Structural Nested Mean Model. *Biometrics*. Sep 13. [Epub ahead of print] PubMed PMID: 26363892
- (97) Kumar, S., Abowd, G., Abraham, W., al Absi, M., Beck, J.G., Chau, D.H., Condie, T., Conroy, D.E., Ertin, E., Estrin, D., Ganesan, D., Lam, C., Marlin, B., Marsh, C.B., **Murphy, S.A.**, Nahum-Shani, I., Patrick, K., Rehg, J., Sharmin, M., Shetty, V., Sim, I., Spring, B., Srivastava, M., Wetter, D. Center of Excellence for Mobile Sensor Data-to-Knowledge (MD2K)(2015). *Journal of the American Medical Informatics Association*. 22(6): 1137-1142 First published online: 3 July 2015
- (96) Gunlicks-Stoessel, M., Mufson, L., Westervelt, A., Almirall, D. and **S.A. Murphy** (2015). A Pilot SMART for Developing an Adaptive Treatment Strategy for Adolescent Depression. *Journal of Clinical Child & Adolescent Psychology*. 2015 Mar 18:1-15. [Epub ahead of print] PMID: 25785788
- (95) Kilbourne, A. M., Almirall, D., Eisenberg, D., Waxmonsky, J., Goodrich, D. E., Fortney, J. C., Kirchner, J. E., Solberg, L. I., Main, D., Bauer, M.S., Kyle, J., **Murphy, S.A.**, Nord, K.M., and M. R. Thomas (2014). Protocol: Adaptive Implementation of Effective Programs Trial (ADEPT): cluster randomized SMART trial comparing a standard versus enhanced implementation strategy to improve outcomes of a mood disorders program. *Implementation Science*. 2014 Sep 30;9:132. PMCID: PMC4189548

- (94) Laber, E., D. Lizotte, M. Qian, W.E. Pelham and **S.A. Murphy** (2014). Dynamic treatment regimes: technical challenges and applications. *Electronic Journal of Statistics, with discussion*. Vol. 8, No. 0, 1225-1272. PMID: PMC4209714
- (93) Shortreed, S.M., E. Laber, T.S. Stroup, J. Pineau, & **S.A. Murphy** (2014). A multiple imputation strategy for sequential multiple assignment randomized trials. *Statistics in Medicine* Oct 30;33(24):4202-14. PMID: PMC4184954
- (92) Kasari C., Kaiser A., Goods K., Nietfeld J., Mathy P., Landa R., **S.A. Murphy**, Almirall D. (2014) Communication Interventions for Minimally Verbal Children with Autism: Sequential Multiple Assignment Randomized Trial. *Journal of the American Academy of Child and Adolescent Psychiatry* Jun;53(6):635-46. PMID: PMC4030683
- (91) Almirall D., Nahum-Shani, I., Sherwood, N.E. & **S.A. Murphy** (2014). Introduction to SMART Designs for the Development of Adaptive Interventions: With Application to Weight Loss Research. *Translational Behavioral Medicine: Practice, Policy and Research*. Sep; 4(3): 260274. PMID: PMC4167891
- (90) Lagoa, C.M., Bekiroglu, K., Lanza, S.T. & **S.A. Murphy** (2014) Designing Adaptive Intensive Interventions Using Methods from Engineering. *Journal of Consulting and Clinical Psychology* Oct;82(5):868-78. PMID: PMC4176810
- (69) Kumar, S., W.J. Nilsen, A. Abernethy, A. Atienza, K. Patrick, M. Pavel, W.T. Riley, A. Shar, B. Spring, D. Spruijt-Metz, D. Hedeker, V. Honavar, R. Kravitz, R. Craig Lefebvre, D.C. Mohr, **S.A. Murphy**, C. Quinn, V. Shusterman, D. Swendeman, (2013) Mobile Health Technology Evaluation, The mHealth Evidence Workshop. *Am J Prev Med* 45(2):228-236. PMID: PMC3803146
- (68) Almirall, D., Griffin BA, McCaffrey DF, Ramchand R, Yuen RA, **Murphy S.A.** (2014). Time-varying effect moderation using the structural nested mean model: estimation using inverse-weighted regression-with-residuals. *Statistics in Medicine*. Sep 10;33(20):3466-87. PMID: PMC4008726
- (67) Bekiroglu, K., Lagoa, C., **Murphy S.** & Lanza, S. T. (2013). A robust MPC approach to the design of treatments. *Proceedings of the 2013 52nd IEEE Conference on Decision and Control* Dec:3505 - 3510. DOI:10.1109/CDC.2013.6760421
- (66) Fonteneau, R., **S.A. Murphy**, Wehenkel, L., D. Ernst, (2013). Batch Mode Reinforcement Learning based on the Synthesis of Artificial Trajectories. *Annals of Operations Research*. 208:383-416. PMID: PMC3773886
- (65) Lizotte D.J., Bowling M., **S.A. Murphy** (2012). Linear Fitted-Q Iteration with Multiple Reward Functions. *Journal of Machine Learning Research*.13(Nov):3253-3295. PMID: PMC3670261
- (64) Almirall D., Compton S.N., Rynn M.A., Walkup J.T., **S.A. Murphy**, SMARTer Discontinuation Trials: With Application to the Treatment of Anxious Youth. *Journal of Child and Adolescent Psychopharmacology*. Oct 2012; 22(5): 364-374. doi: 10.1089/cap.2011.0073 PMID: PMC3482379
- (63) Little RJ, D Agostino R, Cohen ML, Dickersin K, Emerson SS, Farrar JT, Frangakis C, Hogan JW, Molenberghs G, **S.A. Murphy**, Neaton JD, Rotnitzky A, Scharfstein D, Shih W, Siegel JP and H Stern. (2012). The Prevention and Treatment of Missing Data in Clinical Trials. *New England Journal of Medicine*. vol. 367:1355-1360 PMID: PMC3771340

- (62) I. Nahum-Shani, M. Qian, D. Almiral, W.. Pelham, B. Gnagy, G. Fabiano, J. Waxmonsky, J. Yu and **S.A. Murphy**. Experimental Design and Primary Data Analysis Methods for Comparing Adaptive Interventions. *Psychological Methods* 17(4), 457-477. doi: 10.1037/a0029372. Epub 2012 Oct 1 PMID: PMC3825557
- (61) I. Nahum-Shani, M. Qian, D. Almiral, W.. Pelham, B. Gnagy, G. Fabiano, J. Waxmonsky, J. Yu and **S.A. Murphy**. Q-Learning: A Data Analysis Method for Constructing Adaptive Interventions. *Psychological Methods* 17(4):478-94. doi: 10.1037/a0029373. Epub 2012 Oct 1. PMID: PMC23025434
- (60) D. Almiral, S. N. Compton, M. Gunlicks-Stoessel, N. Duan, **S.A. Murphy** (2012). Designing a Pilot Sequential Multiple Assignment Randomized Trial for Developing an Adaptive Treatment Strategy. *Statistics in Medicine* 31(17):1887-1902. PMC3399974
- (59) K. Deng, J. Pineau and **S.A. Murphy** (2011). Active Learning for Developing Personalized Treatment. *Proceedings of the Twenty-Seventh Conference Annual Conference on Uncertainty in Artificial Intelligence (UAI-11)* AUAI Press 161-8. (These papers are externally reviewed; 34% acceptance rate.)
- (58) K. Deng, J. Pineau and **S.A. Murphy** (2011). Active Learning for Personalizing Treatment. *Adaptive Dynamic Programming And Reinforcement Learning (ADPRL), 2011 IEEE Symposium on* 11-15 April 2011. pgs 32-39.
- (57) L. Gunter, J. Zhu, and S.A. Murphy (2011). Variable Selection for Qualitative Interactions in Personalized Medicine while Controlling the Family-wise Error Rate. *Journal of Biopharmaceutical Statistics*. Nov;21(6):1063-78.
- (56) Z. Li and **S.A. Murphy** (2011). Sample Size Formulae for Two-Stage Randomized Trials with Survival Outcomes. *Biometrika* 98(3):503-518, PMID: PMC3254237
- (55) D. Almiral, D.F. McCaffrey, R. Ramchand and **S.A. Murphy** (2011). Subgroups Analysis when Treatment and Moderators are Time-varying. *Prevention Science* Published Online First 22 March 2011. PMID: PMC3135740
- (54) M. Qian and **S.A. Murphy** (2011). Performance Guarantees for Individualized Treatment Rules. *Annals of Statistics* 39(2):1180-1210. PMC3110016
- (53) E. Laber and **S.A. Murphy** (2011), Adaptive Confidence Intervals for the Test Error in Classification. *Journal of the American Statistical Association* 106:904-913. (This paper was selected as the JSM 2011 JASA(T&M) Invited Paper) Posted online on 30 Mar 2011. PMC3285493
- (52) S. M. Shortreed, E. Laber, D. J. Lizotte, T. S. Stroup, J Pineau and **S.A. Murphy** (2010). Informing sequential clinical decision-making through reinforcement learning: an empirical study. *Machine Learning*, July 1; 84(1-2):109-136. PMC3143507
- (51) D. Lizotte, M. Bowling and **S.A. Murphy** (2010), Efficient Reinforcement Learning with Multiple Reward Functions for Randomized Controlled Trial Analysis, *Proceedings of the 27th International Conference on Machine Learning (ICML 2010)* pgs. 695-702. (These papers are externally reviewed.)
- (50) R. Fonteneau, **S.A. Murphy**, L. Wehenkel and D. Ernst (2011). Towards min max generalization in reinforcement learning. In *Agents and Artificial Intelligence: International Conference, ICAART 2010, Valencia, Spain, January 2010, Revised Selected Papers, Series: Communications in Computer and Information Science (CCIS), Volume 129, J. Filipe, A. Fred, and B. Sharp (Editors)*, pp. 61-77. Springer, Heidelberg. (These papers are externally reviewed.)



- (49) Fonteneau, R., **S.A. Murphy**, L.Wehenkel and D. Ernst (2010), Model-Free Monte Carlo-like Policy Evaluation. *Volume 9: AISTATS 2010 Proceedings of the Thirteenth International Conference on Artificial Intelligence and Statistics* May 13-15, 2010, Chia Laguna Resort, Sardinia, Italy 9:217-224, 2010. (These papers are externally reviewed.)
- (48) H. McGowan, R.L. Nix, **S.A. Murphy**, K.L. Bierman and CPPRG (2010), Investigating the Effects of Selection Bias in Dose-Response Analyses of Preventive Interventions. *Prevention Science* 11:239-251. PMC3044506
- (47) Almirall D, Ten Have T, **Murphy SA** (2010). Structural Nested Mean Models for Assessing Time-Varying Effect Moderation. *Biometrics*. 66(1), 131-139, Published Online: 13 Apr 2009 PMC 2875310
- (46) L. Gunter, J. Zhu, **S.A. Murphy** (2011). Variable Selection for Qualitative Interactions. *Statistical Methodology* 8(1):42-55. PMC3003934
- (45) B. Chakraborty, **S.A. Murphy** and V. Strecher (2010). Inference for Nonregular Parameters in Optimal Dynamic Treatment Regimes. *Statistical Methods in Medical Research* 2010 19: 317-343. PMC2891316
- (44) Fonteneau, R., **S.A. Murphy** , L.Wehenkel and D. Ernst (2010). A Cautious Approach to Generalization in Reinforcement Learning. Joaquim Filipe, Ana L. N. Fred, Bernadette Sharp (Eds.): ICAART 2010 - Proceedings of the International Conference on Agents and Artificial Intelligence, Volume 1 - Artificial Intelligence, Valencia, Spain, January 22-24, 2010. INSTICC Press 2010, 64-73. (This paper won the Best Student Paper Award; these are externally reviewed papers.).
- (43) R. Fonteneau, **S.A. Murphy**, L.Wehenkel and D. Ernst. (2009) Inferring bounds on the performance of a control policy from a sample of trajectories. In Proceedings of the IEEE International Symposium on Adaptive Dynamic Programming and Reinforcement Learning (ADPRL09), pages 117-123. Nashville, United States, March 30 April 2, 2009. (These are externally reviewed.)
- (42) **S.A. Murphy** and D. Bingham (2009). Screening Experiments for Developing Dynamic Treatment Regimes. *Journal of the American Statistical Association*, Vol 184:391-408. PMC2892819
- (41) Chakraborty B, Collins L, Strecher V, **Murphy SA** (2009). Developing Multicomponent Interventions using Fractional Factorial Designs. *Statistics in Medicine* September 20; 28(21): 2687-2708. PMC2746448
- (40) Collins, LM, Chakraborty B, **Murphy SA**, Strecher V (2009). Comparison of a phased experimental approach and a single randomized clinical trial for developing multicomponent behavioral interventions. *Clinical Trials*, Vol 6(1): 5-15. PMC2711350
- (39) E. Laber, **S.A. Murphy** (2008). Small Sample Inference for Generalization Error in Classification Using the CUD Bound, *Proceedings of the 2008 Uncertainty in Artificial Intelligence Conference* AUAI Press, 357:365. These papers are externally reviewed. PMC2876736
- (38) V. Nair, V. Strecher, A. Fagerlin, P. Ubel, K. Resnicow, **S.A. Murphy**, R. Little, B. Chakraborty, A. Zhang, 2008. Screening Experiments and Fractional Factorial Designs in Behavioral Intervention Research, *American Journal of Public Health*, Vol.98, No.8:1354-1359. PMC2446451
- (37) **S.A. Murphy**, L.M. Collins, A.J. Rush (2007). Customizing Treatment to the Patient: Adaptive Treatment Strategies (Editorial). Drug and Alcohol Dependence, *Drug and Alcohol Dependence*. 88(2):S1-S72. PMC1924645

- (36) J. Pineau, M.G. Bellemare, A. J. Rush, A. Ghizaru, **S.A. Murphy** (2007). Constructing evidence-based treatment strategies using methods from computer science. *Drug and Alcohol Dependence*, 88, Supplement 2:S52-S60. PMC1934348
- (35) L. Gunter, J. Zhu, **S.A. Murphy** (2007). Variable Selection for Optimal Decision Making. *Proceedings of the 11th Conference on Artificial Intelligence in Medicine*. LNCS/LNAI 4594, 149-154. This proceedings had a 50% acceptance rate.
- (34) L.M. Collins, **S.A. Murphy**, V. Strecher (2007). The Multiphase Optimization Strategy (MOST) and the Sequential Multiple Assignment Randomized Trial (SMART): New Methods for More Potent e-Health Interventions. *American Journal of Preventive Medicine*, 32(5S):S112-118. PMC2062525
- (33) **S.A. Murphy**, K.G. Lynch, J.R. McKay, D. Oslin, T. TenHave (2007). Developing Adaptive Treatment Strategies in Substance Abuse Research. *Drug and Alcohol Dependence*, 88(2):S24-S30. PMC1922034
- (32) **S.A. Murphy**, D. Oslin, A.J.Rush, J. Zhu for MCATS (2007). Methodological Challenges in Constructing Effective Treatment Sequences for Chronic Disorders, *Neuropsychopharmacology*, 32(2):257-62. advance online publication, November 8 2006, doi: 10.1038/sj.npp.1301241 PMC17091129
- (31) Bierman K., R. Nix, J.J. Maples and **S.A. Murphy**. (2006). Examining Clinical Judgment in an Adaptive Intervention Design: The Fast Track Prevention Program *American Journal of Community Psychology* 74(3):468-81. PMC2753970
- (30) Bray, B., D. Almiraal, R.S. Zimmerman, D. Lynam and **Murphy, S.A.** (2006). Assessing the Total Effect of Time-varying Predictors in Prevention Research. *Prevention Science*. 7(1):1-17. PMC1479302
- (29) **Murphy S.A.** (2005). A Generalization Error for Q-Learning. *Journal of Machine Learning Research*. 6(Jul):1073-1097. PMC1475741
- (28) Collins, L.M., **Murphy, S.A.**, Nair, V. and V. Strecher. (2005) A Strategy for Optimizing and Evaluating Behavioral Interventions. *The Annals of Behavioral Medicine* , **30**:65-73.
- (27) **Murphy, S.A.** (2005) An Experimental Design for the Development of Adaptive Treatment Strategies. *Statistics in Medicine*, **24**:1455-1481. PMC15586395
- (26) Barber, J.S., **Murphy, S.A.** & N. Verbitsky (2004), Adjusting for Time-Varying Confounding in Survival Analysis. *Sociological Methodology*, **34**:163-192.
- (25) Collins, L.D., **Murphy, S.A.** and K. Bierman. (2004), A Conceptual Framework for Adaptive Preventive Interventions. *Prevention Science*, **3**:185-196. PMC3544191
- (24) **Murphy, S.A.** (2003) Optimal Dynamic Treatment Regimes (with discussion). *JRSSB*, **65(2)**, 331-366.
- (23) Maples, J.J., **Murphy, S.A.** and W.G. Axinn (2002), Two Level Proportional Hazards Models. *Biometrics*, **58(4)**, 180-188.
- (22) **Murphy, S.A.**, M.J. van der Laan, JM. Robins and CPPRG (2001), Marginal Mean Models for Dynamic Regimes *JASA*, **96** 1410-1423.
- (21) **Murphy, S.A.** and A.W. van der Vaart, (2001). Semiparametric Mixtures in Case-control Studies. *Journal of Multivariate Analysis*, **79**:1-32.
- (20) Barber, J.S., **S.A. Murphy**, W.G. Axinn and J. Maples, (2000) Discrete Time Multilevel Survival Analysis. *Sociological Methodology*, **30** 201-235.

- (19) **Murphy, S.A.** and A.W. van der Vaart, (2000) On Profile Likelihood. (with discussion). *JASA*, **95** 449-485.
- (18) **Murphy S.A.**, van der Vaart AW and Wellner JA. (1999) Current Status Regression. *Mathematical Methods of Statistics*, **8** 407-425.
- (17) **Murphy S.A.** and van der Vaart AW. (1999) Observed Information in Semiparametric Models. *Bernoulli*. **5** 381-412.
- (16) Bacik, J.M., **S.A. Murphy** and J.C. Anthony, (1998) Drug Use Prevention Data, Missing Assessments and Survival Analysis. *Multivariate Behavioral Research*, **33** 573-588.
- (15) **Murphy, S.A.**, A.J. Rossini and A.W. van der Vaart, (1997) MLE in the Proportional Odds Model. *JASA*, **92** 968-976
- (14) **Murphy, S.A.** and A.W. van der Vaart, (1997) Semiparametric Likelihood Ratio Inference. *Annals of Statistics*, **25** 1471-1509
- (13) **Murphy, S.A.** and A.W. van der Vaart, (1996) Likelihood Inference in the Errors-in-Variables Model. *J. of Multivariate Analysis*, **59** 81-108
- (12) **Murphy, S.A.**, (1995) Likelihood Ratio-Based Confidence Intervals in Survival Analysis. *JASA*, **90** 1399-1405.
- (11) **Murphy, S.A.** (1995) A Central Limit Theorem for Local Martingales with Applications to the Analysis of Longitudinal Data, *Scand. J. of Stat.*, **22** 279-294.
- (10) **Murphy, S.A.**, M.A. O'Hanesian, and G. Bentley, (1995) An Analysis for Menstrual Data with Time-Varying Covariates, *Stat. in Med.*, **14** 1843-1857.
- (9) **Murphy S.A.** (1995) Asymptotic Theory for the Frailty Model, *Annals of Statistics*, **23** 182-198.
- (8) **Murphy, S.A.** and B. Li, (1995) Projected Partial Likelihood and its Application to Longitudinal Data, *Biometrika*, **82** 399-406.
- (7) Akritas, M., **S. Murphy**, M. LaValley, and E. Feigelson, (1995) The Theil-Sen Estimator with Doubly Censored Data and Applications to Astronomy, *JASA*, **90** 170-177.
- (6) **Murphy S.A.** (1994) Consistency in a Proportional Hazards Model Incorporating a Random Effect, *Annals of Statistics*, **22** 712-731.
- (5) **Murphy S.**, Tice R., Smit M., and B. Margolin (1992) Contributions to the Design and Statistical Analysis of in vivo SCE Experiments. *Mutation Research*, 271 39-48.
- (4) **Murphy S.A.** (1991) Testing for a Time Dependent Coefficient in Cox's Regression Model, *Scandinavian Journal of Statistics*, **20** 35-50.
- (3) **Murphy S.A.** and Sen P.K. (1991) Time Dependent Coefficients in a Cox-type Regression Model, *Stochastic Processes and Their Applications*, **39** 153-180.
- (2) **Murphy S.**, Caspary W., and B. Margolin (1988) A Statistical Analysis for the Mouse Lymphoma Cell Forward Mutation Assay, *Mutation Research* 203 145-154.
- (1) Jauhar P., Henika P., MacGregor J., Wehr C., Shelby M., **Murphy S.**, and B. Margolin (1988) 1,3- Butadiene: Induction Micronucleated Erythrocytes in the Peripheral Blood of *B6C3F1* Mice Exposed by Inhalation for Thirteen Weeks. *Mutation Research*, 209 171-176.

#### Edited Books

Mobile Health: Sensors, Analytic Methods, and Applications edited by James Rehg, Susan Murphy & Santosh Kumar. *Springer International Publishing AG 2017*, DOI 10.1007/978-3-319-51394-2 4.

### Other Refereed Articles/Editorials/Book Chapters

Qian, T., Cohen, E. and S.A. Murphy,(202?) Statistical Designs for Developing Personalized Mobile Treatment Interventions, Book chapter to appear in *Digital Therapeutics: Scientific, Statistical, Clinical, and Regulatory Development Aspects*, edited by O. Sverdlov and J. van Dam, Chapman & Hall/CRC

Li, S., Psihogios, A.M., McKelvey E.R., Ahmed, A., Rabbi, M. and S.A. Murphy. Micro-Randomized Trials for Promoting Engagement in Mobile Health Data Collection: Adolescent Young Adult Oral Chemotherapy Adherence as an Example. *Current Opinion in Systems Biology*, (2020) <https://doi.org/10.1016/j.coisb.2020.07.002>.

(120) Carpenter, S.M., Menictas, M., Nahum-Shani, I., Wetter, D.W., and Murphy, S.A. Developments in Mobile Health Just-in-Time Adaptive Interventions for Addiction Science. *Current Addiction Reports* Published online: 27 June, 2020

Menictas, M., Rabbi, M., Klasnja, P., Murphy, S.A., AI Decision Making in Mobile Health. *The Biochemist*. October 2019. Volume 41, Issue 5. Portland Press Limited.

Hall, K., Nahum-Shani, I., August, G., Patrick, M.E., Murphy, S.A., Almirall, D., Adaptive Intervention Designs in Substance Use Prevention. To appear in the book: Prevention of Substance Use. Springer

Wagner III, B., Liu, E., Shaw, S., Lakovlev, G., Zhou, L., Harrington, C., Abowd, G., Yoon, C., Kumar, S., **Murphy, S.A.**, Spring, B., and Nahum-Shani, I. ewrapper: Operationalizing engagement strategies in mHealth. Ubicomp Workshop: MENTAL HEALTH AND WELL-BEING: SENSING AND INTERVENTION.

Rabbi, M., Philyaw-Kotov, M., Lee, J., Mansour, A., Dent, L., Wang, X., Cunningham, R., Bonar, E., Nahum-Shani, I., Klasnja, P., Walton, M. and **Murphy, S.A.**. SARA: A Mobile App to Engage Users in Health Data Collection. In Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers (UbiComp '17). ACM, New York, NY, USA, 781-789. DOI: <https://doi.org/10.1145/3123024.3125611>

Smith, S.S., Lee, A.J., Hall, K., Seewald, N.J., Boruvka, A., **Murphy, S.A.** and Klasnja, P., Design Lessons from a Micro-Randomized Pilot Study in Mobile Health, (2017), Mobile Health: Sensors, Analytic Methods, and Applications, Springer International Publishing AG 2017, J.M. Rehg et al. (eds.), pgs. 59-82. DOI 10.1007/978-3-319-51394-2 4. ISBN: 978-3-319-51393-5 (Print) 978-3-319-51394-2 (Online).

Sarker, H., Hovsepian, K., Chatterjee, S., Nahum-Shani, I., **Murphy, S.A.** Spring, B., Ertin, E., al'Absi, M., Nakajima, M., and Kumar, S., From Markers to Interventions: The Case of Just-in-Time Stress Intervention, (2017), Mobile Health: Sensors, Analytic Methods, and Applications, Springer International Publishing AG 2017, J.M. Rehg et al. (eds.), pgs 411-436. DOI 10.1007/978-3-319-51394-2 4. ISBN: 978-3-319-51393-5 (Print) 978-3-319-51394-2 (Online).

Tewari, A. and **S.A. Murphy**, From Ads to Interventions: Contextual Bandits in Mobile Health, (2017), Mobile Health: Sensors, Analytic Methods and Applications, Springer International Publishing AG 2017, J.M. Rehg et al. (eds.), pgs 495-518. DOI 10.1007/978-3-319-51394-2 4. ISBN: 978-3-319-51393-5 (Print) 978-3-319-51394-2 (Online).

Dempsey, W., Liao, P., Klasnja, P., Nahum-Shani, I. & **S.A. Murphy** (2015). Randomized trials for the Fitbit generation. *Significance*, 12(6):20-23. PMID: PMC4721268

Nahum-Shani, I., Xi, L., Henderson, M.M., & **S.A. Murphy** (2013). Innovative experimental design for developing effective technology-supported help-seeking interventions. Book chapter to appear in Advances in Help Seeking Research and Applications: The Role of Information and Communication Technologies. S.A. Karabenick and M. Puustinen (Eds). Information Age Publishing. PMC Exempt-invited review.

Qian, M., Nahum-Shani, I., **S.A. Murphy** (2013). Dynamic treatment regimes, Modern Clinical Trial Analysis, Series: Applied Bioinformatics and Biostatistics in Cancer Research Tang, Wan; Tu, Xin (Eds.), Springer Science, pgs. 127-148. PMC Exempt-invited review.

Almirall, D., Lizotte, D. & **S.A. Murphy** (2012). SMART Design Issues and the Consideration of Opposing Outcomes, Discussion of the paper. Evaluation of Viable Dynamic Treatment Regimes in a Sequentially Randomized Trial of Advanced Prostate Cancer by Wang et al. *Journal of the American Statistical Association*, 107(498):509-512. NIHMSID: NIHMS384756.

H. Lei, I. Nahum-Shani, K. Lynch, D. Oslin, and S.A. Murphy (2012). Using the Sequential, Multiple Assignment, Randomized Trial (SMART) Designs to Build Individualized Treatment Sequences, Annual Review of Clinical Psychology 8:21-48. PM22224838. PMC Exempt-invited review.

A.I. Oetting, J.A. Levy, R.D. Weiss, **S.A. Murphy** (2011). Statistical Methodology for a SMART Design in the Development of Adaptive Treatment Strategies, in Causality and Psychopathology: Finding the Determinants of Disorders and their Cures (P.E. Shrout, K.M. Keyes, K. Ornstein, Eds.) Arlington VA: American Psychiatric Publishing, Inc, pgs. 179-205

R. Fonteneau, **S.A. Murphy**, L. Wehenkel and D. Ernst. (2010). Generating informative trajectories by using bounds on the return of control policies ". In Proceedings of the Workshop on Active Learning and Experimental Design 2010 ( in conjunction with AISTATS 2010), 2-page highlight paper, Chia Laguna, Sardinia, Italy, May 16 2010.

National Research Council (2010). *The Prevention and Treatment of Missing Data in Clinical Trials*. Panel on Handling Missing Data in Clinical Trials. Committee on National Statistics, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. (Member, Panel)

Almirall D, Coffman CJ, Yancy, Jr. WS, **Murphy SA**. (2010) Structural Nested Models. In Analysis of Observational Health-Care Data Using SAS (eds D. Faries, A. Leon, JM Haro & RL Obenchain) Cary NC: SAS Institute, pgs. 231-262. This was externally reviewed.

**S.A. Murphy**, D. Almirall (2009). Dynamic Treatment Regimes, *The Encyclopedia of Medical Decision Making*. (MW Kattan, ed) Sage Publications Inc. pgs. 419-422.

**S.A. Murphy** (2002). Audit Studies and the Assessment of Discrimination. In *Measuring Housing Discrimination in a National Study: Report of a Workshop* (eds: A.W. Foster, F. Mitchell, S.E. Fienberg) Committee on National Statistics, Division of Behavioral and Social Sciences and Education, National Research Council, National Academy Press, Washington, DC

**S.A. Murphy**, L.M. Collins, A.J. Rush (2007). Editorial: Customizing treatment to the patient: Adaptive treatment strategies, *Drug Alcohol Dependence*, 88(2):S1-S72.

**S.A. Murphy** and McKay, J.R. (2003). Adaptive Treatment Strategies: An Emerging Approach for Improving Treatment Effectiveness. *Clinical Science (Newsletter of the American Psychological Association Division 12, section III: The Society for the Science of Clinical Psychology)* Winter 2003/Spring 2004.

**S.A. Murphy** (1993) Discussion of paper by Hastie, T. and R. Tibshirani, *J.R. Statist. Soc. B*, **55** 793.

**S.A. Murphy**(1989) Time-Dependent Coefficients in a Cox-type Regression Model, Institute of Statistics Mimeo Series #2001, (thesis) Dept. of Statistics, University of North Carolina, Chapel Hill, North Carolina.

#### **RESEARCH GRANTS AND AWARDS SINCE 2015:**

Project Leader of Project 3 and PI of Harvard Site P50DA054039 (9/01/2021-6/30/2026), NIDA

“Continual Optimization and Personalization of Just-in-Time Adaptive Interventions for SUD Prevention, Treatment and Recovery.” In the modern, post-pandemic world, digital technology is becoming an increasingly important vehicle for the delivery of substance use disorder and HIV prevention, treatment, and recovery services. The long term goal of the proposed project is to enable digital health technology to deliver intervention services with unprecedented effectiveness and sustainability. We propose to integrate ideas from behavioral science and artificial intelligence to develop methodology for (1) continual optimization of just-in-time adaptive digital health interventions in response to societal changes and evolving population treatment needs and (2) personalized just-in-time adaptive digital health interventions to each individuals evolving treatment needs. This will enable a second generation of just-in-time adaptive digital health interventions with enhanced and highly sustainable effectiveness. To achieve these goals we aim to promote sustainable intervention effectiveness and engagement by integrating approaches from artificial intelligence namely reinforcement learning to develop algorithms that continually optimize mobile health interventions over time. The overall M-PIs are I. Nahum-Shani, D. Almirall, L. Collins and S. Murphy

Project Leader of Project 2 and PI of Harvard Site P41EB028242(7/15/2020-3/31/2024), NIBIB

“Dynamic Optimization of Continuously Adapting mHealth Interventions via Prudent, Statistically Efficient, and Coherent Reinforcement Learning.” The long-term goal of this project is to help individuals manage chronic health issues as they go about their daily life. This project will develop artificial intelligence software for mobile health apps. Mobile health apps can play a critical role in helping people in managing their health, but only if the help is personalized to each individuals needs, and only if people continue to use the app when they need help. To personalize the app and to avoid aggravating individuals Dr. Murphys team will develop artificial intelligence algorithms that prudently determine when and in which settings the app will reach out to the individual to provide helpful suggestions, reminders and messages. Dr. Murphy will collaborate with ongoing NIH-funded projects concerning individuals who are struggling with chronic health issues at the University of Michigan, UMass Medical School, and Pennsylvania State University to evaluate and refine the artificial intelligence algorithms. This project will provide to the mobile health research community open-source software solutions consisting of smartphone and cloud computing components in order to accelerate improvements in the usefulness of mobile health apps for individuals. The overall PI is Santosh Kumar.

Co-Investigator 1UG3DE028723 (7/1/2019-6/30/2023) DE

“Personalized Digital Behavior Change Interventions to Promote Oral Health.” The goal of this grant is to support at-risk individuals execute high quality dental brushing behaviors. We will leverage tracking capabilities of our innovative eBrush platform to remotely monitor tooth-brushing activities in home settings. Using the 2x2x4 OHI and eBrush as foundational elements, we will develop and evaluate the effectiveness of personalized Digital Oral Health Interventions (DOHI) for promoting ideal OHBs in at-risk individuals. In the UG3 phase, we will build out the technologic infrastructure for collecting brushing data and delivering the DOHI. Then, we will engage target end-users in the co-design of an app for oral self-care and establish the usability and feasibility of the system. In the UH3 phase, we will build and validate computational models to infer the quality of OHBs from brushing data and personalize the DOHI. Using a cohort of 130, we will conduct a 10-week Micro-Randomized Trial to optimize the adaptive tailoring of engagement strategies. Finally, we will evaluate effectiveness of the computationally-driven, adaptive DOHI in promoting sustained engagement in the 2x2x4 OHB. We hypothesize that a dynamic and personalized DOHI will be more effective than traditional, static, clinician-delivered OHI in improving oral health and adherence to 2x2x4 OHBs. We will test our hypothesis through a 6-month, pragmatic, randomized, controlled, parallel-group clinical trial. The PI is Vivek Shetty.

Co-Investigator U01 CA229437 (9/1/2018-8/31/2022) NCI

“Novel Use of mHealth Data to Identify States of Vulnerability and Receptivity to JITAIs.” The goal of this grant is to systematically investigate the nature of the states of individual vulnerability and receptivity as well as how knowledge of these states can be used to optimize real-time engagement in self-regulatory activities aimed at helping individuals quit smoking. This project will use a racially/ethnically diverse collection of real time, real world data on individuals attempting to quit smoking to investigate how the temporal dynamics and interactions of emotions, self-regulatory capacity, context, and other factors can be used to detect states of vulnerability to a lapse and states of receptivity to engage in self-regulatory activities. We will investigate how knowledge of these states can be used to optimize real-time engagement in self-regulatory activities by conducting a Micro-Randomized Trial (MRT) enrolling 150 smokers attempting to quit. Utilizing a mobile smoking cessation app, the MRT will randomize each individual multiple times per day to either (a) no intervention prompt; (b) a prompt recommending engagement in brief (low effort) strategies; or (c) a prompt recommending a more effortful practice of self-regulation strategies. The proposed research will be the first to yield a comprehensive conceptual, technical, and empirical foundation necessary to develop effective JITAIs based on dynamic models of vulnerability and receptivity. Overall Co-PIs are Inbal Nahum-Shani and David Wetter.

Principal Investigator R01 AA023187 (9/1/2015-8/31/2020) NIAAA

“Data-Based Methods for Just-In-Time Adaptive Interventions in Alcohol Use.” The purpose of this proposal is develop, and bring to fruition, methods for using data to optimize mobile interventions aimed at preventing, treating and supporting the recovery from alcohol use disorders. The goal of this project is (1) to develop and evaluate data analysis methods and optimization algorithms that can reside on the mobile device and that, as an individual experiences the mobile intervention and provides responses, will optimize the timing and selection of the behavioral intervention to the individual; (2) to develop data analysis methods and optimization algorithms that can be used following a clinical study involving the mobile intervention to further optimize the intervention; and (3) to disseminate and illustrate the developed methods and algorithms to the clinical science community so as to maximize clinical impact.

Project Leader of Research Component and PI of Michigan Site P50 DA039838(09/01/15 - 08/31/20) NIDA

“Innovative Methods for Constructing Just-In-Time Adaptive Interventions.” The long-term goal of this component is to improve public health by facilitating the evidence-based construction of effective, individualized mobile substance use prevention and intervention services. This component develops data analytic methods that will enable drug abuse prevention and services scientists to more effectively adapt interventions to individuals changing needs over time and more effectively expand the reach of their interventions. The overarching goal of this component is to integrate ideas from statistics, computer science, and behavioral science to develop data analytic methodologies that will (i) enable scientists to construct more effective mobile interventions for delivery of SUD/HIV prevention and SUD recovery services, and (ii) inform development of more dynamic and nuanced behavioral theories. Overall PI is Linda Collins.

Co-Investigator R01 DA039901 01 (09/01/15 - 07/31/20) NIDA

“Novel Longitudinal Methods for SMART Studies of Drug Abuse and HIV.” The treatment of drug use and HIV often requires sequential, individualized decisions concerning the type or delivery of treatments. The methods developed in this project will improve clinical and public health outcomes by enabling drug use and HIV scientists to develop more potent approaches to guide the sequential, individualization of drug use and HIV treatments. The Co-PIs are I. Nahum-Shani and D. Almirall

Co-Investigator R01 HL125440 (9/1/2014-8/31/2019) NIH/NHLBI/NIA

“Heart Steps: Adaptive mHealth interventions for physical-activity maintenance.” In this project, we will conduct a micro-randomized trial and using this data, design, and evaluate a personalized, adaptive mHealth intervention that leverages frequent interactions that people have with their mobile phones to enable individuals with heart disease to stay focused on their health goals, engage in opportunistic physical activity throughout the day, and build robust and sustainable physical-activity habits that can help reduce and keep down their cardiac risks. PI is P. Klasnja.

Co-Investigator and PI of Michigan Component U54EB020404 (07/01/14-06/30/18) NIBIB through funds provided by the trans-NIH Big Data to Knowledge (BD2K) initiative ([www.bd2k.nih.gov](http://www.bd2k.nih.gov)). “Centers of Excellence for Big Data Computing in the Biomedical Science.” The goal of this project is to design a micro-randomized trial and evaluate statistical learning methods for using sensor data to identify precipitants and antecedents of adverse behavior as well as predict times of high risk so as to inform future development of a just-in-time adaptive intervention. Overall PI is S. Kumar

Co-Investigator (09/04/12-05/31/17) NICHD

“Adaptive Interventions for Minimally Verbal Children with ASD in the Community” The overarching aim of this Network study is to construct an adaptive intervention that utilizes two efficacious interventions (JASP-EMT and CORE-DTT) that rely on distinct intervention procedures and that show promise for optimizing the number of unique socially communicative and spontaneously spoken words in minimally verbal children with ASD. JASP-EMT (Joint Attention, Symbolic Play and Enhanced Milieu Teaching) focuses on creating a context for joint engagement within naturally occurring, child-led play activities. CORE-DTT (discrete trial training for core features of ASD) emphasizes didactic, adult-led instruction. The study utilizes a novel sequential multiple assignment randomized trial to evaluate and construct an optimal adaptive intervention. PI is C. Kasari.

Co-Investigator (12/01/2013-11/30/2018) NIMH



“Improving Mental Health Outcomes: Building an Adaptive Implementation Strategy” The overarching goal of this study is to build the most cost-effective adaptive implementation intervention involving Replicating Effective Programs (REP) and the augmentation of the External Facilitation (EF) and Internal Facilitation (IF) roles to improve patient outcomes and the uptake of an evidence-based program (EBP) for mood disorders (Life Goals-LG) in community settings. PI is A. Kilbourne.

**PRESENTATIONS:**

Invited Papers Presented at Professional Meetings since 2019

Oct., 2021	Design and Analysis of Experiments Conference	Micro-Randomized Trials & Online Decision Making Algorithms
Aug, 2021	JSM 2021	Assessing Causal Inference Using Adaptively Collected Data
July, 2021	UAI 2021	We used RL but..... Did it work?!
June, 2021	Statistical learning methods in modern AI Tianyuan Mathematical Center Northwest China	We used RL but..... Did it work?!
May, 2021	Frontiers of Causal Inference in Data Science: Perspectives from Leaders in Tech and Academia	We used RL but..... Did it work?!
May, 2021	Workshop on AI for Public Health, International Conference on Learning Representations, 2021	Assessing Personalization in Digital Health
Feb., 2021	The Obesity Society 2021 Preconference Workshop Synergistic Rigor in the Intersection of Epidemiology & Obesity(Virtual)	Using Mobile Health Interventions to Support Individual Decision Making
Feb., 2021	AAAI 2021 Trustworthy AI for Healthcare Workshop (Virtual)	Assessing Personalization in Digital Health
Dec., 2020	NeurIPS 2020 Machine Learning for Mobile Health Workshop (Virtual)	Assessing Personalization in Digital Health
Dec., 2020	NeurIPS 2020 Deep RL workshop (Virtual)	We used RL... but.... did it work?!
Nov., 2020	Sixth Seattle Symposium in Biostatistics (Virtual)	Challenges in Developing Learning Algorithms to Personalize Treatment in Real Time
Nov., 2020	4th Annual Mobile & Electronic Health-ARC Symposium Boston University	Data, Personalization, Digital Health!
Sept., 2020	Joint Convergence of the GMDS & CEN-IBS 2020	Clinical Trial Designs for Personalizing

	(Virtual Presentation)	Digital Interventions
August, 2020	Numerical Analysis for Data Science Opening Workshop SAMSI (Virtual Presentation)	Intelligent Pooling for Thompson Sampling With Applications to Mobile Health
June, 2020	41st Annual Meeting: Society for Behavioral Medicine, Presidential Symposium: From Ideas to Interventions: A Review of Frameworks for Designing and Optimizing Health-Related Behavior (virtual)	Optimizing Behavioral Mobile Health Interventions: Micro-Randomized Trials (joint with Tianchen Qian)
April, 2020	ICLR workshop, ML-IRL: Machine Learning in Real Life Virtual (Ethiopia)	Challenges in Developing Learning Algorithms to Personalize Treatment in Real Time
Jan, 2020	Keynote, 13th International Conference on Health Policy Statistics San Diego	Online Experimentation and Learning Algorithms in a Clinical Trial
Dec, 2019	NeurIPS Workshop, Do the right thing”: machine learning and causal inference for improved decision making	Challenges in Developing Learning Algorithms to Personalize Treatment in Real Time
Oct, 2019	Academy of Medicine, Health and Technology Special Interest Group	Personalizing Interventions in Digital/Mobile Health
Oct, 2019	Georgia Statistics Day	Stratified Micro-randomized Trials with Applications in Mobile Health
Sept, 2019	Department of Statistics 50th Anniversary Symposium University of Michigan	Online Experimentation with Learning Algorithms in a Clinical Trial
July, 2019	JSM Denver	Online Experimentation with Learning Algorithms in a Clinical Trial
July, 2019	IMS New Researchers Conference Fort Collins	Personalized HeartSteps: A mHealth RL Algorithm for Optimizing Physical Activity
July, 2019	The Multi-disciplinary Conference on on Reinforcement Learning and Decision Making, Montreal	Reinforcement Learning for the HeartSteps V2 Mobile Health Trial
June, 2019	Statistics conference In honor of Aad van der Vaart’s 60th Birthday Leiden	A Challenge in Developing Learning Algorithms to Personalize Treatment in Real Time
June, 2019	Southern Regional Council on Statistics Summer Research Conference Kentucky	Time-Varying Causal Treatment Effects
Feb, 2019	Workshop on Analysis of Data from mHealth Intervention Studies Singapore	Challenges in Developing Learning Learning Algorithms to Personalize Treatment in Real Time

Feb, 2019	IMS Singapore	Mobile Health Intervention & Engagement Optimization
Feb, 2019	Workshop on Design of mHealth Intervention Studies Singapore	Stratified Micro-Randomized Trials
Feb, 2019	The Royal Society, London Big data for better science: technologies for measuring behaviour	Mobile health intervention and engagement optimisation
<u>Invited Seminars Since 2019</u>		
Nov., 2021	IACS SEAS, Harvard Univ.	We used RL; but did it work?
Nov., 2021	Nineth Makuch Distinguished Lecture, UConn	Inference Using Adaptively Collected Data
Nov., 2021	Technology and Operations Management Unit, Harvard Business School	We used RL; but did it work?
Sept, 2021	Grand Rounds at the Herbert Wertheim School of Public Health and Human Longevity Science, UCSD	Assessing Personalization in Digital Health
Sept, 2021	Research Methods, Measurement, & Evaluation Program, UConn	Assessing Personalization in Digital Health
Sept, 2021	Departments of Statistical Science & Biostatistics and Bioinformatics Duke University	Assessing Personalization in Digital Health
June, 2021	Distinguished Speaker Seminar Department of Statistics, University of Oxford	Assessing Personalization in Digital Health
June, 2021	Artificial Intelligence Student Society (AISS), University of Pretoria, South Africa	We used a Bandit Algorithm to Personalize but..... Did it work?!
May, 2021	CSAIL-MSR Trustworthy and Robust AI Colloquium MIT, MSR	Learning both within and between trials involving sequential decision making
May, 2021	Stanford Biomedical Data Science Seminar	We used RL but..... Did it work?!
May, 2021	MIT Operations Research	We used RL but..... Did it work?!
Feb., 2021	SESSTIM Facult des Sciences Medicales et Paramdicales et Paramdicales, Marseille, France	Data, Personalization, Digital Health!
Jan., 2021	Univ of Alabama, Nutrition Obesity Research Center	Data, Personalization, Digital Health!
Dec., 2020	Univ of Colorado, Dept of Statistics	Challenges in Developing Learning Algorithms

Dec., 2020	Boulder, CO Univ of Alabama, Dept of Biostatistics	to Personalize Treatment in Real Time Challenges in Developing Learning Algorithms
Nov., 2020	UCLA, Dept of Statistics	to Personalize Treatment in Real Time Challenges in Developing Learning Algorithms
Nov., 2020	Yale, Center for Biomedical Data Science	to Personalize Treatment in Real Time Challenges in Developing Learning Algorithms
Oct., 2020	Neyman Statistics Seminar Berkeley Statistics Dept	to Personalize Treatment in Real Time Challenges in Developing Learning Algorithms
Oct, 2020	Archimedean University of Cambridge UG Mathematical Society	to Personalize Treatment in Real Time Data, Personalization, Digital Health!
Oct, 2020	Harvard Science Research Conference for HS Students	Data, Personalization, Digital Health!
Oct, 2020	Harvard Science Research Conference for HS Students	Data, Personalization, Digital Health!
May, 2020	Online Causal Inference Seminar <a href="https://sites.google.com/view/ocis/home">https://sites.google.com/view/ocis/home</a>	Inference for Batched Bandits
Feb, 2020	Department of Biostatistics Columbia University	Challenges in Developing Learning Algorithms to Personalize Treatment in Real Time
Jan, 2020	UCSD Public Health Grand Rounds UCSD	Personalized HeartSteps: A mHealth RL Algorithm for Optimizing Physical Activity
Jan, 2020	Biostatistics and Bioinformatics Division UCSD	Time-Varying Causal Excursion Effects in Mobile Health with Binary Outcomes
Dec, 2019	Grand Rounds, Yale Center for Implementation Science, Emergency Medicine, Yale University	Using Data to Inform Just-in-Time Adaptive Intervention Development in Digital Health
Nov, 2019	Dept of Biostatistics UNC	Challenges in Developing Learning Algorithms to Personalize Treatment in Real Time
Oct, 2019	Duncan Lecture in Applied Mathematics & Statistics, Johns Hopkins University	Online Experimentation with Learning Algorithms in a Clinical Trial
Oct, 2019	Biostatistics Department Johns Hopkins	Time-Varying Causal Treatment Effects with Applications to Mobile Health
Sept, 2019	Center for Technology and Behavioral Health	Using Data to Inform Just-in-Time Adaptive Intervention Development

	Dartmouth College	for Digital Health
Sept, 2019	Econometrics University of Texas, Austin	Personalized HeartSteps: A mHealth RL Algorithm for Optimizing Physical Activity
	<u>Webinars and Workshops Since 2015</u>	
Oct., 2021	2020-21 Summer Institute: Building Just-in-Time Adaptive Interventions Two-day virtual workshop for Behavioral Health Scientists	
Oct., 2021	Methods for Adapting and Personalizing Prevention, Treatment, and Recovery Services for SUD at the Addiction Health Services Research Conference	Continual Optimization and Personalization of Just-in-Time Adaptive Interventions
Sept., 2021	Micro-Randomized Trials & Online Decision Making Algorithms ASA Regulatory Industry Statistics Workshop	
Jan, 2021	Challenges in Developing Online Learning and Experimentation Algorithms in Mobile Health AI4HealthWinterSchool: Transforming healthcare with Artificial Intelligence	
2019	Optimizing Just-In-Time Adaptive Interventions for Mobile Health 2019 Research Society on Alcoholism Satellite Workshop	
Sept, 2018	Analyzing Data from a Micro-randomized Trial, 1 & 1 Webinar sponsored by the Methodology Center, PSU	
June, 2018	Micro-randomized Trials, 1 & 1 Webinar sponsored by the Methodology Center, PSU	
May, 2018	Developing Just-in-time Adaptive Interventions Using Micro- randomized Trial Designs, M3 Pre-conference Workshop University of Connecticut	
April, 2018	Workshop on Novel Experimental Approaches to Designing Effective Multi- Component Interventions, Society for Behavioral Medicine	
March, 2018	Tutorial on Micro-randomized Trials for Constructing Mobile Health Interventions, ENAR	
Jan, 2018	Webinar on Time-Varying Causal Treatment Effects, Prevention Science Methodology Group	
May, 2017	Workshop on Novel Experimental Approaches to Designing Effective Multi- Component Interventions, Chicago Chapter of the ASA and Dept. of Preventive Medicine, Northwestern Univ.	
May, 2016	Workshop on JITAI mobile intervention development Annual Meeting of the Association for Psychological Science, Chicago, IL, by Daniel Almirall, Inbal Nahum-Shani, Pedja Klasnja, Susan Murphy & Bonnie Spring	
May, 2016	Introduction to JITAI: Just-in-Time Adaptive Interventions, Micro-Randomized Trials for Developing mHealth JITAI & Data Analytics for Developing JITAI Workshop at the Training on Optimization of Behavioral and Biobehavioral Interventions Washington, DC	
March, 2016	Workshop on JITAI mobile intervention development Annual Meeting of Society of Behavioral Medicine, Washington, DC, by Daniel Almirall, Inbal Nahum-Shani, Pedja Klasnja, Susan Murphy & Bonnie Spring	
May, 2016	Micro-Randomized Trials in Mobile Health,	

Webinar for Mathematica  
April, 2016 Micro-Randomized Trials in Mobile Health,  
Webinar for Google, Ann Arbor  
March, 2016 Building Just-In-Time Adaptive Interventions  
in Mobile Health: The Role of Micro-Randomized Trials  
Workshop at the Society of Behavioral Medicine Annual Meeting  
March, 2016 Micro-Randomized Designs for Research Using mHealth Technologies,  
Webinar for the NIDA Clinical Trials Network  
Dec., 2015 Micro-randomized Trials in mHealth  
Big Data Workshop at American Academy of Addiction Psychiatry  
August 2015 Clinical Trial Methodology: Micro-randomized Trials & Primary Group Mentor  
mHealth 2015 Summer Training Institute, UCLA