Exploring the Link between Self-assessed Mimicry and Embodiment in HRI

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ABSTRACT

This work explores the relationship between a robot's embodiment and people's ability to mimic its behavior. It presents a study in which participants were asked to mimic a 3D mixed-embodied robotic head and a 2D version of the same character. Quantitative and qualitative analysis were performed from questionnaires. Quantitative results show no significant influence of the character's embodiment on the self-assessed ability to mimic it, while qualitative ones indicate a preference for mimicking the robotic head.

CCS Concepts

•Human-centered computing → Empirical studies in HCI; •Computing methodologies → Intelligent agents;

Keywords

Human-robot interaction; Mimicry; Embodiment.

1. INTRODUCTION

This paper investigates the relationship between a character's embodiment and people's ability to mimic in social human-robot interactions. Social robots play an important role in assistive settings, where they provide social and physical support [7]. However, the success of such social robots is highly depended on their likability and perceived pleasure to interact with them. Mimicry has shown to have a positive effect on the likability of an artificial agent and research from psychology suggests that this holds for both the mimicker and the one being mimicked [6]. In addition to the implicit use of mimicry to strengthen the rapport between a human and a robot, mimicry is also explicitly used in autism therapy, among others [2]. Despite the advantage of using mimicry, mimicking robots is difficult due to technical limitations in robot's faces. Back-projected robot platforms like Furhat [1] use technology from virtual agents to accurately display human-like facial expressions. With this work, we analyze if people assess the effort to mimic the Furhat robot due to its 3D presence differently from the same character displayed in 2D.

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2. METHODOLOGY

In this paper, we empirically address what influence the type of embodiment (2D virtual character vs. 3D mixed-embodied robot) has on the self-assessed ability to mimic using laughter as a case study.

2.1 Experimental Design & Stimuli

We designed a within-subject experiment with the two independent variables *type of embodiment* and *type of laughter* in which participants were asked to mimic an artificial character. A male character was presented as a *3D mixed-embodied Furhat robot* [1] and a *2D virtual agent on a screen.*

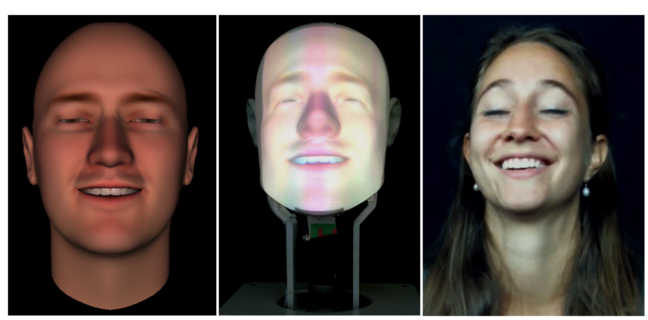

Figure 1: 2D representation of the stimulus (left), 3D representation (middle) and a user performing the mimicry task (right).

In our study, we chose a joyful laughter associated with positive emotions and a schadenfreude laughter associated with both negative and positive emotions [5] as a stimulus. In addition, two trial facial expressions were displayed.

Both laughter types consist of an audio and facial expression component and a head movement. The audio for the laughter stimuli was selected in an online pre-study. Virtual facial expression synthesis was grounded in the work by Ruch et al. [5], which describes laughter according to the Facial Action Coding System (FACS).

The *self-assessed ability to mimic the robot* was the dependent variable in this experiment. Participants rated how well they mimicked the character, how much effort the mimicry took and how comfortable they felt on a 5 point Likert scale. In addition, they could freely elaborate on their experience in a final questionnaire after the experiment.

23 students (Age: M = 26.5, SD = 2.5, 21.7% female) enrolled in Computer Science and related subjects were recruited to take part in the experiment. The data of two participants were excluded from the analysis because the data suggested a misunderstanding of the task.

2.2 Experimental Setup & Procedure

The experimental sessions took place in a private laboratory room at Uppsala University. The participant was standing at a distance of about 100 cm from the character that was placed on a table at approximately 170 cm from the ground. An iPad was available for filling-in questionnaires.

Prior to the experiment, participants filled out an online questionnaire including demographic and personality questions which aimed to assess their level of *gelotophobia* ("the fear of being laughed at"), among others. Participants with a high gelotophobia rating were excluded from participation.

After arriving at the experiment session, participants gave informed consent to participate. They were then instructed to mimic by imitating facial expressions, head movements and voice within 8 seconds given for each mimicry task. After each mimicry recording, participants rated their mimicry performance on the iPad.

Each behavior was mimicked and assessed three times before the next behavior was displayed. The order of embodiment and laughter type was determined using Latin square prior to the experiment to minimize ordering influences.

After all four behaviors were mimicked three times for the first embodiment type, participants were given a short break while the embodiment was switched. Then, the second mimicry session started. It included the same four behaviors as in the previous embodiment in the same order.

3. RESULTS

Quantitative Analysis

Since this short paper is only focused on the independent variable *type of embodiment*, a One-way ANOVA with Type III sum of squares was performed. The results show no significant influence of the embodiment on the self-assessed ability to mimic, $F(1,268) = 0.015$, $p = 0.903$, the effort to mimic the character, $F(1,268) = 0.061$, $p = 0.806$, and the comfort during the mimicry, $F(1,268) = 0.983$, $p = 0.322$.

Qualitative Analysis

In the free-text assessment in the end of the experiment, participants generally described it as more difficult to mimic the 2D character. It was noted that the mimicry in 2D was more strange "due to the tangible face in 3D", that "every movement of the eyes and small micro-expression were much clearer and noticeable in 3D" and that the 3D version was "easy to follow". Participants also commented that the "2D character was not as pleasant to mimic as the 3D character" and that they "liked interacting with the 3D representation better". Only one participant noted that "the behaviors were more easily discerned in the 2D version of the model".

4. DISCUSSION & CONCLUSION

The quantitative analyses showed *no difference in the ability to mimic the 2D versus the 3D embodiment of the character.* Interestingly, previous work in the literature showed different results. Leyzberg et al. [4], for example, found a clear influence of the embodiment type on task success, but not in the context of mimicry. Moreover, Hofree et al. [3] found differences between the ability to mimic an android robot and the ability to mimic a 2D video recording of the same. Contrary to their work, however, we used a mixed embodiment (and not fully robotic) platform.

In opposition to the quantitative analyses, participants mentioned in the post-questionnaire they *found the expressions to be clearer visible and felt they were better able to mimic in 3D*, which would be more in line with other related work [3][4]. These contradictory findings are interesting, because they suggest that the *feeling of task success examined qualitatively afterwards differs from the more systematic measures during the interaction.* This early exploratory work is part of a larger study on conscious mimicry of social agents. In the future, we will introduce a method to objectively measure the ability to mimic and thereby understand which of the results from self-assessment matches with the objective analysis. In addition, we aim to further investigate the influence of the likability on the ability to mimic.

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