

Daniel Schulman

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Research Statement

My research is in the areas of Human-Computer Interaction and Health Informatics, applied to technology that enables and assists long-term health behavior change. I have focused on the the analysis and modeling of human behavior, particularly the behavior of a human counselor, who develops rapport with clients through face-to-face conversation, with the aim of developing computer agents which can reproduce this behavior. I am interested in developing and employing models of long-term participant engagement in behavior change.

Education

Northeastern University, Boston, MA (2005–2013)
Ph.D., Computer and Information Science

Brandeis University, Waltham, MA (1997–2001)
Bachelor of Arts, Computer Science
Bachelor of Science, Neuroscience
Cum Laude

Thesis Work

Embodied Agents for Long-Term Interaction

<http://hdl.handle.net/2047/d20002954>

An Embodied Conversation Agent (ECA) is a computer interface designed to simulate human face-to-face conversation with its users. A key research problem in the design and implementation of realistic ECAs is generating the range of verbal and nonverbal behavior present in human conversation with appropriate frequency, timing, and quality. ECAs have been used in a variety of applications, motivated by their potential to leverage the affordances of face-to-face conversation to build trust and engagement with users. Many applications, including education and counseling, are examples of long-term interaction; where an effective agent must have many conversations, over a long period of time, while building rapport with its users. However, prior work on realistic conversational behavior for ECAs has focused heavily on single conversations, isolated from any larger context.

In this thesis, I present an approach to designing ECAs with realistic verbal and nonverbal behavior in long-term interaction. Based on a longitudinal corpus of health behavior change counseling dialogue, containing multiple conversations between several

counselor-client dyads, I demonstrate systematic changes in human conversational behavior across multiple conversations; these changes are predicted both by the interaction history of a dyad, and by the strength or quality of their interpersonal relationship. I then present a model and implementation of verbal and nonverbal behavior generation for ECAs which reproduces some of the observed behavior patterns. Finally, I present a longitudinal randomized controlled evaluation study demonstrating that this model, implemented in an ECA that acts as a virtual health behavior change counselor, produces measurable improvements in user-agent interpersonal bond in long-term interaction.

Other publications: [\[C2\]](#) [\[C5\]](#) [\[C7\]](#)

Research Experience

VA Boston Healthcare System, Boston, MA (2013–2014)

VA Advanced Fellowship Program in Medical Informatics

- **Telerehabilitation Intervention to Promote Exercise for Diabetes (TLC-PED)**

PI: Dr. DeAnna Mori

[\[W3\]](#) [\[W4\]](#)

- Participated in econdary analysis of data gathered from a clinical trial of TLC-PED, an automated telephone-based physical activity intervention.
- Explored methodology for physical activity assessment in the context of an automated intervention.
- Explored methodology for developing models of participant behavior over time in a longitudinal trial of an automated physical activity intervention.

Northeastern University, Boston, MA (2005–2013)

Graduate Research Assistant, Human-Computer Interaction

Advisor: Dr. Timothy Bickmore, Relational Agents Group

- **Virtual Patient Advocates for Preconception Care**

[\[J1\]](#) [\[W5\]](#) [\[W8\]](#) [\[W9\]](#)

- Led technical development of a virtual agent system for education and intervention targeting preconception health risks.
- In consultation with domain experts, developed shared decision making aids for choosing birth control methods.
- In consultation with domain experts, developed motivational content for addressing preconception health risks drawing from Motivational Interviewing.

- **Computational Models of Health Behavior Change Dialogue**

[\[J2\]](#) [\[J4\]](#) [\[C9\]](#) [\[W10\]](#) [\[W11\]](#)

- Developed an ontology of health behavior change counseling.
- Developed DTask, a dialogue system designed for reusable, ontology-based behavior change interventions with virtual agents.
- Developed the Litebody framework, open-source components for implementing web-based conversational agents.
- Developed and implemented computational models of Motivational Interviewing for behavior change.
- Led technical and content development of interventions to promote physical activity and fruit and development consumption.
- Conducted two formative evaluation studies and a longitudinal pilot study.

- **A Virtual Laboratory for Studying Long-Term Human-Computer Relationships**
[C3] [C4] [J6] [C8] [C11]
 - Led development of the Virtual Laboratory, a system for efficient longitudinal evaluation of virtual agents for health behavior change, using a persistent pool of participants.
 - Conducted four longitudinal studies examining long-term engagement and behavior change.
- **Tinker: A Relational Guide for the Boston Museum of Science**
[J3] [C1] [C6] [C12] [W12]
 - Developed a virtual agent designed to interact with museum visitors.
 - Developed and evaluated systems for identifying repeat visitors and maintaining continuity of interaction.
- **Automated Comforting by Relational Agents**
[J5] [W13] [W14]
 - Designed and conducted two studies examining the use of empathic messages by computer agents.
 - Assisted with design and analysis of an empirical study examining the use of empathic touch in human-robot interaction.

Publications and Talks

Journal Articles

- [J1] Jack, B., Bickmore, T., Hempstead, M., Yinusa-Nyahkoon, L., Sadikova, E., Mitchell, S., Gardiner, P., Adigun, F., Penti, B., Schulman, D., and Damus, K. (2015). Reducing Preconception Risks among African American Women with Conversational Agent Technology: Results of an RCT. *Journal of the American Board of Family Medicine* (to appear).
- [J2] Bickmore, T., Schulman, D., and Sidner, C. (2013). Automated Interventions for Multiple Health Behaviors Using Conversational Agents. *Patient Education and Counseling*, 92 (2): 142–148.
- [J3] Bickmore, T., Pfeifer Vardoulakis, L., and Schulman, D.. (2013). Tinker: A Relational Agent Museum Guide. *Autonomous Agents and Multi-Agent Systems*, 27 (2): 254–276.
- [J4] Bickmore, T., Schulman, D., and Sidner, C. (2011). A Reusable Framework for Health Counseling Dialogue Systems based on a Behavioral Medicine Ontology. *Journal of Biomedical Informatics*, 44 (2): 183–197.
- [J5] Bickmore, T., Fernando, R., Ring, L. and Schulman, D. (2010). Empathic Touch by Relational Agents. *IEEE Transactions on Affective Computing*, 1 (1): 60–71.
- [J6] Bickmore, T., Schulman, D. and Yin, L. (2010). Maintaining Engagement in Long-term Interventions with Relational Agents. *International Journal of Applied Artificial Intelligence*, 24 (6): 648–666.

Peer-Reviewed Conference Articles

- [C1] Carafo, A., Vilhjamsson, H., Bickmore, T., Heylen, D., and Schulman, D.. First Impressions in User-Agent Encounters: The Impact of an Agent's Nonverbal Behavior on Users' Relational Decisions. (2013) *Autonomous Agents and Multi-Agent Systems*, Saint Paul, MN.
- [C2] Schulman, D. and Bickmore, T. (2012). Changes in Verbal and Nonverbal Conversational Behavior in Long-Term Interaction. *International Conference on Multimodal Interaction*, Santa Monica, CA.
- [C3] Bickmore, T. and Schulman, D. (2012). Empirical Validation of an Accommodation Theory-Based Model of User-Agent Relationship. *Intelligent Virtual Agents*, Santa Cruz, CA.
- [C4] Ring, L., Bickmore, T., and Schulman, D. (2012). Longitudinal Affective Computing: Virtual Agents that Respond to User Mood. *Intelligent Virtual Agents*, Santa Cruz, CA.
- [C5] Schulman, D. and Bickmore, T. (2011), Posture, Relationship, and Discourse Structure. *Intelligent Virtual Agents*, Reykjavik, Iceland.
- [C6] Bickmore, T., Pfeifer, L. and Schulman, D. (2011). Relational Agents Improve Engagement and Learning in Science Museum Visitors. *Intelligent Virtual Agents*, Reykjavik, Iceland.
- [C7] Schulman, D. and Bickmore, T. (2010). Modeling Behavioral Manifestations of Coordination and Rapport over Multiple Conversations: Speaking Rate as a Relational Indicator for a Virtual Agent. *Intelligent Virtual Agents*, Philadelphia, PA.
- [C8] Bickmore, T., Schulman, D. and Yin, L. (2009). Engagement vs. Deceit: Virtual Humans with Human Autobiographies. *Intelligent Virtual Agents*, Amsterdam, Netherlands. *Awarded best paper.*
- [C9] Bickmore, T., Schulman, D. and Shaw, G. (2009). DTask and LiteBody: Open Source, Standards-Based Tools for Building Web-deployed Embodied Conversational Agents. *Intelligent Virtual Agents*, Amsterdam, Netherlands.
- [C10] Schulman, D. and Bickmore, T. (2009). Persuading Users through Counseling Dialogue with a Conversational Agent. *Persuasive Technology*, Claremont, CA.
- [C11] Bickmore, T. and Schulman, D. (2009). A Virtual Laboratory for Studying Long-term Relationships between Humans and Virtual Agents. *Autonomous Agents and Multi-Agent Systems*, Budapest, Hungary.
- [C12] Schulman, D., Sharma, M. and Bickmore, T. (2008). The Identification of Users by Relational Agents. *Autonomous Agents and Multi-Agent Systems*. Estoril, Portugal.

Peer-Reviewed Workshop and Poster Presentations

- [W1] Schulman, D., Mori, D., and Niles, B. (2015). Use of Accelerometers for Physical Activity Assessment: Do Calibration Estimates Change over Time? *Society of Behavioral Medicine Annual Meeting (rapid communication abstracts)*, San Antonio, TX. (to appear).
- [W2] Schulman, D., Mori, D., Reese, R., Niles, B., Allsup, K., Bachand, A., and Forman, D. (2015). Improving Accelerometer Estimates of Physical Activity in a Sedentary Diabetic Population. *Society of Behavioral Medicine Annual Meeting*, San Antonio, TX. (to appear).

appear).

Selected as a meritorious poster abstract.

- [W3] Schulman, D., Mori, D., Reese, R., and Niles, B. (2014). Behavioral Assessment and Participant Compliance in an Automated Physical Activity Intervention for Diabetics. *Society of Behavioral Medicine Annual Meeting (rapid communication abstracts)*, Philadelphia, PA.
- [W4] Reese, R., Niles, B., Schulman, D., and Mori, D. (2014). Concordance between Self-Report and Accelerometer Measures of Physical Activity in Overweight Veterans with Type 2 Diabetes. *Society of Behavioral Medicine Annual Meeting (rapid communication abstracts)*, Philadelphia, PA.
- [W5] Ren, J., Schulman, D., Jack, B., and Bickmore, T. (2013). Supporting Longitudinal Change in Many Health Behaviors. *CHI Extended Abstracts*, Toronto, Canada.
- [W6] Bickmore, T., Schulman, D., Yin., L. (2013). Increasing Engagement in Web-based Interventions using Relational Agents. *Society of Behavioral Medicine Annual Meeting (abstracts)*, San Francisco, CA.
- [W7] Bickmore, T., Schulman, D., Yin., L., and Ring, L. (2013). Reaching Minority Populations with Relational Agents. *Society of Behavioral Medicine Annual Meeting (abstracts)*, San Francisco, CA.
- [W8] Imperato, C., Damus, K., Hempstead, M., Schulman, D., Kopy, M., Tran, H., Yinusa-Nyahkoon, L., Paasche-Orlow, M., Bickmore, T., and Jack, B. (2012). Incorporating Motivational Interviewing into Virtual Contraceptive Counseling. *American Public Health Association Annual Meeting (abstract)*, San Francisco, CA.
- [W9] Mitchell, S., Imperato, C., Schulman, D., Hempstead, M., Tran, H., Kopy, M., Bickmore, T., Paasche-Orlow, M., and Jack, B. (2012). Developing Virtual Patient Advocate Technology for Shared Decision Making. *Annual Meeting of the Society for Medical Decision Making (abstract)*, Phoenix, AZ.
- [W10] Schulman, D., Bickmore, T. and Sidner, C. (2011). An Intelligent Conversational Agent for Promoting Long-term Health Behavior Change using Motivational Interviewing. *AAAI Spring Symposium on AI and Health Communication*, Palo Alto, CA.
- [W11] Bickmore, T., Schulman, D. and Sidner, C. (2009). Issues in Designing Agents for Long Term Behavior Change. *Engagement by Design Workshop, CHI '09*, Boston, MA.
- [W12] Bickmore, T., Pfeifer, L., Schulman, D., Perera, S., Senanayake, C. and Nazmi, I. (2008). Public Displays of Affect: Deploying Relational Agents in Public Spaces. *CHI Extended Abstracts*, Florence, Italy.
- [W13] Bickmore, T. and Schulman, D. (2007). Practical Approaches to Comforting Users with Relational Agents. *CHI Extended Abstracts*, San Jose, CA.
- [W14] Bickmore, T., and Schulman, D. (2006). The Comforting Presence of Relational Agents. *CHI Extended Abstracts*, Montréal, Canada.

Invited Presentations

- [I1] *Virtual Agents for Long-term Engagement and Health Behavior Change.* Opening of Northeastern University satellite campus, October 2011, Charlotte, NC.

- [12] *Tools and Toolkits for Voice and Animated Character-based Interventions* (with T. Bickmore). At “Towards Standardization and Reuse in Behavioral Informatics”, a course at the Society for Behavioral Medicine annual meeting, April 2011, Washington, DC.

Teaching Experience

Northeastern University, Boston, MA

Graduate Teaching Assistant (Fall 2005, Fall 2007)

Dr. Timothy Bickmore, CS G170, Human-Computer Interaction

- Graded class assignments.
- Provided mentorship for student design projects.
- Taught several lectures.

Brandeis University, Waltham, MA

Teaching Assistant (Spring 1999)

Dr. James Storer, CS 22, Data Structures and Algorithms

- Graded student homeworks and projects.
- Held office hours and review sessions.

Employment

MOTU, Inc., Cambridge, MA

Software Developer (2001–2005)

- Participated in development of Digital Performer, a digital audio sequencing package.
- Authored device drivers for USB audio and MIDI products.
- Participated in development of open standards for the description of audio synthesizer products.

Professional Service

Professional Membership

- American Medical Informatics Association (AMIA)
- Society for Behavioral Medicine (SBM)
- Association for Computing Machinery (ACM)
- Association for the Advancement of Artificial Intelligence (AAAI)
- International Association for Relationship Research (IARR)

University Service

- Ph.D. recruitment open house
Volunteer 2006–2010
- Ph.D. admissions and curriculum committee
Student representative 2007–2008
- Faculty hiring committee
Student representative 2008–2009

Conferences

- *Intelligent Virtual Agents* 2010, Philadelphia, PA
Co-chair, poster and demo sessions

Peer Review

- ACM Transactions on Management Information Systems
- International Journal of Human-Computer Studies
- Interacting with Computers
- ACM SIGCHI Conference on Human Factors in Computing Systems
- International Conference on Intelligent Virtual Agents
- International Conference on Autonomous Agents and Multi-Agent Systems