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The emotional robotic storyteller: On the influence of affect congruency on narrative transportation, robot perception, and persuasion

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Abstract

We connected theory and research on narrative persuasion to the literature on social robots and examined the effects of a robotic storyteller's facial expressions. The congruency between the emotional arc of a story and the facial expressions of the robot was of particular interest. In a lab experiment, participants were confronted with a storytelling robot who displayed emotions that were congruent or incongruent with the events unfolding in the story or it displayed no emotions. Affect congruency increased participants' transportation in the story world, led to more positive evaluations of the robot, and increased the likelihood of choosing a product that was advertised in the story. Although the robot's voice was held constant in all three conditions, congruent facial expressions led to the illusion of a more congruent intonation by the robot.

Keywords: Transportation; Narrative Persuasion; Emotional Shifts; Social Robots; Human-Robot Interaction

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1. Introduction

In recent years, the use of robots in non-industrial fields has increased substantially. Robots are not only built to clean carpets and mow the garden lawn, they are envisaged to play an important role in future education, tourism, healthcare, and entertainment (International Federation of Robotics, 2019; KPMG, 2016; Gnambs & Appel, 2019). Therefore, so-called *social (or sociable) robots* are designed to interact with people in a natural, interpersonal manner (Breazeal et al., 2016). This study examines social robots as storytellers, thereby connecting robotics to narrative theory and research. In the latter field, emotions and emotional shifts have gained increasing attention (Appel, Schreiner, Haffmans, & Richter, 2019; Guido, Pichierri, & Pino, 2018; Nabi, 2015; Nabi & Green, 2015). Against this background, we believe that social robots bear great potential to tell stories to human listeners (oral storytelling, cf. Ong, 1982), as they can support the narrative flow by using facial expressions and other modes of nonverbal communication. Moreover, social robots can be used to manipulate variables with high theoretical relevance. We investigate the influence of a robotic storyteller's story-congruent (vs. story-incongruent or missing) facial expressions on a) the experience of being transported in a narrative world (Gerrig, 1993), b) the evaluations of the robot, and c) story-consistent attitudes and behavior regarding a consumer product. A behavioral measure was included because story effects on actual behavior have largely remained an open question in narrative persuasion research. Although the audio was identical in all three conditions, we traced down the possibility that the facial expressions would influence the perceived intonation of the robot's voice, a perceptual illusion that we call *illusory intonation effect*.

1.1 Narratives, Transportation, and Storytelling

Stories or narratives (we use both terms interchangeably) are omnipresent in our everyday lives. Stories are defined as “the representation of an event or a series of events” (Abbott, 2002, p. 12) and they typically portray the actions and experiences of one or more protagonists. Stories tend to follow a plot line with certain schematic elements (e.g., setting, event, attempt, reaction, and consequence; Rumelhart, 1975). The focused experience while reading, listening to, or watching a story has been characterized with a number of different but closely related terms and concepts, such as flow, identification (Cohen, 2001), narrative engagement (Busselle & Bilandzic, 2008), or transportation (Gerrig, 1993; Green & Brock, 2000). Our focus here is on transportation, due to its elaboration on the conceptual (Gerrig, 1993; Green & Brock, 2002) and the empirical level (e.g., Gnambs et al., 2014).

When highly transported into a story world, “all mental systems and capacities become focused on the events occurring in the narrative” (Green & Brock, 2000, p. 701). The resulting mental state has been conceptualized as a co-activation of attention, imagery, and emotion. Researchers’ interest in storytelling has been fueled by its propensity to persuade individuals – even if the story content was fictional (cf. Appel & Maleckar, 2012). Recent theory suggests that the power of stories lies in its narrative arc and its sequence of positively and negatively valenced situations and events. The emotional shifts implied by the narrative are crucial for narrative persuasion (Nabi & Green, 2015) as they attract recipients to the story and facilitate transportation into the narrative world.

The power of stories to persuade has been examined in several applied communication contexts. Consumer research has been among the most vibrant research fields (e.g., Escalas, 2004; Guido et al., 2018; Phillips & McQuarrie, 2010; Van Laer, De Ruyter, Visconti, & Wetzels, 2013). Although narrative persuasion research has been prolific, rarely did researchers address effects on actual behavior. And if behavior was measured, the behavior was self-reported after the fact by the participants, rather than observed (e.g., Appel & Mara, 2013; Lemal & van den Bulck, 2010). The lack of research on behavior is arguably one of the largest research lacunae in the field.

Transportation into fictional worlds and related persuasion effects were found to be a function of the story itself (e.g., its craftsmanship, Green & Brock, 2002), the situation in which recipients encounter the story (e.g., the presence of others, Tal-Or, 2016), and rather stable recipient characteristics (such as narrative engageability, Bilandzic et al., 2019, or the need for affect, Appel & Richter, 2010). Little research in this thriving field has examined the arguably oldest form of storytelling, oral storytelling, in which humans tell stories to each other (cf. Ong, 1982). Thus, there is a scarcity of research on the influence of the narrator on story experience. In Human-Human Interaction (HHI) non-verbal indicators of emotions, especially facial expressions (rapid facial signals in terms of Ekman & Friesen, 1978) are important cues that assist at communicating and interpreting verbal information. The fit of non-verbal displays of emotions and the verbal information is decisive in fluent comprehension and prevents misunderstandings and cognitive conflict (Knapp, Hall, & Horgan, 2013). In one of the few studies on facial expressions in a storytelling context, Decety and Chaminade (2003) recorded actors who presented several sad or neutral stories with a happy, neutral or sad motor expression. The stories were about 200 to 250 words in length and a repeated-measures design was used. Storytellers with a mismatch between story content and facial expressions were rated as less sympathetic (no indicator of immersion or persuasion was assessed). This was consistent with recipients' skin conductance responses and activities in the ventromedial prefrontal cortex, indicative of emotional and cognitive conflicts. A potential limitation of this study is that even trained actors might unintentionally change their tone of voice, or other modalities, in correlation with their facial expressions. This highlights the potential of social robots in this domain, as single aspects of behavior, timing, or intensity can be varied in isolation, and repeated in the exact same manner in live performances.

1.2 Social Robots and Emotions

Since computers and related technologies have entered mass markets, the potential of digital technologies to entertain and to persuade users has been of key interest to the industry, scholars, as well as the general public (cf. Fogg, 2003; Lee & Liang, 2018). Social robots in particular can be used as a medium to transmit messages and to interact with users. Unlike other platforms (e.g., smartspeakers such as Amazon Echo/Alexa), social robots use multimodal communicative channels. Verbal communication is accompanied by nonverbal cues such as facial expressions.

The expression of emotions has proven to be a powerful tool for robots to persuade human listeners. Already at the very beginning of research on social robotics, Breazeal (2003) highlighted the importance of emotions in social robotics and the importance of communicating the affective state of a social robot through facial expressions, gaze, and affective speech. Eyssel and colleagues (2010) showed that people rate a robot as more sympathetic and anthropomorphic when it expresses emotions non-verbally as a reaction to the participants' speech compared to a robot that shows no emotions. Research has also shown that through the display of emotions, not only the perception of the robot itself can be enhanced, but also the perception of the task it is involved in. In that vein, Leite and colleagues (2008) showed that an emotional robot can enhance the user's perception of a game that is played with the robot, compared to playing with a non-emotional robot. More recent research demonstrated that whenever a medical receptionist robot was smiling (versus a non-smiling sequence) attitudes towards the robot were more positive and human interaction partners smiled more themselves (Johanson et al., 2020). Another string of research on human-robot communication examined the effect of robot embodiment and robot behavior on the self-disclosure by human interaction partners using subjective and objective self-disclosure measures (e.g., Laban, George, Morrison, & Cross, 2021; Shiomi, Nakata, Kambara, & Hagita, 2020).

In the domain of storytelling several behavioral aspects such as eye-gaze (Mutlu, Forlizzi & Hodgins, 2006), gestures (Ham, Cuijpers & Cabibihan, 2015), contextual head movements and different voices (Striepe et al., 2019) were studied to enhance social robots in the role of storytellers. Compared to virtual storytellers displayed on a screen, social robots were shown to increase the narrative attention of listeners (Costa et al., 2016). Striepe and Lugrin (2017) applied an emotional robot in the role of a storyteller to investigate whether its facial display of emotions influences the human listener's transportation into the story. Results showed that the robot was evaluated more positively when it expressed emotions non-verbally compared to a neutral condition. Comparing the robot to a more traditional modality of telling a story, namely an audiobook version of the same story, revealed that the emotional robot transports the user equally well, while the non-emotional robot performs significantly worse.

In the above-mentioned studies researchers intentionally modelled the robot to display emotions that fit the storyline. However, when aiming at automatically generating emotional displays, a timewise incorrect placement of emotions could unintentionally lead to an incongruent display. Or developers could refrain from programming negative emotions with the goal to increase the acceptance of the robot. The influence of incongruent facial expressions is unchartered territory. Thus, the present study extends prior findings by investigating how the display of emotions and the congruency between robot facial expressions and a story's narrative arc content affect story experience (transportation) and persuasion. As indicated in the research described above, the emotional display can further influence perceptions of the robot itself. Based on the uncanny valley hypothesis (Mori, 1970; Shimada, Minato, Itakura, & Ishiguro, 2018), a mismatch of the narrative arc and the robot's facial expressions could decrease the appeal of the robot, leading to eeriness among human interaction partners. Possibly, a mismatch could translate to other features of the robot, such as its voice. Such a transfer might happen as people use to seek for consistency in their observations. Prior research suggests that the visual information of a speaking human can change the auditory perception of a sound (McGurk effect, McGurk & McDonald, 1976). Thus, users could have the illusion of experiencing the robot's voice to be more adequate in a matched condition, even if the voice remains the same across conditions.

In line with research in HHI, initial evidence suggests that humans can indeed be confused by their non-human, robotic interaction partners when these express incongruent emotions. Zhang and Sharkey (2011) showed that participants were better able to recognize the emotional expressions of a robot if these matched the context compared to when there was a mismatch. However, Malchus and colleagues (2013) found no evidence that the incongruence between the emotional expression of a robot and the semantic content of a narration is negatively affecting the listener's story comprehension. Regarding the dynamics of gestures, Xu and colleagues (2015) found, among other things, a tendency for higher ratings of a robotic storyteller by participants if there was a congruency between story mood and the robot's gestures, compared to showing incongruous gestures. Paradeda et al. (2016) further used strategies such as small talk and facial expressions for a robot that tells a story to persuade participants to make monetary donations. While trust could be increased with small talk, no significant differences were found for the behavioral measure of donating money.

1.3 Study Overview and Predictions

Our overarching goal was to connect the literature on robot emotions to theory and research on narrative processing and narrative effects, particularly narrative shift theory (Nabi & Green, 2015; Nabi, 2015). Our focus was on story-congruent (vs. incongruent) facial expressions in a consumer research setting, observing recipients' transportation into the story world, perceptions of the robot, and story-consistent attitudes and actual behavior. The experimental setting consisted of a robot that was able to display facial expressions. The robot told a story which involved an energy bar that served as our attitude object and was the target of our behavioral response measure.

Story experience. We first predicted that a robotic storyteller with facial expressions that were congruent with the narrative flow of the story would increase recipients' transportation into the narrative world, as compared to a robotic storyteller with facial expressions that are incongruent with the narrative arc or a robotic storyteller without facial expressions. More formally expressed:

Hypothesis 1: If the emotions displayed by the robot fit the semantic content of the story (affect congruent condition), the recipients will experience more transportation into the story compared to the incongruent and neutral condition.

The audio of the story was identical in all three conditions. However, we wondered whether the facial expressions would influence the perceived intonation of the voice – a perceptual illusion that we call *illusory intonation effect*.

Research Question 1: Do participants perceive *an illusory intonation effect*, that is, a better fit between the voice of the robot and the story content in the affect congruent condition as compared to both other conditions?

Evaluations of the robot. We further predicted that the congruency of the affective display would influence evaluations and perceptions of the robot. In previous research the potential eeriness of robotic communication partners had been of key interest to researchers (e.g., Mara & Appel, 2015; Shimada et al., 2018, based on the uncanny valley hypothesis, Mori, 1970). As the robotic platform used was designed to be rather cute, effects on eeriness were addressed as a research question. The resulting expectations regarding the perceptions of the robot are therefore framed as a hypothesis and a research question:

Hypothesis 2: If the emotions displayed by the robot fit the semantic content of the story, the recipients will evaluate the robot as more anthropomorphic (Hypothesis 2a) and more likeable (Hypothesis 2b) compared to the incongruent and no-affect condition.

Research Question 2: Does the fit between facial expressions and story content influence the eeriness elicited by the robot?

Attitudes and behavior. Our final set of hypotheses addressed the attitudes towards the product advertised in the story. Moreover, we expected that the congruency would have implications for the actual consumer behavior.

Hypothesis 3: If the emotions displayed by the robot fit the semantic content of the story, the recipients will evaluate the advertised product as more positively (Hypothesis 3a), show a higher purchase intention (Hypothesis 3b), and choose a greater amount of the advertised product (Hypothesis 3c), as compared to the affect incongruent and neutral (no-affect) condition.

2. Method

2.1 Study Design

An experiment was conducted to examine the influence of the facial expressions of our robotic storyteller on recipients' experience of the story (transportation, illusory intonation differences), perceptions of the robot (anthropomorphism, likability, eeriness), and persuasive impact. The experiment was based on a one-factorial between-subjects design with three conditions: In the first condition the robot displayed emotions, and the emotions expressed were consistent with the semantic content of the story (affect-congruent condition, see below for a concrete description of the implementation). In the second condition, the robot displayed emotions as well, but the emotions expressed were inconsistent with the semantic content of the story (affect-incongruent condition). In the third condition, the robot did not show any emotions (no affect condition).

2.2. Participants

Prior research on user experiences in response to different facial expressions that used the same robotic platform (Striepe & Lugrin, 2017) reported effect sizes ranging from r = .32 to .45 (d = .68 to d = 1.01 in the d-metric). Based on these previous results, we set our goal at detecting a large effect (d = .80). An analysis with g*power (Faul, Erdfelder, Buchner, & Lang, 2009) yielded a required sample size of 26 per cell given a large effect (d = .80), two-tailed testing of two group means, α error probability = .05, and power = .80. Thus, we set the sample size a priori at 90. Ninety-one media communication undergraduates of the University of Würzburg participated in our study, 84.6 % of them were female. Participants were between 18 and 27 years old (M = 20.84 years, SD = 1.78). Each participant was randomly assigned to one condition, 30 participants were assigned to the affect-congruent condition (25 female, 5 male), 31 to the incongruent condition (27 female, 4 male), and 30 to the neutral condition (25 female, 5 male). Participants provided written informed consent before taking part in the experiment. They were debriefed after the experiment had ended.

2.3 The Story

The story was written exclusively for the purpose of this study. It contains changes between sad and joyful semantic content (see Figure 1) and is told from the first-person perspective of a robotic storyteller. The story starts with a description of the robot about how happy it is to work for its human owner. At one point, however, the robot experiences a massive loss of energy and performance. The robot realizes that its owner is looking out for a new robot. The robot, anxious about getting replaced, thinks about ways to get fit again. It then becomes aware of the „Lifebar“ energy bar. After trying the energy bar, the events turn to the better as the robot is stronger than ever before. The story ends by describing the relief of the robot that it is liked again by its owner. Throughout the story the brand Lifebar is displayed very positively. Only because of this energy bar the robot can avert the fate of being replaced. Overall the story has a humorous tone, in the end the robot states: “Moreover I did not gain any weight! A light hardware isn’t only advantageous for laptops.” The story was identical in all three conditions.

Emotions of specific text parts were matched by the annotation of two encoders who encoded the specific feeling or emotion they found suitable while reading the story. Coders agreed for most parts, inconsistencies were discussed and an appropriate solution was agreed on (see online supplement).

2.4 Implementation of Robot Behavior

For our endeavor, the story written for the experiment had to be translated into three behavioral sequences for a robotic platform that represent the three experimental conditions.

2.4.1 The robot. The technical implementation was carried out with the social robot Reeti (Robopec Reeti: http://www.reeti.fr) that was designed to be emotionally expressive. With its flexible head that contains 15 degrees of freedom it is able to simulate human-like emotions through the following facial features: Elastic facial skin, movable mouth, two independently movable eyes and corresponding eyelids, two elastic and movable ears. A set of LED lights in its cheeks can display different colors. They can additionally serve as channels to transmit emotions or feelings. Furthermore, the robot provides speech synthesis. Its appearance is a cartoon-like design: big head, disproportionately large and wide eyes as well as funnel-shaped ears. Its gender-neutral design and white body-color let it seem unthreatening and suitable to tell stories of different genres without strongly influencing the reception through its design. The robot’s voice was generated with the Loquendo text-to-speech (TTS) system V7, using the German default male voice “Stefan”. This voice is designed to produce a naturally sounding (human-like) voice to any given input text.

2.4.2 Robot behavior. To model the experimental conditions, the expression of emotions (facial displays, movements of the head, eyes, and eyelids), as well as speech synthesis, were combined in behavioral sequences.

Modeling of emotions. Facial expressions are an important channel to transmit emotional states and aid recipients to decode messages in the intended context. There are various emotion theories that define emotions and the way they are mirrored through facial expressions. In this study, the modeling of facial emotion expressions was based on the Facial Action Coding System (FACS) (Ekman, Friesen & Hager, 2002) and Emotional Facial Action Coding System (EMFACS) (Ekman, 2003). FACS records visually discernible changes in muscle movements on the human face. Individually or in combination, 44 of these muscle movements are defined as the smallest units of movement, called Action Units (AU). For example, the emotion joy is described by raising the cheeks (AU 6), pulling up the lip corners (AU 12) and parting the lips (AU 25). The emotion sadness is described by raising the inner eye brows (AU 1), lowering the eye brows (AU 4), and lowering the lip corners (AU 15). Similarly, typical head positions can accompany different emotions (Wallbott, 1998). For example, an upright head position is typical for joy, while sadness is usually accompanied by a head tilted downwards. Further research was conducted to determine the position of the ears by examining emotional expressions of cartoon characters, for example from Disney movies.

The robot's emotional expressions were created using the built-in RPilot user interface. Initially eight basic emotions were modeled. Since only few AUs can be simulated with the robot (compared to the full expressiveness of a human face), some facial expressions were not as expressive as desired, e.g. anger. Using a separate sample in a pilot study, we verified the validity of the recognition of the modeled emotions by human observers. The emotions joy and sadness were recognized most reliably. Since, according to Plutchik’s wheel of emotion (Plutchik, 2001), they constitute contrary emotions, we chose those two emotions for our experiment.

With the Reeti robot, the emotion joy can be displayed by simulating AUs 12 and 25 using the motors of its lip corners and mouth, combined with an upright head position and ears that point upwards (see Figure 2, left). The emotion sadness can be displayed by simulating AU 15 with the motors of the lip corners, and turning the head, gaze and ears downwards (see Figure 2, right).

Modeling of sequences. With the tool RShowMaker, the emotional expressions and text sequences were aligned to behavioral sequences. Figure 3a illustrates the process of modeling the behavioral sequence for the congruent condition. To make the facial expression match the spoken text, the speed of its appearance, the time it is maintained, and the speed of its decrease was individually modified. Depending on the condition, different emotional displays were merged into the sequence, matching or mismatching the corresponding spoken text passage. In that vein, the display of joy and sadness was exchanged for the incongruent condition. See Figure 3b for the same text passage modelled for the incongruent condition.

In both emotional conditions, emotional facial expressions are shown 22 times in total. In the congruent condition, twelve happy and ten sad emotions are shown. In the incongruent condition ten happy and twelve sad emotions are shown. In the neutral condition, no emotional movements of the face, head or ears were added. Only eye-blinking was maintained to give the robot a lively impression. The duration of each sequence is equally long and lasts for 155 seconds each. Additional information on the experimental procedure can be found in an online repository. This includes videos of all three conditions as well as a transcription of the story with the story emotions ascribed for the different story parts and the implemented facial expressions (https://osf.io/mgbnx).

2.5 Dependent Variables

In addition to sociodemographic questions the following operationalizations were used. All items were presented in German.

2.5.1 Manipulation check. To test if our manipulation was successful, we constructed 4 items, measured on 7-point response scales. Two items examined the fit between the robot's facial expressions and the story (e.g. “The course of the story was reflected in the robot’s facial expressions.”) and two items assessed whether the robot was perceived as emotional or not (e.g. “The robot has shown strong emotions.”). These subscales showed good reliabilities with Cronbach’s α = .93 for the first two items and Cronbach’s α = .91 for the latter two items.

2.5.2 Story experience

Transportation. Transportation was assessed with the German version of the Transportation Scale - Short Form (TS-SF, Appel, Gnambs, Richter, & Green, 2015). It consists of six items (with 7-point response scales, ranging from 1 = “not at all” to 7 = “very much”) that refer to cognitive, affective, and imaginative aspects of transportation (e.g., “The narrative affected me emotionally”, “I could picture myself in the scene of the events described in the narrative”). The reliability of the scale was good (Cronbach’s α = .83).

Intonation. To test, whether the emotions displayed by the robot had an influence on the impression of the robot’s voice (illusory intonation differences), two items were constructed (e.g. “The course of the story was reflected in the robot’s tone of voice.”). The items were measured on 7-point response scales. The scale showed good reliability with Cronbach’s α = .91.

2.5.3 Perceptions of the robot

Likeability and anthropomorphism. To assess specific perceptions of the robot the likeability and anthropomorphism scales of the Godspeed questionnaire were used (Bartneck, Kulić, Croft, & Zoghbi, 2009). Both of them were translated into German and consisted of five items, measured on 7-point semantic differential scales (e.g. machinelike/humanlike, unpleasant/pleasant). The reliabilities of the likeability (Cronbach’s α = .87) and anthropomorphism scales (Cronbach’s α = .81) were good.

Eeriness. Perceived eeriness was measured with the help of three items that went with a 7-point response scale. The instruction text was “How did you feel when you listened to the robot?”, followed by the items “uneasy”, “unnerved”, “creeped out” (Gray & Wegner, 2012). The reliability of the scale was satisfactory (Cronbach’s α = .69).

2.5.4 Product-related attitudes and behavior

The energy bar Lifebar was chosen as the product to be advertised. It is a vegan, gluten free energy bar containing unsweetened fruits and nuts. An energy bar was chosen for three reasons. First, low-involvement products benefit more from emotional advertising appeals than high-involvement products (Dens & De Pelsmacker, 2010). Second, we assumed that healthy energy bars appealed to our sample of undergraduate students. Third, it allowed us to implement a behavioral measure. The particular brand was selected because it could not be purchased in local shops at the study location and we suspected that it was unknown by our participants.

Brand awareness. One item examined, whether the brand Lifebar was known before the study. Participants could answer with yes or no. This variable was used as a control question. Eleven people had already known the target brand “Lifebar” before[1].

Attitude towards the brand and purchase intention. Attitude towards the brand was assessed with the scale by Spears and Singh (2004). It consisted of five items, measured on a 7-point semantic differential scale (e.g. unfavorable/favorable, unappealing/appealing). Purchase intention was estimated with four self-constructed items on 7-point response scales, ranging from 1 = ”not at all” to 7 = “very much”. These items should cover different aspects of purchase intention, e.g. “I could imagine searching online for a way to buy the Lifebar energy bar”, “I would buy the Lifebar energy bar if I saw it in the store”. The reliabilities of the two scales were good with Cronbach’s α = .90 and Cronbach’s α = .86, respectively.

[1] Additional analyses showed that the results were similar with or without these eleven participants.

Product-related behavior. When the study was ostensibly completed, participants were offered to take as many Lifebar energy bars as they desired before leaving the room. All utterances by the experimenters were standardized in order to avoid any subtle influence on the participants' choice. We assessed whether or not the participant took a Lifebar upon leaving and if so, how many. This measure served as a behavioral indicator of the persuasive effect of the story.

2.6 Procedure

Upon entering the room each participant was asked to sit down on a chair opposite to a small cupboard on which the robot was placed. The participant was informed that the robot would tell him or her a story after which a questionnaire had to be filled out on a desktop computer. The desktop computer was placed on the opposite side of the room. As soon as the investigator hid behind the movable wall and the participant was ready, the experiment started (see Figure 4). While the participant filled out the questionnaire, the experimenter provided a bowl with twenty "Lifebar" energy bars next to the door behind the screen. After the participant indicated that he or she had completed the questionnaire, the investigator thanked him or her for participating and the participant had the opportunity to pick one or more of the Lifebars that were advertised in the story. After the participant had left, the "Lifebar" bars in the bowl were counted and it was noted whether or not and if so, how many of them were taken.

3. Results

Zero-order correlations and the means and standard deviations for all measures for the three experimental groups are shown in Table 1. We conducted ANOVAs and planned contrast analysis for the manipulation check and for testing the hypotheses.

3.1 Manipulation Check

As part of our manipulation check, there was a significant effect of the emotions displayed by the robot on the perception of expressed emotions by the participants, $F_W(2, 57.82) = 15.10$, $p <$

.001, $\omega^2 = .24$[2]. In detail, the robot was perceived to display stronger emotions in both conditions in which facial expressions were implemented (affect-congruent or affect-incongruent) than in the no-affect condition, $t_W(48.77) = -4.91$, $p < .001$, $d = 1.42$. Another ANOVA revealed a significant effect of the emotions displayed by the robot on the perception of the fit between the facial expressions and the story, $F_W\,(2, 55.18) = 149.44$, $p < .001$, $\omega^2 = .64$. The fit of the robot's facial expressions and the story was perceived to be higher in the congruent emotions condition than in both other conditions, $t_W\,(67.10) = 13.49$, $p < .001$, $d = 3.23$.

3.2 Story Experience

We expected that the story presented with affect-congruent emotions would elicit stronger transportation than the story presented in the two other conditions (Hypothesis 1). There was a significant effect of the emotions displayed by the robot on transportation, $F(2, 88) = 8.96$, $p < .001$, $\omega^2 = .15$. A planned contrast analysis showed that the affect-congruent condition yielded more transportation than the affect-incongruent condition and the no-affect condition, $t(88) = 3.79$, $p < .001$, $d = .80$. These findings support our first hypothesis and are illustrated by Figure 5. Note that differences between the incongruent and the no-affect condition are not significantly different from zero, $t(59) = 1.75$, $p = .086$. In sum, when the robot is showing emotions congruent to the story recipients are more immersed into the story world.

We further explored a potential illusion effect in a sense that the facial expressions by the robot would influence recipients' experience of the robot's voice – even if the sound file was identical in all three conditions (Research Question 1). Indeed, there was a significant effect of the emotions displayed by the robot on the impression of the robot's voice, $F_W\,(2, 57.94) = 5.88$, $p =$

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[2] Inference statistics and calculation of effect sizes followed existing best practice recommendations (e.g., Field, 2013). Whenever inhomogeneous variances were detected with the help of Levene's tests, Welch-tests were conducted, indicated as F_W and t_W respectively. For the planned contrasts analyses we calculated r and transferred it to d since this effect size measure is more common when differences between groups are analyzed.

.005, $\omega^2 = .09$. Planned contrasts showed that participants in the affect-congruent condition had the strongest experience of story-consistent voice modulation, as compared to participants in the incongruent emotions condition and in the no emotion condition, $t_W\,(68.94) = 3.45$, $p = .001$, $d = .82$. A robot's facial expressions affect the perceptions the robot's voice, even if the robot's voice was held constant across all three conditions.

3.3 Perception of the Robot

We further expected that the participants would evaluate the robot as more anthropomorphic and more likeable in the affect-congruent condition compared to the incongruent and no-affect condition (Hypothesis 2). Regarding anthropomorphism, the emotions displayed by the robot had a significant effect, $F(2, 88) = 7.24$, $p = .001$, $\omega^2 = .12$. A planned contrasts analysis showed that the robot was perceived as significantly more anthropomorphic in the affect-congruent condition than in the affect-incongruent condition and the no affect condition, $t(88) = 3.77$, $p < .001$, $d = .80$.

The ANOVA regarding likeability also showed a significant effect, $F(2, 88) = 4.58$, $p = .013$, $\omega^2 = .07$. Once again planned contrasts showed that the robot was rated as significantly more likeable in the affect-congruent emotions condition than in the incongruent condition and the no affect condition, $t(88) = 3.02$, $p = .003$, $d = .65$. Therefore, our second hypothesis was also supported. These results indicate that displaying emotions congruently with the story content can enhance the acceptance of a robot by the users.

Moreover, we explored if the emotions displayed by the robot had an effect on the perceived eeriness of it (Research Question 2). The conducted ANOVA showed no significant effect, $F_W\,(2, 56.76) = 2.81$, $p = .069$, $\omega^2 = .03$.

3.4 Product-related Attitudes and Behavior

Finally, we assumed a positive effect of congruent affect displayed by the robot on the evaluations, purchase intentions, and behavioral responses regarding the advertised product compared to the affect incongruent and no-affect conditions (Hypothesis 3). When considering brand attitude, our data showed no significant effect, $F(2, 88) = 0.41$, $p = .668$, $\omega^2 = .01$. A subsequent ANOVA regarding purchase intentions also showed no significant effect, $F(2, 88) = 1.18$, $p = .312$, $\omega^2 = .00$.

To analyze whether our affect congruency manipulation influenced the choice of the advertised product (our behavioral measure), we assessed the number of Lifebar energy bars taken. Most participants (73.62 %) took exactly one energy bar, some took no bar at all (16.48%). The remaining participants took two (7.69%) or three (2.20%) energy bars. Given the extreme kurtosis of this measure ($k = 2.93$, $SE_k = .50$) non-parametric inference statistics were applied. There was a significant influence of the emotions displayed by the robot on whether or not a recipient took one or more of the energy bars, Fisher exact test, $\chi^2(2) = 6.23$, $p = .046$, *Cramer's V* = .25. The proportion of people who took one or more energy bar(s) was significantly higher in the affect-congruent condition (96.7 %) than in both other conditions (incongruent = 77.4 %; no affect = 76.7 %). An ordinal logistic regression analysis with the exact number of energy bars as the DV yielded a significant difference between the affect congruent condition and both other conditions, model fit, $\chi^2(1) = 4.80$, $p = .029$, effect estimate = -1.14, $SE = .55$, Wald(1) = 4.30, $p = .038$, Nagelkerke pseudo $R^2 = .066$.

4. Discussion

Our study investigated the influence of affect congruency of a robotic storyteller from three different angles: effects on the story experience, effects on the perception of the robot, and effects on attitudes and behavior towards a product featured in the story. Concerning the participants' experience of the story, our results are in line with our predictions and the literature on emotions in storytelling, indicating that recipients of a narrative are more deeply transported into the story when it is told by a robot that shows story-congruent emotional expressions compared to a neutral robot or a robot with story-incongruent emotional expressions. Interestingly, the impact of congruent emotional expressions in the robot's face also affected the perception of the robot's voice. More specifically, we found an *illusory intonation effect*, meaning that participants thought, particularly in the congruent condition, that the robot adapted its voice to the emotional content of the story. This could be explained by the participants seeking consistency in all channels used by the multimodal robotic storytelling experience, and thus imagining positive or negative intonations in the auditory presentation by the robot's voice in line with the actual visual emotional expressions in the robot's face and the semantic emotional content of the story told. A similar cross-modality effect is described by the McGurk effect (McGurk & McDonald, 1976). In this perceptual phenomenon, a different sound may be perceived when the auditory component of the sound does not match the visual component of the sound. However, this effect is usually shown with sounds produced by a human voice coupled with mismatching lip movements. Since the robot used in our experiment only simulated speech movements by opening and closing the mouth, but not by showing different lip- (or even tongue-) movements, our findings can only partly be explained by this effect. The illusionary intonation effect observed in our study could be conceived as a special form of the Halo effect (Dion et al., 1972) that describes the assumption of certain characteristics to a person of whom only other characteristics are known, e.g. the judgment that a visually attractive person is also a nice or polite person.

Regarding the participants' perception of the robot, results were partly in line with our predictions. As expected, participants rated the robot as significantly more anthropomorphic and likeable in the congruent condition compared to the incongruent and neutral conditions. Concerning perceived eeriness, we did not find significant differences. Previous research on the perceived eeriness of robots is typically based on the uncanny valley hypothesis (Mori, 1970). However, this phenomenon is usually investigated to compare different robots, and in particular, regarding their visual design using pictures of different robots. As we implemented live performances of one and the same robot, a robot that was designed to be rather cute and non-threatening, we believe that the manipulations of non-verbal behavior were not strong enough to elicit measurable differences in the perceived eeriness of the robot.

Our results on participants' attitudes and behavior towards the product that was advertised in the story were inconsistent. While the questionnaires measures did not show any significant effects, the behavioral measure showed that participants were significantly more likely to try the energy bar (that has saved the robot in the story told) in the affect congruent condition, compared to both other conditions. Within the narrative persuasion literature there is a surprising scarcity of causal evidence regarding the influence of story factors on actual behavior. The effect on choosing the energy bar that was part of the story world is therefore an important contribution to the literature. The lack of evidence on the self-report scales could, on the one hand, be influenced by the fact that people are often not aware of the influence marketing has on their subjective impressions of a product and actual behavior. On the other hand, our participants came mainly from the domain of media communication, and thus have a certain background on marketing, which might have influenced their self-assessment on how strongly they are biased towards an advertised product. However, these interpretations would need further investigations. Of note, across all conditions, the product was rated rather positively, which could have been triggered by the emotional content of the story and the positive role of the product within the story arc, which might have overruled the emotional display of the robot. Although our results on behavior are promising, we acknowledge that our dependent variable was measured in the lab context, shortly after the experimental treatment. Longer-term effects had not been the focus of our study.

Our study comes along with a couple of limitations: we have only used one story, one robot, one product, and two contrary emotions. The other factor that needs to be considered in this regard, however, is the rather complex and resources-consuming implementation of the different robot behaviors and the execution of a live-performance study (as compared to, for example, presenting a text-based story or presenting images of robots or videos online). Moreover, the choice of robot Reeti limited the multimodal channels that could be used for communication, Reeti is not able to use gestures or body postures. Despite these limitations, we have illuminated a number of important hypotheses and research questions pertaining to robotic storytellers and emotions in storytelling more generally.

Our results inform roboticists and individuals or organizations who wish to develop or apply humanoid robots in several ways. Our study, along with prior research (e.g., Paradeda et al., 2016; Striepe & Lugrin, 2017; Johanson et al., 2020), makes a rather strong case that robots who display facial expressions that fit the content and context of an interaction are more effective than robots without facial expressions. This finding can inform human-robot communication in non-storytelling settings, such as settings in which conversations are meant to elicit human self-disclosure. In this line of research, the embodiment of AI/robotic interaction partners has been a matter of interest (e.g., Laban et al., 2020). Extending prior studies, we showed that facial expressions need to match the content of the robotic utterance. This result likely applies to fields of human robot interaction beyond the growing field of robotic storytelling. Technical failures to align facial expressions and content are likely to have a negative impact on communication goals. Moreover, based on our research, we advise to implement the full emotional spectrum of emotional expressions. Implementing positive emotions exclusively, for example, could lead to incongruent communication with likely negative consequences to any communicative goal.

5. Conclusion

This contribution connects two fields of scholarship, entertainment and narrative persuasion research on the one hand and human-robot-interaction on the other. We investigated the influence of congruent emotional display (compared to an incongruent emotional display and no emotional display) of a robotic storyteller on the perception of recipients of the multimodal story experience. Extending prior knowledge on the positive effect of emotional display compared to a non-emotional robot, our results suggest that the affective congruency between robot's facial expressions and the emotional content of the semantics of the story has a positive effect on story transportation, perceptions of the robot, as well as behavioral responses to a product that was promoted in the story. These findings highlight the importance of the correct placement of emotional display, e.g. for automatic generation approaches, particularly since the incongruent and neutral versions were rated equally lower than the congruent version. We thus claim that affect congruency of emotional displays should be carefully taken into account in order to increase the acceptance of a social robot in a storytelling context.

The limitations of our study, such as the predetermined story and robot, leave room for a large number of further investigations. In line with our research, additional studies can be conducted that include, but are not limited to: 1) stories that do or do not contain emotional content, 2) robots with different appearances or communicative channels such as gestural display, and 3) different emotions. With the technical and methodical implementations described in this paper, we aim at providing guidance for further investigations into the outlined directions. In our own, near future work, we will have a closer look at the illusionary intonation effect observed in our study, indicating that recipients imagined an emotional tone in the robot's voice, although the speech was consistent across the conditions. Therefore, we will systematically investigate how a recipient's perception is influenced when the robotic voice is actually emotionally colored, e.g., by varying the speed, volume or pitch of the robotic voice, either in congruence or incongruence to the semantic content of the story, or the visual emotional display in the robot's face. Regarding a more practical application of our work, we aim at combining our robotic storyteller with state-of-the-art annotation approaches relying on machine learning algorithms that automatically annotate given texts (such as novels) with emotional labels (e.g., Zehe et al., 2017). In that vein, we want to create a robotic storyteller that automatically generates congruent emotional, non-verbal display to any given story. Such a robot could provide an intriguing mode of access to traditional fairytales or literature to audience members of different ages.

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Table 1
Means, standard deviations and zero-order correlations of the measures.

	Total	NAC	AIC	ACC								
Measure	M (SD)	M (SD)	M (SD)	M (SD)	1	2	3	4	5	6	7	8
1. Perceived Emotional Expressions	4.13 (1.66)	3.00 (1.63)	4.32 (1.46)	5.05 (1.21)	-							
2. Perceived Congruency	3.62 (2.10)	1.85 (0.79)	3.13 (1.77)	5.90 (1.00)	.51**	-						
3. Transportation	4.24 (1.15)	3.68 (1.21)	4.20 (1.11)	4.84 (0.81)	.53**	.35**	-					
4. Intonation	3.68 (1.60)	3.25 (1.74)	3.39 (1.50)	4.42 (1.32)	.39**	.50**	.23*	-				
5. Anthropomorphism	3.35 (1.06)	3.20 (0.79)	3.34 (0.96)	4.11 (1.20)	.52**	.42**	.52**	.30**	-			
6. Likeability	5.72 (0.85)	5.51 (0.83)	5.57 (0.96)	6.09 (0.62)	.54**	.47**	.47**	.32**	.59**	-		
7. Eeriness	1.64 (0.78)	1.71 (0.90)	1.81 (0.79)	1.41 (0.59)	-.06	-.20	-.19	-.04	-.15	-.45**	-	
8. Brand Attitude	5.56 (0.89)	5.59 (0.84)	5.45 (0.99)	5.65 (0.85)	.18	.17	.19	.09	.16	.28**	-.24*	-
9. Purchase Intention	3.16 (1.41)	3.23 (1.48)	2.85 (1.40)	3.39 (1.34)	.16	.14	.15	.18	.31**	.29**	-.20	.51**

Note. **p* < .05, ** *p* < .01. NAC = No-Affect Condition; AIC = Affect-Incongruent Condition; ACC = Affect Congruent Condition

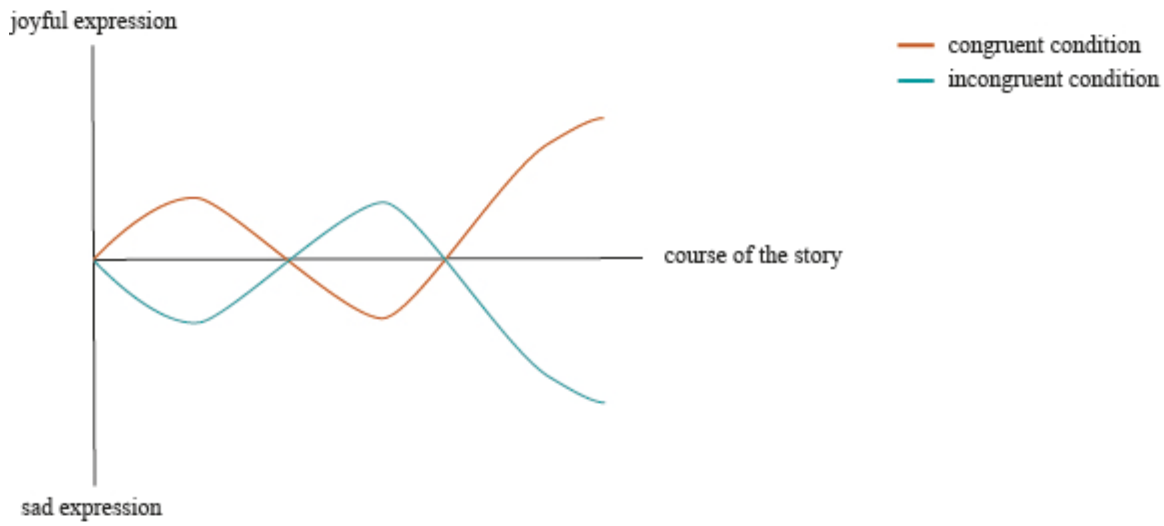

Figure 1. Comparison of expressed emotions in the congruent and incongruent conditions.

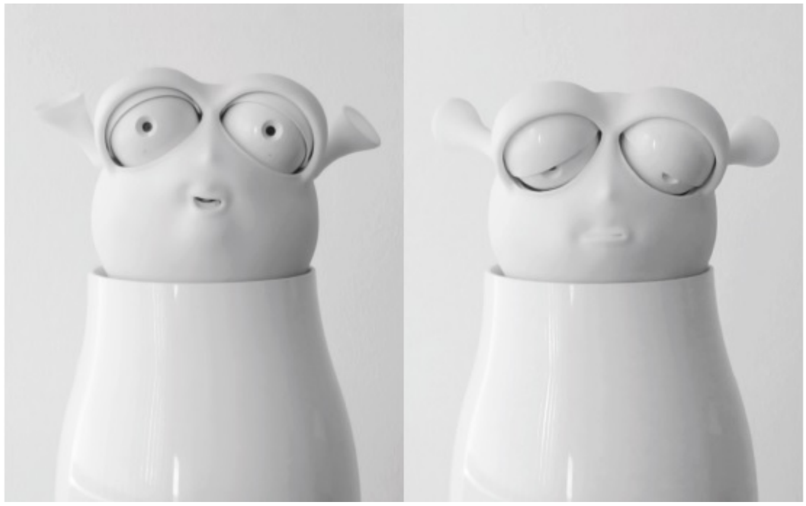

Figure 2. Reeti robot displaying joyful (left) and sad (right) facial expressions.

There is nothing **[blink]** *that gives me* **[head = up]** *more pleasure* **[lip corners = up]. PAUSE: 2sec [head = down; lip corners = down; eyelids = down; ears = down]** *But last week I* **[head = further down + tilt]** *hardly* **[blink; eyelids = half downward]** *recognized myself.*

Figure 3a. Illustration of behavioral sequence in the congruent emotional condition.

There is nothing **[blink]** *that gives me more pleasure* **[lip corners = further down; head = further down, tilt]. PAUSE: 2sec [head = up; lip corners = up; eyelids = up; ears = up]** *But last week I* **[head = further up]** *hardly* **[blink; eyelids = further up]** *recognized myself.*

Figure 3b. Illustration of behavioral sequence in the incongruent emotional condition.

Figure 4. A participant listens to the robotic storyteller

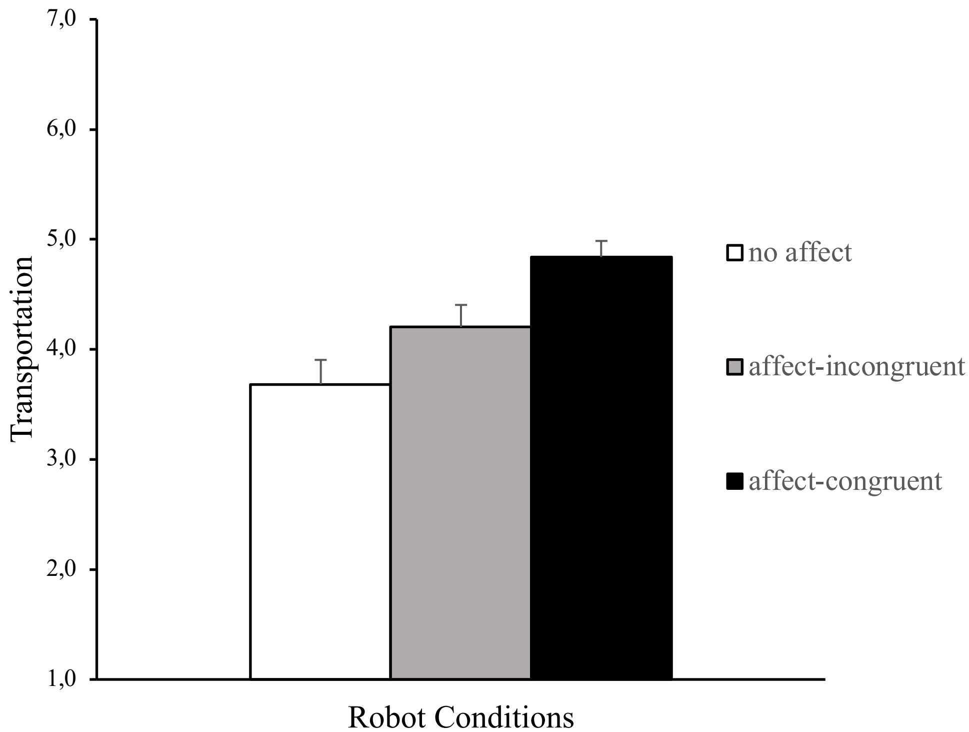

Figure 5. Transportation into the story dependent on robot's facial expressions.