Relational Agents for Health Behavior Change

Timothy Bickmore, Ph.D.
Medical Information Systems Unit
Boston University School of Medicine

Gesture & Narrative Language Group, Prof. Justine Cassell
- Study & emulate human face-to-face conversation
- Embodied Conversational Agents
- Focus on nonverbal communicative behavior
  - gaze, posture, gesture, etc.

Embodied Conversational Agents

Affective Computing Group
Prof. Rosalind Picard
- Computing that relates to, arises from, or deliberately influences emotions.
- Focus on detection of emotional state via mobile / wearable sensors.

Management of User Emotional State
- Computer interfaces that actively support human users in their ability to regulate, manage, and recover from their own negative emotional states.
- Experiment:
  - Intentionally frustrated users
  - When computer elicited user’s emotional state and offered empathetic feedback users continued to work with it significantly longer.

Relational Agents
Computational artifacts designed to build and maintain long-term, social-emotional relationships with their users.
How do people benefit from social relationships?

- Direct benefits
  - Instrumental, emotional support
- Indirect benefits
  - Persuasion (e.g., sales)
  - Educational gains
  - Health & Well-being
  - Helping (e.g., psychotherapy, behavior change)

Previous Work: Computers As Social Actors studies

- Liking
  - Flattery
  - Use of praise for others
  - Similarity attraction
  - Teaming
  - Humor
- Attraction / Cooperation
  - Reciprocal deepening self-disclosure

Commercial Products

- Fulfill need for nurturance
- “unique” behavior
- Persistence

Shortcomings in Previous Work

- No longitudinal studies
- Little or no persistence
- No effects on task outcome

Relational Agents Implemented

<table>
<thead>
<tr>
<th>Focus</th>
<th>REA</th>
<th>Laura</th>
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<tbody>
<tr>
<td>Face-to-face conversation</td>
<td>Long-term relationship</td>
<td></td>
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<td>Dimensional (familiarity, solidarity)</td>
<td>Time Common ground</td>
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<td>Activation network</td>
<td>Augmented transition networks</td>
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<td>Small talk</td>
<td>Maintenance</td>
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<td>Real estate</td>
<td>Exercise adoption</td>
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<td>Trust</td>
<td>Working Alliance</td>
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Working Alliance

- Trust and belief that a helper and client have in each other as team-members in achieving a desired outcome.
- Strong effect on outcomes across wide range of psychotherapeutic disciplines.
- Subscales: bond, task, goal
Agent: Exercise “Advisor”

- Not a personal trainer
- Uses ‘I’ rather than ‘this computer’
- Can express empathy, but
- Does not have feelings
- No personal ‘backstory’
  - Describes 3rd person experiences (“One of my clients always packs her gym clothes...”)

Design Studies

- 5 face-to-face Meetings
- 5 x 2 week daily chats
- Series of surveys on agent design.

Typical Daily Interaction

- Fill out activity logs
- View self-monitoring charts
- Fill out surveys
- Discussion with agent
  - Greeting
  - Find out physical & emotional state
  - Follow up
  - Give tips
  - Get commitment
  - Farewell
- Educational content

Behavior Change Strategies

- Via Forms and Content Pages
  - Goal setting
  - Shaping
  - Self-monitoring
  - Education
  - Decisional Balance (weighing pros and cons)
- Via Agent
  - More detailed goal setting (commitments)
  - Positive reinforcement
  - Obstacle avoidance / Performatives / Relapse prevention / Coping thoughts / Social proof

Relational Strategies

- Small talk
- Emotional Support
  - Empathy exchanges (following Klein)
- Increasing common ground
- Continuity behaviors
- Meta-relational communication
- Humor
- Politeness & Forms of Address
- Reciprocal self-disclosure
- Performing routine behaviors together
- Nonverbal immediacy behaviors
**System Architecture**

- BEAT
- Dialogue Server
- Web Server
- Relational Database

**Dialogue Server**

- Augmented Transition Network
  - (76 networks / 976 states for 30 interactions)
- Property/value pairs loaded for each user at start of interaction; saved at end.
  - Single-valued (e.g., ISLONER)
  - Session-valued (e.g., TOLDSTORY)

**Extensions to BEAT for Relational Agents**

- Utterances specify
  - Relational Stance (high/low immediacy)
  - Frame (task, social, empathy, encourage)
- Index a set of modifiers to apply to BEAT
  - Frequency
    - e.g. gestures
  - Modulation
    - e.g. proximity

**Evaluation Study Objective**

- Determine if
  - Character can build a working alliance.
- Behavior change objective
  - “30 minutes or more of moderate or better activity on most, if not all, days of the week” (recommend walking)
  - Secondary goal: 10,000 steps a day

**Relational Measures**

Hypotheses: NON-REL < REL

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<th>Baseline</th>
<th>Intervention</th>
<th>Two Week</th>
<th>Break</th>
<th>Follow-up</th>
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<tr>
<td>CON-REL</td>
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<tr>
<td>NON-REL</td>
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<td>REL</td>
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Subjects

- 96 eligible subjects
- 30 non-relevant intake meetings
- 641 decided not to participate
- 128 maintainers 30 poor health during intake
- 76 no shows or screened out during intake
- 187 scheduled intake meetings
- 76% show up or remain out during intake
- 101 start intervention
- 91 complete at intervention
- 82 complete follow-up
- 101 complete at least 1st week
- 91 complete at least 2nd week
- 46 complete follow-up

Between Subjects Design:

- RELATIONAL – relational agent
- NON-RELATIONAL – relational behaviors ablated
- CONTROL – no agent

**Intake 1st Login**

Hypotheses: NON-REL < REL

- Between Subjects Design:
  - Behavior change objective
  - Determine if
    - Character can build a working alliance.
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**Between Subjects Design:**

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- CONTROL – no agent
Relational Results
All Subjects

Differences in BOND subscales significant:
WK1 p<.05
WK4 p=.007

Working Alliance Inventory

Single items:
- “How much do you like Laura?” p<.05
- “How would you characterize your relationship with Laura?” p<.05
- “Would you like to continue working with Laura?” (at end of WK4) p<.05

Behavioral measure:
- Sentimental farewell (70% REL vs. 32% NON-REL; p<.001)

Relational Results
All Subjects

“The who was most helpful in getting you to exercise?”

Only difference between groups is WK4,
CONTROL < AGENT
p=.06

Significant increase
WK0-WK4  p<.001
Significant decrease
WK4-WK6  p<.001

Behavioral Results, All Subjects (Representative)

Qualitative Analyses

- 28 interviews, 78 feedback messages

- Overall Impressions...

I guess I thought... it's a really really good idea, and some aspects of it were very helpful, like being able to record your progress and things like that.
(RELATIONAL)

It was useful. It was my number one motivation for working out. It was a consistent motivation for working out. (NON-RELATIONAL)

It was really good. I was exercising much more than before. (RELATIONAL)
Qualitative Analyses

Acceptance of Laura

- Ss weighed in on both sides..

It was a really, really great idea to have some kind of animated character because it makes you feel like you're actually talking to a person rather than having words on the computer screen. (NON-RELATIONAL)

I like talking to Laura, especially those little conversations about school, weather, interests, etc. She's very caring. Toward the end, I found myself looking forward to these fresh chats that pop up every now and then. They make Laura so much more like a real person. (RELATIONAL)

I didn't really like Laura very much. ... Actually, I liked all of the software except for the animated conversation thing. (RELATIONAL)

Personally I detested Laura. (NON-RELATIONAL)

Qualitative Analyses vs. Human Trainer

No, not given my time constraints. With respect to a webcam and a live trainer, that would be a toss up, but I don't think you could get one to be available at 11pm. (NON-RELATIONAL)

Probably not. More painful that way, if I decide not to do something. I've interacted with live people before and given up on them because of exercise. Because sometimes I want to go off the wagon for awhile on exercise. And, when talking with a computer program about exercise, I never want to avoid that person in real life if I haven't made my exercise goal. So, I kind of liked the fact that she was a computer program and not a person. (RELATIONAL)

Qualitative Analyses

Laura as Motivator

- Most felt responsible to her

When I said I couldn't exercise I felt bad. When she said "are you sure you can't exercise?" it would make me think about it. (NON-RELATIONAL)

It sort of kept me motivated, because I always do more if I know I'm responsible to someone. (RELATIONAL)

It kept you on your toes because you didn't know if you were going to meet with the animated person. (RELATIONAL)

As silly as it sounds, I find that I found a little motivation to exercise knowing that Laura would ask if I did or not. Now that I don't have anyone checking, I find it harder to get motivated. (RELATIONAL)

Study Conclusions

- Demonstrated ability of relational agents to build caring, trusting relationships with users
  - "Laura and I trust one another." (p<.001)
  - "I believe Laura is genuinely concerned about my welfare." (p<.001)
  - "My relationship with Laura is very important to me." (p<.001)
  - "I feel Laura cares about me..." (p<.001)
  - "Laura and I respect each other." (p<.001)
  - "I feel Laura appreciates me." (p<.001)
  - "I believe Laura likes me." (p<.001)
  - Reported liking of Laura. (p=.007)
  - Reported desire to continue working with Laura. (p=.001)
- Demonstrated the efficacy of having an animated exercise advisor who set and followed up on goals.

Future Work

- Relational agents to address social isolation & depression in elder-care
  - DOM Pilot Project with Geriatrics
  - Kiosk-based health education
  - PDA-based health behavior interventions
  - Long term social interaction with agents
  - Dialogue planning for treatment negotiation

Conclusion

- “Patient centered computing” is important for patient satisfaction and health outcomes

- More info
  bickmore@bu.edu
  http://www.misu.bmc.org/~bickmore/