The Role of Emotional Expression in Behavior Change Coaching by a Social Robot

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Abstract. This experimental study evaluates the suitability of a social robot for inducing behavior change, where the robot serves as a behavior change coach. Using a simulation of the social robot Haru developed by the Honda Research Institute, this study measured the effect of the robot's emotional expressions and behaviors on behavior change and the perceived quality of the session.

The method for behavior change employed is the 'Tiny Habits' approach developed by (Fogg 2019), which assumes that behavior can be changed if a) the behavior to be changed is broken down into a tiny habit, b) this habit is anchored in the person's everyday life, and c) every success is celebrated. Based on these principles, a scripted dialogue was created to coach participants in a session in which they chose a behavior they wanted to change themselves.

The experiment proceeded with altogether 30 participants. In the experimental condition, the dialogue between participant and the robot simulator was interspersed with emotional expression and behaviors such as dancing, bowing and vocalizing. The control condition utilized the same setup with the robot simulator and provided participants with the same guidance, but without emotional expression.

Our results reveal a positive effect of emotional behavior on most of the measured variables. Compared to the baseline, the participants in the emotional condition had a higher motivation to change their behavior, felt more confident in applying the behavior change method, confirmed that they would think differently about behavior change and rated the quality of the lesson higher.

Keywords: Behavior change · Tiny Habit method · Persuasive technology

1 Introduction

In this paper, we want to find out whether a simulated robot can function as a persuasive technology that effectively supports people in their attempt to acquire a new habit and to what extent emotional expression by the robot facilitates the retention of the habit.

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1.1 Behavior Change – Tiny Habits Method

Individual habitual behavior is a frequently repeated, learned behavior with a high degree of automaticity (Orbell and Verplanken 2010). It is also stably cued in context such that there is a link between a certain context and certain response (Gardner, 2015). The Tiny Habit method by BJ Fogg (2019) used for our behavior change coaching experiment, builds on these principles. The core of the model consists of three elements: a) the tiny habit itself, b) an anchor moment, and c) a celebration.

According to Fogg (2019), people often fail to change their behavior because they overestimate the level of their motivation and willingness to change; while a high aspiration or a final goal is essential, it is difficult to reach the final aspiration without regularly repeating it – which, according to his experience, is often too demanding. Fogg's response to this potential issue is to break down the habit into a simplified version of the aspiration (e.g. the aspiration to run every day can be broken down into taking on running shoes). Individuals who would like to acquire a new behavior should create a habit which they can perform every day, does not take longer than 30 s, and only requires little effort.

The second pillar of the Tiny Habit method, the anchoring, helps to firmly incorporate the tiny habit into everyday life. Another routine, already firm in an individual's daily routines, is employed to anchor the new tiny habit.

The third element is the celebration. By intentionally creating positive emotions, participants are rewarding the completion of their small steps and thus strengthening the position of tiny habits in the individuals' everyday life.

This potential effect of emotional experience on behavior change and habit retention was suggested also by Bargh and Morsella (2009). Moreover, in interactive storytelling, the display of emotional expression has been found to be important element for memory retention, and of the quality of the storytelling itself (Bavelas et al. 2002).

The current paper explores to what extent a one-time coaching session with the Tiny Habits method using a simulated social robot may lead to behavior change and what role emotional displays play in the retention of the new habit.

1.2 Robots as a Persuasive Technology

Previous work on robots as persuasive technologies is sparse, and none of the studies addressing persuasion target habit formation and longterm behavior change. For instance, Andrist et al. (2013) and (2015) investigate the effects of different speaking styles and find that robots that use persuasive speaking styles are more persuasive than robots that don't. Similarly, Fischer, Niebuhr et al. (2020) show that robots' speech characteristics influence the degree to which people follow their advice. Winkle et al. (2019) studied the effects of certain persuasive messages and document several effects. Ham et al. (2015) detect interaction effects on robot persuasiveness between robot speech and accompanying gestures, and Fischer, Langedijk et al. (2020) show that the effectiveness of persuasive messages by robots is influenced by mutual gaze. These studies confirm that robots that use persuasive signals may actually serve as persuasive technologies.

Previous work on emotional expression in robots has mostly focused on identifying the emotions expressed given the special robot morphologies and limited modalities for emotional expression (Fischer, Jung et al. 2019). Jung (2017) argues that emotional

expression is socially required in social interactions. However, in Fogg's 'Tiny Habit' behavior change method, emotional expression plays a specific role, namely it is taken to reinforce habit formation. This particular role of emotional expression has not previously addressed in human-robot interaction research.

2 Case Study: Emotional Expression in Behavior Change Coaching

Our study aims to explore the effects of emotional expression in behavior change coaching by a social robot, focusing on the perceived quality of the lesson. Furthermore, we analyze the effects of the method on retention and motivation to change behavior by means of a questionnaire administered at least 10 days after the session.

2.1 Method

To measure the effect of emotional expression on the quality of the lesson and residual willingness to change behavior, two experimental conditions – experimental, i.e. emotional, and control – were created. In both conditions, we used the same script, presenting the Tiny Habit coaching session by the simulation of a social robot Haru from the Honda Research Institute in Tokyo. In both scenarios, the robot uses the same synthesized voice; however, in the experimental condition, the robot uses emotional expression, whereas in control condition 2 it does not. In both conditions, the robot behavior was controlled by a wizard operator (cf. Riek 2012).

2.2 Experimental Setup

The script that presents participants with the Tiny Habit method was created and divided into five sections. The core of the script, consisting of 66 utterances, explains the basics of the Tiny Habit method and is used to guide participants through the session. Furthermore, 82 additional utterances were created to give the robot operator the possibility to react to the most common questions, help participants to return to the core of the script and move forward in the session. These utterances were created based on extensive pilot testing and used in order to ensure a smooth interaction; however, on average only 3–4 of these specific utterances were used in each interaction, so that the interactions remain largely comparable.

In the experimental condition, the robot's behavior is enriched with emotional expression by means of behaviors other than speech, such as dancing, smiling, bowing or vocalizing, which were used 34 times per interaction, thus prolonging the average time to complete the core of the session from 15 to 17 min. In all other respects, the robot's behavior was identical across conditions.

The script itself was divided into five sections, reflecting the overall structure of the method as outlined by BJ Fogg (2019):

a) In the short introduction, Haru presented the purpose of the session, introduced itself and explained the structure of the session.
b) Participants were guided to define their aspirations.

c) Participants were explained the importance of making their aspirations tiny and helped to create a simplified version of their future habit.
d) The Tiny Habit formula was presented: After I *anchor moment, I will *tiny habit, and celebrate.
e) At the end, participants learned about the importance of celebrating their success and were given the chance to present their tiny habit.

The whole script was created in such a way that the robot was able to react to participants' most common questions – in addition, further clarifications of the concepts were prepared and used if needed (Fig. 1).

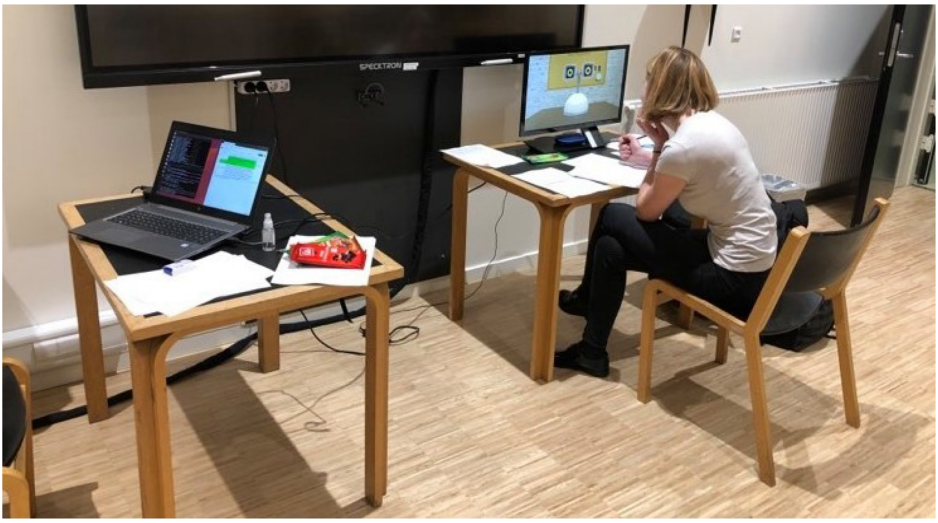

Fig. 1. Experimental setup of the behavior coaching session

Procedure: Participants, who volunteered to participate in the experiment, were seated in front of a screen with the robot simulation and presented with a paper that introduced them to the Tiny Habit method, expected length of the session and the fact they would be rewarded with chocolate. Part of this pre-session period was also an introduction to the Haru simulator in front of them. The script started with a question: "Hi, what is your name?" In case the participant did not reply, this was followed by the utterance "You can talk to me!", followed by the rest of the script. Participants were given a questionnaire at the end of their session; another one was sent to them after 10–14 days.

Materials: As stated above, the Haru robot was run as a simulator on a 27-inch LCD with a loudspeaker hidden behind the screen. The simulator itself runs on a laptop equipped with a Gazebo simulator environment. The whole setup was made in such a way that the robot could be teleoperated, using the Wizard-of-Oz method (Baxter et al. 2016). The operator was present in the same room, but out of the direct line of sight of the participant. The same wizard controlled the robot through all 30 interactions.

Participants: A total of 30 people with a mean age of 28.4, all residents of Southern Denmark, participated in the experiment. The 18 women and 12 men were distributed equally between the two conditions. Before the session, 39% of the participants had only seen a robot on TV, 28% had seen one or a few robots in reality, 23% had played or worked with one and 10% stated that they regularly work with robots. Most of the participants were international students while 23% were of Danish nationality.

Questionnaire: Every participant received a questionnaire after finishing the session. The first part of this questionnaire (q1–q5) focused on demographics such as age, nationality, line of study, and robot experience. In the second part of the questionnaire (q6–q7), participants rated their motivation to change their behavior before and after the session. The next two blocks of questions (q8–q14) focused on the course content, quality of the session and the learning outcomes. To measure the retention of the method, another questionnaire focusing on the progress with participant's behavior change was sent at least 10 days after the session.

2.3 Results

Questionnaire data from the experimental condition with emotional behaviors (C1) and control condition (C2) were compared, using a paired student t-test. Figure 2 presents the questionnaire results concerning the evaluation of the session. Participants interacting with the robot that uses emotional behaviors were significantly more willing to think differently about the behavior change ($p = 0.0394$), and we identified a positive statistical trend in their rating of the overall quality of the session ($p = 0.0680$).

		Experimental condition		Control condition		
		Mean	stdv	Mean	stdv	p
q7b	**Motivation difference**	1.40	-0.27	1.20	-0.36	0.2708
q8	**Overall quality**	4.33	0.49	3.93	0.88	0.0680
q9	**Understanding concepts**	4.40	0.63	4.40	0.63	0.5000
q10	**In-depth**	2.40	1.24	2.47	1.41	0.4458
q11	**Was logical**	4.47	0.52	4.40	0.74	0.3881
q12	**Confident applying**	4.47	0.52	4.20	1.08	0.1982
q13	**Course tought you**	2.67	0.90	2.53	1.36	0.3767
q14	**Think differently**	4.00	0.85	3.20	1.47	0.0394

Fig. 2. Statistical analysis of the data in C1 and C2 from the post-session questionnaire

Furthermore, t-test comparisons of the other questions revealed statistical tendencies towards more favorable ratings of the robot that used emotional behaviors.

Another statistical trend was identified in the post-experimental questionnaire focusing on participants' retention of the new habit. Those who had interacted with the robot in the experimental condition were more likely to maintain the habit they created during the session ($p = 0.04$). All the participants from the experimental condition carried out their new habit at least once, while the majority (66%) practiced their behavior at least twice (Fig. 3).

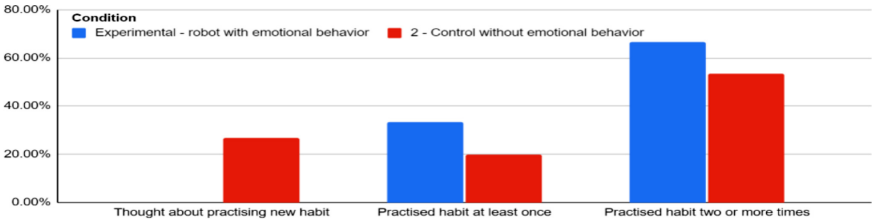

Fig. 3. Habit retention from post-questionnaire send at least 10 days after the initial session.

3 Discussion

The study shows that the robot's emotional behaviors have a significant effect on how participants think about behavior change. Furthermore, the results reveal positive effects on the perceived quality of the lesson and retention of the new habit. However, our findings, possibly influenced by the small number of participants, did not reveal any significant effects on other measured categories, such as the difference between motivation before and after the session or on understanding the concepts presented.

To evaluate the effects of Haru's emotional behaviors more precisely, the effect of particular behaviors used during the session should be measured. After the sessions, some of the participants mentioned that they disliked some particular behaviors, which may have influenced the results. Also, the effect of non-human behaviors used in the experimental condition (such as the visualization of a lotus flower, question mark or fireworks) could be evaluated independently in the future. Therefore, we are now conducting another study, measuring the effects of the habitual retention in another condition, which uses the same script but presents the contents as a website.

4 Conclusion

To conclude, there is a significant effect of emotional behavior on the perceived quality of the lesson and on the retention of the habit practiced. Therefore, a long-term effect can be expected. We can thus conclude that emotional expression has a positive effect on the quality of human-robot interactions in general and on behavior change coaching in particular. In addition, we can conclude that robots may be effective persuasive technologies, and that the Tiny Habits method is a suitable approach for robot-human behavior change coaching.

References

Andrist, S., Spannan, E., Mutlu, B.: Rhetorical robots: making robots more effective speakers using linguistic cues of expertise. In: 2013 8th ACM/IEEE International Conference on Human-Robot Interaction (HRI), pp. 341–348. IEEE (2013)

Andrist, S., Ziadee, M., Boukaram, H., Mutlu, B., Sakr, M.: Effects of culture on the credibility of robot speech: a comparison between English and Arabic. In: Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction, pp. 157–164 (2015)

Bargh, J.A., Morsella, E.: Unconscious behavioral guidance systems. In: Agnew, C.R., Carlston, D.E., Graziano, W.G., Kelly, J.R. (eds.) Then a Miracle Occurs: Focusing on Behavior in Social Psychological Theory and Research, pp. 89–118. Oxford University Press (2010)

Bavelas, J.B., Coates, L., Johnson, T.: Listeners as co-narrators. J. Pers. Soc. Psychol. **79**(6), 941–952 (2000)

Bavelas, J.B., Coates, L., Johnson, T.: Listener responses as a collaborative process: the role of gaze. J. Commun. **52**, 566–580 (2002). https://doi.org/10.1111/j.1460-2466.2002.tb02562.x

Fischer, K., Niebuhr, O., Jensen, L.C., Bodenhagen, L.: Speech melody matters – how robots can profit from using charismatic speech. ACM Trans. Hum.-Robot Interact. **9**(1), 1–21 (2020)

Fischer, K., Langedijk, R.M., Nissen, L.D., Ramirez, E.R., Palinko, O.: Gaze-speech coordination influences the persuasiveness of human-robot dialog in the wild. In: Wagner, A.R., et al. (eds.) ICSR 2020. LNCS (LNAI), vol. 12483, pp. 157–169. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-62056-1_14

Fischer, K., Jung, M., Jensen, L.C., aus der Wieschen, M.: Emotion expression in HRI–when and why. In: 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), pp. 29–38. IEEE (2019)

Fogg, B.J.: Tiny Habits: The Small Changes That Change Everything. Virgin Books (2019)

Gardner, B.: A review and analysis of the use of "habit" in understanding, predicting and influencing health-related behaviour. Health Psychol. Rev. **9**(3), 277–295 (2015)

Ham, J., Cuijpers, R.H., Cabibihan, J.J.: Combining robotic persuasive strategies: the persuasive power of a storytelling robot that uses gazing and gestures. Int. J. Soc. Robot. **7**(4), 479–487 (2015)

Jung, M.F.: Affective grounding in human-robot interaction. In: 12th ACM/IEEE International Conference on Human-Robot Interaction (HRI), pp. 263–273. IEEE (2017)

Orbell, S., Verplanken, B.: The automatic component of habit in health behavior: habit as cue-contingent automaticity. Health Psychol. **29**(4), 374–383 (2010)

Riek, L.D.: Wizard of oz studies in HRI: a systematic review and new reporting guidelines. J. Hum.-Robot Interact. **1**(1), 119–136 (2012)

Winkle, K., et al.: Effective persuasion strategies for socially assistive robots. In: 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), pp. 277–285. IEEE (2019)