Designing Non-Verbal Humorous Gestures for a Non-Humanoid Robot

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Figure 1: Non-humanoid robot [19]

ABSTRACT

Humor has various positive implications for our daily lives, and it has shown to improve human-robot interaction as well. To date, humor has been applied to robots that mimic human behavior thus missing out on improving interactions with the non-humanoid robots continually being deployed to our daily lives. In this work, we conducted an initial evaluation of the far-out possibility to create non-verbal humorous behavior for a robot with no human features. The robot's humorous gestures were designed by a clown therapist, animator, and HRI expert. The initial evaluation compared participants' responses to humorous and non-humorous robotic gestures. Our study indicates it is possible for a simple non-humanoid robot to communicate a humorous experience through gestures alone, provided the movements are carefully balanced to bring about this good humor encounter. This study's gesture design insights can serve as first steps toward leveraging humorous behaviors in non-humanoid robots to enhance HRI.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in interaction design**.

KEYWORDS

Humor; HRI; Humor-Computer Interaction; Non-humanoid robots; Gestures design

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1 INTRODUCTION

Humor is an indispensable feature of everyday life and has been shown to positively affect and benefit our psychological [8, 23, 54], interpersonal [11] and physical [37] connections. Humor encourages resilience and well-being [1, 8, 16, 23, 36, 37], enhances creativity and problem solving [18, 20], and plays an important role in improving interactions [11, 22, 35, 62]. There is no one all-embracing definition or theory to describe what humor is but there is universal acceptance of its many benefits [10, 25, 47, 51, 56]. It is no surprise then that HCI and HRI researchers are exploring possibilities of employing this key feature of everyday social interactions to improve Human–Robot Interactions (HRI). HRI research to date has evaluated how humor eases and improves human-robot interaction [32, 43, 52, 65], increases sociality of a robot [31, 43], creates robotic amusement [3, 13, 21, 48, 59, 64], impacts how a human accepts robot failure/errors [49], raises likability of a robot [31, 33, 39, 65], and alters perception of robots [13, 43, 65]. HRI studies utilize a variety of methods to apply humor to robotic behavior. Prior studies have used verbal humor (witty statements or jokes) [63] and non-verbal humor (comical actions or gestures that others recognize to be funny) [50] that mimic human behavior [43, 52, 58, 65].

In this work, we test the possibility of creating a humorous experience when interacting with a simple non-humanoid robot that cannot mimic human behavior and communicates via simple non-verbal gestures. In today's world, non-humanoid robots are increasingly being deployed to the daily landscape in a gamut of fields including hospitality, educational, health and industrial settings as well as to automate different public services [40]. Just as humor has a positive impact on Human-Human Interaction (HHI), and taking a cue from the Computers Are Social Actors (CASA) paradigm [41], it follows that humor could be leveraged to enhance positive-affecting, more natural and fluid HRI, as well as better user experience when interacting with a non-humanoid robot [49].

But how do you create a humorous interaction with a robot that has no humanoid features and cannot directly mimic human

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behaviors? Using clowning and animation elements, we defined design principles for such robotic gestures. We also took into account design principles that use appropriate incongruities [24]. These were previously shown to lead to humorous experiences with non-animated products (e.g. a mustache bottle opener, designed in an unexpected way to generate a humorous experience) [66]. We created and implemented humorous and non-humorous gestures on a simple, non-humanoid robotic object (see Figure 1 [19]). We tested whether gestures and movement alone, which are performed by a non-humanoid robot, could be perceived as humorous. We compared two types of robotic gestures, humorous and non-humorous, and evaluated participant responses and participant experience.

2 RELATED WORK

Several studies have tested humor in HCI [34, 45, 49] and HRI [52]. Relevant HCI studies indicated advantages of using humor as part of the affective computing domain [15, 47, 55], determining that systems which simulate humorous emotions as part of their communication mechanisms can improve interaction [5, 12]. This is especially important when the technology involves autonomous features (as in the case of robots) [12]. Adding humor to computer agents was shown to increase their likability and competence, as well as a willingness to cooperate with them [34, 35]. Dybala et al. (2009) showed that pun-telling agents were deemed more human-like because of their humor and rated as more likable and funny [15], while Nijholt (2013) showed that humor implementation into embodied conversational agents, replete with facial expressions and animated talking interaction elements, can smoothen interactions between human and computer [46]. Humor's influence has also been shown to facilitate communication and solve problems that arise in human-computer interactions [2, 5].

In HRI specifically, the majority of studies explored verbal humor via canned jokes or spoken humorous remarks and using a humanoid robot [52]. For example, Niculescu et al. (2013) [43] used an Olivia roboceptionist [44] telling preprogrammed jokes (the robot told a punning riddle or an incongruous joke) with different voice pitches while participants performed a series of mundane tasks. The researchers tested how humor could influence the quality of the interaction and found that participants' perception of the humorous robot and the interaction with it depended on their own culture and on their individual sense of humor [43]. Tay et al. (2016) tested how different types of disparaging and non-disparaging jokes that an NAO robot performs are accepted as compared to when a human counterpart tells the same jokes [61]. The results showed that participants perceived non-disparaging jokes to be more humorous and preferred these jokes to be told by a human and not a robot. Further studies tested whether humanoid robots can mimic human humorous behavior of telling jokes while performing as stand-up comedians. These studies indicated that social signals such as facial gestures and verbal utterances between humans and robots could lead to more enjoyable interactions [21, 48, 64].

In other studies, humor's effect on likability has been a repeated theme [31, 32, 60]. For example, Mirnig et al. (2016) used two robots, an iCat and a NAO robot, with different laughing behavior to test the effect of laughter in HRI and the level of likability. In the study, participants observed a robot-robot interaction, whereby each robot laughed differently either with self-irony or *Schadenfreude*, and then rated the likability of how the robots acted. The findings showed higher likability ratings for a robot showing positively attributed humor [32].

Robotic humor was also indicated with robots that use non-verbal gestures as their main channel of communication. For example, Wendt and Berg (2009) [65] created a robot based on a Pioneer P3-DX platform. The robot was dressed up as a butler and decked out in a wig, bow tie, waistcoat, and white gloves. Participants were asked to order different objects from the butler robot. In the non-humorous condition, the robot brought items as ordered from a list. In the humorous condition, the robot delivered a funny object (paper snake) or reacted with a gesture (dancing, clapping) or cheerful sound. The study found that participants perceived the non-verbal humorous behavior to be more entertaining than the baseline condition but also less reliable [65].

Overall, these studies indicate that it is possible to create a humorous experience with a robot, using human-like behaviors. In this work, we explore the possibility of creating a humorous experience without mimicking human behavior. Instead, we implemented and tested non-verbal humor on a simple non-humanoid robot through minimal gestures alone. The robot performed simple up-and-down or side-to-side gestures, according to prescribed patterns inspired by clowning, animation and humor principles. We conducted an initial evaluation testing whether these gestures can lead to a humorous experience (in comparison to gestures that were designed as non-humorous movements).

3 GESTURE DESIGN

We started the gesture design process by inviting a clown therapist/drama expert, HRI expert, and animator to a joint brainstorming session. We spoke about the related hypotheses on the use of humor in HRI and the challenge of mapping humorous gestures to a simple non-humanoid object. The experts engaged in active discussion about various artistic inspirations such as physical theater, character animation and clowning. They also discussed possible temperaments for the robotic object, and debated specific movement characteristics such as start position, pace, style of movement, end position, vertical vs. horizontal movement, straight vs. curved trajectories, and more. During the brainstorming session, the animator sketched some of the ideas and how to translate clowning principles to the robotic object (see Figure 2). We heeded prior literature indicating the need for incongruity [4, 10, 36], laughter

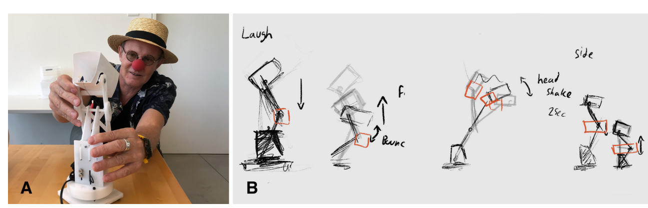

Figure 2: Left, A: A clown therapist demonstrates gestures on the robotic object; Right, B: Sketches for humorous robotic gestures

by surprise [4], perception of expectations versus ensuing experience [9], repetition and contradiction [4], and a juxtaposition of moments of movement and moments of stillness [9] to create humorous processes of movement. The experts agreed that these notions are needed to create the humorous experience, as well as speed and tempo fluctuations [4], and the Rule of Three theory, in which a pattern of movements is set up, reinforced and then offers a surprise [27]. Moreover, it was noted that humor in movement cannot be harmonious.

3.0.1 Design principles. Toward the end of the session, five animation principles were selected: (1) Timing: *quick for humorous, slow for non-humorous*; 2) Degrees of Freedom of motion *limited for humorous, wide range for non-humorous*; 3) Pose-to-pose *quick for humorous, slow for non-humorous*; 4) Ease in, ease out *not used for humorous, used for non-humorous*; 5) Bouncing *used for humorous, not used for non-humorous.* Based on this set of principles, the animator designed five humorous robotic gestures and five non-humorous gestures (as a basis for comparison). Each gesture runs just six seconds in length to ensure the participant could see the critical difference in movement and not lose interest. The animator designed the non-verbal gestures using a 3D model of the robotic object [30] and applied them to the robot.

3.0.2 Pilot study. To identify the most humorous gestures and non-humorous gestures, we conducted a pilot study with 14 students from the university. The participants observed the 10 gestures and ranked the movements on a 1-7 scale from least humorous to most humorous. The differences in gesture relied on the speed and tempo of the movement, location of the movement on the top part or bottom part of the robot, and the pattern and rhythm of motion. The gestures were presented in a random order.

The results revealed three highly humorous gestures (see Figure 3):

- Side Laugh: A mixture of slow and fast moments of movement, repetition and speed fluctuations. The gesture begins with two slow full-length up-down movements and then performs two unexpected quick up-down shakes of the robot's top part only (Avg: 6; SD: 1.03).
- Spark Laugh: A mixture of slow and fast moments of movement with repetition. The gesture begins with one slow vertical down movement and then switches to one wide-angle incongruent back-forth movement, a short pause, and another wide-angle quick back-forth movement (Avg: 5.92; SD: 1.07).
- Short Laugh: Fast moments of movement with a very short moment of stillness. The gesture begins with a surprising, quick burst of shaking up-down movements, very slight pause, and repeats the quick shaking moments of movement (Avg: 4.92; SD: 1.59).

And three highly non-humorous gestures (see Figure 3):

- Uprise Short: Moderate speed movement. The robotic object folds its body up and down three times in a rocking movement, not too fast and not too slow (Avg: 2.28; SD: 1.32).
- Spark Neutral: A mixture of slow and very slow movement. The robotic object slowly folds its body halfway down, turns its base slightly, and unfolds back up, ending the gesture with an even slower motion of extending its top part (Avg: 2; SD: 1.63).
- Uprise Slow: Very slow movement. The robotic object very slowly folds its body all the way down and then all the way up (Avg: 1.42; SD:0.64)

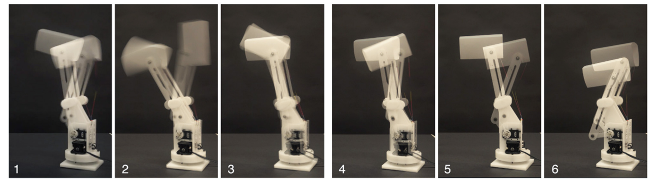

Figure 3: From left to right, humorous gestures: 1-Short Laugh, 2-Spark Laugh, 3-Side Laugh, and non-humorous gestures: 4-Uprise Short, 5-Uprise Slow, 6-Spark Neutral

The other four gestures were dismissed from the study for either not being humorous enough or not being non-humorous enough.

4 EVALUATION STUDY

To gain an initial evaluation of whether the robotic object's gestures can lead to a humorous experience, we conducted an evaluation study. Participants were told they were taking part in an experiment that tests how people perform a task on a computer in the presence of a robotic object. The robotic object was positioned to the right of the participant as if it was watching the computer screen. The task involved responding to sentences presented on a computer screen. Each time a new sentence was presented on the screen, the robotic object performed one of the gestures. The participants' experience and responses to the gestures were evaluated. The robot's gestures were triggered via the E-Prime software, a gold-standard software for experimental (behavioral) studies [57]. The E-Prime software orchestrated the order of the sentences (presented on the computer) and their complementary gestures accordingly. The gestures were activated and animated through the Butter Robotics animation platform which controls the motors [29].

5 METHOD

The study was conducted under strict COVID-19 safety regulations. It was reviewed and approved by the ethics committee of the research institute.

5.0.1 Participants. 15 students participated in the study (Mean age = 21.2, SD = 0.7 ; 7 males, 8 females). Participants were BA students at the university and received extra course credits.

5.0.2 Experimental Design. Similar to previous studies assessing participant responses to robotic emotional expression [28], we used a within-participants experimental design and compared participants' responses to the robot's humorous and non-humorous gestures. Each participant experienced all six gestures (three humorous and three non-humorous (see Figure 3)). The gestures were counterbalanced and each participant experienced a different order of gestures and a different association between the robot's gestures and the sentences on the screen (see Figure 4).

Figure 4: A participant performs a computer task alongside the robot

5.0.3 Experimental setting. The experiment was conducted in a quiet room at the research lab. The room was set to minimize associations to a specific environmental context (i.e. home or work). There was a chair and a table with a laptop computer, and the non-humanoid robot. The robotic object was set on the table, at a fixed location, 27-cm to the right of the laptop computer, 79-cm from the participant. A smartphone and tripod were placed on a fixed shelving unit in the room for documentation.

5.0.4 Measures. We used both quantitative and qualitative measures. The qualitative measures included a set of semi-structured interviews. The quantitative measure was a questionnaire assessing judgment and perception of humor.

5.0.5 Interviews. The interviews included short in-experience interviews for evaluating each gesture, and a concluding interview. Interview questions were designed to assess the participants' experience and their perception of the gestures (e.g. "What did you think of the movements?", "What did you like best about the gestures?, What did you like least?").

5.0.6 Humor questionnaire. A humor questionnaire was adapted from Wendt and Berg (2009) [65]. The questionnaire involved nine statements rated on a 1-7 Likert scale (not at all to strongly agree) (e.g. *"I found it amusing", "I thought its gestures were a mechanical failure"*).

5.1 Procedure

Prior to arrival at the lab, participants filled in a demographic form, a questionnaire assessing their attitudes towards robots [7], and the self-enhancing humor subscale of the Humor Styles Questionnaire [26], verifying a valid range of individual differences. When participants arrived at the lab, they signed an informed consent form and were told they could choose to withdraw from the experiment at any time without penalty. They were then invited to enter the experimental room.

Participants sat in front of a laptop computer, with the robotic object sitting on the right-hand side of the desk. The researcher provided a general explanation concerning the activity and activated the computerized task via the E-Prime software. The robotic object performed an initial greeting opening gesture, turning to face the participant and back to the computer. As the gesture ended the computerized task began. At each trial, the participant responded to a sentence that was presented on the screen (accompanied by an audio clip). The robotic object performed a gesture as the sentence appeared on the screen. The sentences used were: "It matters how people treat robots"; "It is possible to communicate with robots"; "Robots could have human names"; "A robot can recognize you'; "Robots can have intent"; "Robots can be happy". The researcher stayed in the room, sitting on a chair against the wall and to the left of the participant, in order to ask questions after every gesture. Once the participant experienced all six gestures, the concluding interview was conducted in the experiment room. Participants then filled out a humor questionnaire on a tablet. At the final stage of the experiment, the researcher debriefed the participants and verified that they left with an overall positive experience.

6 ANALYSIS

We transcribed and analyzed the semi-structured interviews using the thematic coding method [6, 17]. The analysis included five stages: (1) Interviews were transcribed, and half of the interviews were read several times by two coders to develop a general understanding of the data before the coding process began; (2) Initial themes were identified, presented to a third researcher, and discussed in-depth until inconsistencies were resolved; (3) A list of mutually-agreed themes was defined; (4) The raters used these themes to analyze part of the data independently, verifying inter-rater reliability (kappa=86.4%); (5) The two coders analyzed the rest of the data.

7 FINDINGS

In order to understand whether we succeeded in creating humorous gestures for a non-humanoid robot, we analyzed participants' interpretation of each gesture as well as their overall perception of the robot.

7.1 Qualitative findings

In total, 283 quotes were analyzed, leading to two main themes that highlight participants' perspective of the experience: Interpretation of the gestures and General perception of the robot overall. During the thematic coding, we accepted synonyms and related words of "humor", "humorous" and "humoristic", according to the Merriam-Webster dictionary, to ascertain whether the robot was perceived as humorous. These words include: comedic, lighthearted, funny, laugh, amusing, entertaining, playful, fun, exciting, joy, silly [14].

7.1.1 Theme 1: Interpretation of the gestures. A majority of participants (10/15) interpreted the humorous gestures with positive emotions, though they differed across the three gestures. By comparison, most of the participants (12/15) described the non-humorous gestures using placid adjectives.

Spark Laugh gesture. In this gesture, 10/15 participants described the robot as expressing strong, fun movements: "It's jumping, it looks very ecstatic, it's really weird but it just seemed happy" (P1, F); "It looks like he's celebrating something. Exciting" (P13, F); "That was fun (...) a little bit comedic, happiness" (P9, M); "Like in a movie when the robot is happy. He makes these moves, it's hyper, happy" (P11, M). A minority of participants, 3/15, described the movements as uneasy: "Attacking or like bugging out" (P14, M); "It was unsettling" (P10, F).

Side Laugh gesture. Over half the participants, 9/15, interpreted the robot's pattern of movements as trying to communicate with them in an amusing way: "A moment of surprise and then humor" (P5, M); "It seemed perked up" (P10, F); "It's like what a human would do, joy" (P11, M). For three participants, the gesture implied that something was a bit off: "It freaked out" (P4, F); "It's pushing away" (P14, M). The other three participants described the movements as a malfunction: "Something was wrong" (P6, M); "It seemed like it was not functioning" (P9, M).

Short Laugh gesture. 4/15 participants interpreted the gesture's movements as positive: "It could have been excited" (P10, F); "It looked like it was mimicking a jump or happiness" (P14, M); "He's getting all hyped. He's enthusiastic. He almost fell over. Pure happiness" (P12, M). On the other hand, 5/15 of the participants perceived the gesture as negative: "It was scary, it moves so much" (P1, F); "A little intense. It's like spazzing out" (P2, F); "It was angry" (P3, F; P8, F), "Very aggressive" (P7, M). For another 4/15 participants, the robot was understood to have a malfunction: "Is it broken?" (P9, M), "Not working" (P4, F).

The three non-humorous gestures were described using mild terminology, and often not given any emotional interpretation at all.

Uprise Short gesture. Just under half of the participants, 7/15, did not associate the gesture with any robotic emotional response. 5/15 participants interpreted the rhythm of the movement: "Dancing" (P3, F; P13, F); "Like a shake of a hand" (P14, M); "It was like being caressed" (P7, M); "It was cute. Like my dog, it was sitting and then going up" (P8, F). For two participants the gesture's moderate tempo was described as waiting: "If I were to associate that robot to a human emotion, I would think it would be probably patience or maybe discerned waiting" (P5, M); "It was waiting for something" (P6, M). One participant interpreted the gesture as humorous: "Kind of lighthearted, it was more of a funny movement" (P9, M).

Spark Neutral gesture. 8/15 of the participants did not associate the gesture with any robotic emotional response. Another four participants described its slow and very slow movements by linking them to the robot being calm or sad: "This movement was a little bit calmer" (P2, F); "A calm interaction" (P3, F); "It was very slow. It looked a little sad" (P15, F). The remaining three participants thought it was a functional gesture: "It was monitoring what I was doing" (P9, M).

Uprise Slow gesture. 8/15 of the participants did not associate the gesture with any robotic emotional response. For 4/15 participants, the very slow movements depicted calmness: "That was calm and relaxed" (P3, F); "It was soothing, calming" (P9, M). One participant interpreted the gesture negatively: "It feels like it's approaching. A little scary" (P1, F) and another positively: "Hopeful. When you're about to receive news, which you hope will be good" (P6, M). For one participant, the gesture had a function: "It was scanning you" (P7, M).

7.1.2 Theme 2: General perception of the robot overall. Participants' overall perception of the robot (as indicated in the post experiment interview) seemed influenced by the humorous gestures. A majority of participants (13/15) described its characteristics and personality using words related to humor [14]. Of them, 11/13 perceived the robot as humorous: "A happy robot. He gives the gesture of joy (…) I think it's to show us it is a happy playful machine" (P11, M); "He was so nice and funny and very interested in what I was doing. He was moving and everything. Like a silly one" (P13, F). Despite the robot's non-humanoid characteristics, some participants compared its gestures to human humoristic behavior: "If you can picture that as a person, you can kind of see them get jittery, excited, pop up" (P10, F); "I liked how it was like a happy-go-lucky person" (P12, M); "I think it's like a fun person, it was entertaining" (P15, F).

7.2 Quantitative findings

The humor questionnaire showed that participants ranked the robot overall as having a humorous nature (Average = 4.97, SD = 0.23). The phrasing *"I found it amusing"*, which was used in Wendt and Berg (2009) [65] to denote whether the robot's behavior had been perceived as humorous, resulted in an even higher ranking (Average = 5.33, SD = 0.71).

8 DISCUSSION

In this work, we evaluated the feasibility of applying interpretable non-verbal humor to a simple non-humanoid robotic behavior. Whereas previous HRI studies researched humor with robots that mimic human behavior, we explored the possibility that a non-humanoid robotic object lacking facial expressions, limb kinesics or any other humanoid features, could lead to a humorous experience. Our findings indicate partial success. Two out of three humorous gestures were interpreted by most participants as humorous. Participants used synonyms and related words of humor including *"comedic", "playful", "exciting", "joy"*. On the other hand, the three gestures that were designed to be non-humorous were only rarely associated with humor. Instead, most participants perceived them as indicating the robot was *"calm", "soothing", "waiting", "slow"*. In addition, the overall interaction with the robot was perceived as humorous and joyful, and most participants described it as *"fun", "funny", "entertaining"*.

Some participants perceived the humorous gestures (and especially the Short Laugh gesture) as aggressive and unsettling. They described the robot as "scary", "intense" or "very aggressive" or that it was "not working". This finding echoes previous studies indicating that there is a thin line between surprising someone to enjoy an unexpected situation and surprising someone into a fight-or-flight response [38]. This variance in participants' response to the Short Laugh gesture suggests that designing humorous gestures for a non-humanoid simple robot is nontrivial. The inability to directly mimic human behavior requires a subtle and accurate application of the five design principles, which should be balanced carefully in order to lead to the unique experience of humor.

Despite partial success in the design of specific humorous gestures, the overall perception of the robot as humorous indicates that even minimal humorous interactions can lead to an overall perception of the robot as *"happy-go-lucky", "playful", "funny"*. Our application of humor differs from the bulk of humor research in HCI and HRI where the humor implemented in humanoid robots and conversational agents mirrors human behavior (using human-like expressions to trigger emotion, non-verbal humorous behavior such as pranking, and canned jokes) [45, 52, 65]. In contrast, our study's design principles show that it is possible to create a humorous experience with a robot that has no humanoid features and does not mimic human-like behavior. With humor having already been shown to enhance likability in HRI, as well as supporting human's well-being, this finding suggests wide-ranging potential for leveraging humor in non-humanoid robots.

9 LIMITATIONS AND FUTURE WORK

This study has several limitations. Qualitative interviews may be biased by the interviewers' expectations [53] so we minimized this risk by following a detailed protocol. Interviews may also be biased by the "good subject effect" [42]. To minimize this, we explained all answers are helpful. Also, participants experienced all six gestures and did not know which responses would "please" the interviewer. In addition, as a first step in designing humorous gestures, we used one robot with a specific morphology for this initial study. Future work should test additional gestures with different robots.

10 CONCLUSION

In sum, we show the potential and challenges of designing humorous behaviors for simple non-humanoid robots that communicate via non-verbal gestures and that do not mimic human behavior. The five design principles suggested in this work serve as a first step in developing a comprehensive understanding on how to design non-verbal humorous gestures for robotic objects. Such humorous behaviors can be used to improve interaction with these robots, ever being deployed to our daily lives, and create a pleasant experience in our everyday interactivity with them.

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