Science fiction reduces the eeriness of android robots: A field experiment

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Abstract

As suggested by the uncanny valley hypothesis, robots that resemble humans likely elicit feelings of eeriness. Based on the social-psychological model of meaning maintenance, we expected that the uncanny valley experience could be mitigated through a fictional story, due to the meaning-generating function of narratives. A field experiment was conducted, in which 75 participants interacted with the humanlike robot *Telenoid*. Prior to the interaction, they either read a short story, a non-narrative leaflet about the robot, or they received no preliminary information. Eeriness ratings were significantly lower in the science fiction condition than in both other conditions. This effect was mediated by higher perceived human-likeness of the robot. Our findings suggest that science fiction may provide meaning for otherwise unsettling future technologies.

Keywords: human-robot interaction, uncanny valley, narrative, meaning maintenance model, field experiment

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"As long as there's a story, it's all right." – Graham Swift, Waterland

1. Introduction

The robots are coming—what recently evolved as a highly popular headline in mass media around the world (e.g., Kelly, 2014; Miller, 2013; Newenham, 2014; Wakefield, 2014) mirrors an ongoing acceleration of technological progress: from self-driving vehicles and autonomous delivery drones to your spaceman lookalike robo-assistant able to serve your future tea, the industry announces their current prototypes to become commonplace technologies within the next two decades. Among the various forms of such autonomous systems, social service robots of more or less humanlike appearance represent one of the key fields. Plans for their increasing use in geriatric care, as household helpers, or as communication companions already exist in many countries. However, many people are still skeptical about the idea of being assisted by or teaming up with a robotic creature in their day-to-day life (e.g., European Commission, 2012; Nomura, Kanda, Suzuki, & Kato, 2008; Nomura, Suzuki, Kanda, & Kato, 2006). In particular, android robots that mimic the visual appearance, motion, sound, or behavior of human beings, are reported to likely provoke aversive reactions among human interaction partners (e.g., Ho & MacDorman, 2010; Mori, 1970), especially at the first encounter (e.g., Koay, Syrdal, Walters, & Dautenhahn, 2007).

We argue that negative responses towards android robots (often captured by the term *uncanny valley*, see below) are reduced when people become accustomed to the robot by means of a fictional story. Science fiction can provide a meaning framework that increases the

likelihood of positive interactions with future technologies—such as android robots. After an introduction of our main theoretical underpinnings, we will present the results of a field experiment that involved real-life human-android interactions.

1.1 The Uncanny Valley

In 1970, Masahiro Mori, a roboticist at the Tokyo Institute of Technology, introduced the hypothetical concept of "bukimi no tani" (Mori, 1970), which later got translated to "uncanny valley" (Reichardt, 1978). According to Mori, the closer robots resemble humans, the more positive responses such as familiarity, acceptance, and empathy are triggered in human observers and interaction partners. However, at some point of high similarity, but not perfect resemblance, the acceptance will drop sharply and the robot will be rated as unfamiliar, eerie, or uncanny (Mori, MacDorman, & Kageki, 2012). With even greater human-likeness, positive perceptions are supposed to increase again (see Figure 1).

- Figure 1 around here -

Psychological theory and research on *the uncanny* and related experiences dates back to the beginning of the twentieth century. In his 1906 article "Zur Psychologie des Unheimlichen" (On the psychology of the uncanny) Viennese psychologist Ernst Jentsch mentioned the "doubt as to whether an apparently living being really is animate and, conversely, doubt as to whether a lifeless object may not in fact be animate" as a powerful cause of uncanny feelings (Jentsch, 1906/1997, p. 197). Jentsch's thoughts on the eeriness of automata were picked up by Sigmund Freud. In his popular essay "Das Unheimliche" (The uncanny) Freud further suggested that the (encounter with the) *unfamiliar in the familiar* (situation) might be an important driver of uncanny feelings (Freud, 1919).

Fuelled by the continuing efforts to develop humanlike robots by research labs and the industry, Mori's uncanny valley phenomenon has become a popular concept in the field of robotics. In contrast to the widespread use of the term, only few empirical investigations have dealt with the uncanny valley and the factors by which it is driven. Of the comparably small body of available empirical literature, to date almost all studies have focused on (manipulating) the visual appearance of a robot along a human-likeness continuum as their independent variable. Participants' reactions then were typically assessed for different conditions of the creature's appearance (cf., MacDorman, Green, Ho, & Koch, 2009; MacDorman & Ishiguro, 2006; Seyama & Nagayama, 2007), for example, recipients reported the level of eeriness they experienced while watching a picture of a human, a robot, or a hybrid figure. Research from this tradition suggested that the uncanny valley experience might be associated with categorization difficulties induced by anthropomorphic artifacts that do not only have attributes typical for human nature, but at the same time show characteristics of other ontological categories (e.g. machine, puppet, goat, cf. Burleigh, Schoenherr, & Lacroix, 2013; Yamada, Kawabe, & Ihaya, 2013, see also Guitton, 2013, for human-animal hybrids in fantasy settings).

Based on the *Meaning Maintenance Model* (Heine, Proulx, & Vohs, 2006) and in line with the latter mentioned research, we explain the uncanny valley phenomenon as a threat to the user's meaning framework. Meaning is "what links people, places, objects, and ideas to one another in expected and predictable ways" (Heine et al., 2006, p. 89). Individuals organize their experiences into meaning frameworks, which are mental representations of expected associations. Based on Freud's discussions of the uncanny (Freud, 1919), Proulx, Heine, and Vohs (2010) suggested that feelings of uncanniness arise by a mixture of familiarity and unfamiliarity that does not fit an individual's meaning frameworks. We suppose that for most

persons, their meaning framework for robots still includes a rather broad and flexible range of expectations (e.g. regarding variations in size, color, symmetry, movement, or audio signals). In contrast, their meaning framework for other human beings is very likely to be more restricted (e.g., variations in shape, symmetry, and size have to stay in a very limited range to be clearly identifiable as human). The more robots resemble humans, the more likely the meaning framework for humans may be activated. Unless the android matches an individual's expectancies about the ontological category of human beings in a clearly identifiable and (nearly) perfect manner, however, the meaning framework is expected to be violated, resulting in an uncanny experience.

We further assume that in a given human-android encounter, the violation of meaning frameworks is not only subject to the visual appearance or other features of the robot; rather, we believe that the uncanny experience varies substantially with the human being that interacts with the robot. The experience may vary with rather stable characteristics of the interaction partner such as her cultural background or personality. Importantly, we further assume that the uncanny valley experience can be changed by prior situational or contextual factors such as the information provided to users prior to interacting with the robot. Any information that successfully provides a valid meaning framework for the robot may decrease the uncanniness elicited by an android robot.

1.2 Stories as Meaning Makers

Our focus here is on the meaning-generating function of fiction. We assume that science fiction can provide a meaning framework for android robots (and possibly other new technologies) that makes these innovations appear less scary and uncanny. Throughout the ages, humankind tended to tell stories in order to overcome potential threats to established meaning

frameworks (e.g., in the context of mortality salience, terror management, and grief, cf. Gilbert, 2002), to share moral values and purpose with others, and to explain to children why things are the way they are (cf. Gottschall, 2012). As such, narratives have always been a primal form of communicating meaning, from early myths and religious writings to contemporary multimedia manifestations or science fiction movies. Humans are *meaning makers* (Heine et al., 2006) and *storytelling animals* (Gottschall, 2012) at the same time. If our storytelling minds – "allergic to uncertainty" and "addicted to meaning" – are not able to find meaningful patterns in the real world, they will have to impose them (Gottschall, 2012, p. 103). Possibly, our need for meaning is one of the main factors underlying the popularity of fictional stories (Oliver & Raney, 2011; see also Bartsch & Mares, in press; Oliver, Hartmann, & Woolley, 2012).

Our thoughts about the meaning-generating function of fictional stories are backed by theorists from different disciplinary backgrounds. Several scholars have argued that stories are the instrument through which people create meaning of experience and identity (Bruner, 1990; Kerby, 1991; Polkinghorne, 1988; Rossiter, 1999; Sarbin, 1986). Narrative form—including elements of plot, character, setting, scene, and theme—helps us to organize single experiences of our life and relate them to each other (McAdams, 1985; Polkinghorne, 1988; Rossiter, 1999). In classical narratives, events are linked to each other as cause to effect (Chatman, 1980). Thus, the narrative structure transforms separate incidents into interrelated sequences of causality in such a way that they can be understood within an integrated context or meaningful principle (Kerby, 1991). By their inherent causal sequences, stories also provide order. When we seek certainty, classical narratives, due to their structural composition, are familiar, expectable, and comforting to us (Appel, 2008).

Absurdist literature, in contrast, violates these expectations on purpose. Thus, examples of this genre should affront rather than strengthen or establish meaning frameworks. In order to test this prediction, Proulx and colleagues (2010) compared the effects of reading a conventional parable by Aesop with an absurdist parable by Franz Kafka. Based on the meaning maintenance model, the authors expected that a violation of meaning frameworks should increase the importance of one's cultural identity (as a means to compensate for the meaning violation). As expected, after reading Kafka, cultural identity importance was higher than after reading Aesop. In contrast to absurdist literature, most fictional stories encountered in popular mass media follow an expected structure that arranges information in causal sequences. Our understanding of the "lifelike" events in the story (Bruner, 1986) thereby goes beyond the cognitive processing of logic arguments. As a consequence of the meaning-generating function of stories, science fiction is expected to draw relations between a new, possibly frightening technology and familiar places, objects, routines, or rules. It allows readers to experience a remote narrative world and to identify with otherwise foreign characters (Gerrig, 1993). Story worlds can be safe places that allow the development of meaning frameworks for future technologies that otherwise appear foreign, unpleasant or eerie—as described in works on the uncanny valley phenomenon.

1.3 Study Overview and Predictions

People have a natural need for meaning and organize their perceptions of the world through glasses shaped by their mental representations of expected relations, that is, their meaning frameworks (e.g., Heine et al., 2006). Based on that, a confrontation with an unfamiliar, very humanlike robot may evoke feelings of ambiguity and uncanniness, because it violates our meaning framework for human beings. As a function of the meaning-generating power of stories,

we assume that a science fiction narrative can compensate this lack in meaning and provide a fitting context for the otherwise unsettling machine.

We conducted a field experiment in a technology museum. Participants interacted with the android robot *Telenoid*. We expected that a science fiction story with this robot as the protagonist, presented prior to an actual interaction with it, would increase the perceived human-likeness of the robot—as compared to non-narrative pre-information of comparable length and content or a no-text condition. Moreover, participants in the narrative condition should experience less eeriness, the key indicator of the uncanny valley phenomenon. The story-effect on eeriness should at least in part be mediated through greater ascribed human-likeness. We further expected that the science fiction story yielded higher ratings of the robot's attractiveness and fewer harmful cognitions toward the robot.

2. Method

2.1 Participants

Seventy-five visitors of the Ars Electronica Museum located in Linz, Austria, took part in our field experiment. They were recruited either directly in the entrance area of the museum or through an introductory university course (results for both subgroups did not differ). Regarding the purpose of the study, participants were told that several new exhibits in the museum needed to be evaluated by visitors and that they would get assigned to just one of them. Data from three participants were excluded from statistical analyses because they did not finish the material. Thus, our final sample consisted of 72 participants (41 women) between the ages of 17 and 68 years ($M = 31.24$, $SD = 11.56$). The educational level of the participants was rather high, 27 (38%) had a university degree, 39 (54%) had a university entrance qualification (*matura*), the

remaining six participants (8%) had obtained basic school education. All participants were native German speakers.

2.2 The robot

We chose Hiroshi Ishiguro's *Telenoid* for the experimental human-robot interaction. It is a puppet-sized tele-presence robot of humanlike appearance and able to physically transmit a human operator's voice, facial expressions, and gestures (Ogawa et al., 2011; also see Figure 2 and http://www.youtube.com/watch?v=N9JyDQlHo1A). Anecdotal evidence suggests that the Telenoid evokes strong uncanny reactions at the first encounter (user comments on *YouTube* reach from "The scariest robot I've ever seen" to "Kill it with fire"). The robot was installed in the (museum name blinded for review) public robot lab, which is part of one of the museum's main exhibition halls. No participant had been in contact with the involved robot before.

- Figure 2 around here -

2.3 Stimulus texts

One out of two texts (or no text) was presented before the participants interacted with the robot: a narrative science fiction story or a non-narrative fact-based text. In view of the experiment's validity, it was crucial to manipulate the stimulus texts systematically. They should differ in terms of their narrative form, but apart from this allow for comparability. Both texts, therefore, were designed to be of the same length (one page each) and to describe key features of the Telenoid. This included its appearance (puppet-sized, humanlike looks, light skin), its functionality (e.g., transmits an operator's voice and facial expressions in real-time), and its suggested purpose (e.g., helps the elderly to stay in contact with family members). Whereas the non-narrative text was an adaptation of the Telenoid leaflet given to ordinary museum visitors, the narrative was created especially for this experiment. We chose a science fiction short story that provided a fitting contextual frame for

the robot protagonist. The pre-defined content regarding Telenoid's appearance, functionality, and purpose was embedded in a story plot that introduced the Telenoid as an extraterrestrial traveler who comes to Earth and helps a grandmother contact her granddaughter who lives thousands of kilometers away. In a scene that plays in the living room of the elderly lady, the robot transmits messages and emotions over the long physical distance between the two of them, as depicted, a.o., in the following short excerpt: "(…) With its tele-presence function, the little robot managed to create a feeling of closeness between Johanna and her granddaughter Andrea (…) Not only did Telenoid convey the young woman's voice, but with his artificial muscles he was also imitating her movements while Johanna was holding the Telenoid in her arms on the living room couch (…)". The informational leaflet, in comparison, described the robot's function and purpose in a purely factual way, as in this example: "When two people are connected via Telenoid, (…) a feeling should evolve that the other person is actually present. This impression of 'tele-presence' is mainly based on the fact that the robot mirrors the gestures of the other person through its body (…)".

2.4 Dependent measures

Our dependent measures were self-report ratings of the participants' experience while interacting with the robot, including attributed human-likeness, eeriness, attractiveness, and harmful cognitions towards the Telenoid.[1]

Human-likeness was measured with the help of five items (7-point semantic differential scale, e.g., 1 = *very machinelike*, 7 = *very humanlike*; 1 = *very artificial*, 7 = *very lifelike*). This index yielded good reliability, as indicated by Cronbach's α = .82. *Eeriness* was assessed with five items (e.g., 1 = *very reassuring*, 7 = *very eerie*; 1 = *very bland*, 7 = *very uncanny*). A reliable

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[1] Other variables measured but not reported here were *perceived usefulness* and the participants' *intention to purchase* the Telenoid for themselves. These variables followed the same pattern of results as the variables reported here. The results on these two variables have been presented in the course of the 8th ACM/IEEE International Conference on Human-Robot Interaction, Tokyo, 2013, and resulted in a two-page poster report.

index could be formed, as indicated by a Cronbach's α = .86. We measured the *attractiveness* of

the robot again with five items (e.g., 1 = *very unattractive*, 7 = *very attractive*; 1 = *very ugly*, 7 =

very beautiful) which yielded good reliability, Cronbach's α = .82. Whereas our measures for the

attribution of human-likeness, eeriness, and attractiveness were based on the uncanny valley

indices by Ho and MacDorman (2010), we further examined participants' *harmful cognitions*

with a five-item scale that was developed for the purpose of this study (e.g., *The Telenoid should*

get destroyed after the end of this exhibition; *I can imagine that I would harm the Telenoid if I*

got an opportunity to do so). The items went with a seven-point scale (1 = *not at all*; 7 = *very*

much). The reliability was satisfactory, Cronbach's α = .74.

Due to the fact that our field experiment was conducted in Austria, all items stemming

from pre-existing scales had to be translated into German. Therefore, to allow for greater

validity, the authors first developed two German versions independent from each other with the

help of English native speakers. In a second step, inconsistent translations were discussed with a

professional translator before the final items were added to the German survey.

2.5 Procedure

Each experimental session involved one participant. After arriving at the museum, the

participant was randomly assigned to either read the narrative short story about the Telenoid, to

read the non-narrative information leaflet about it, or to receive no preliminary information.

After having read their text (or immediately in the no-text condition), participants were taken to

the museum's RoboLab, where the Telenoid was installed. During their interaction with the

Telenoid, participants sat on a sofa and held the robot on their lap. Because the Telenoid is a tele-

presence robot that needs to be remotely controlled by a human being, a female research assistant

operated the robot from a hidden room. This operator assisted in all experimental sessions and

was blind to the experimental conditions. She conversed with the participant on the base of a predefined script (including questions on how participants have come to the museum that day and what the weather was like). After five minutes of interaction, the participant was guided to another place and worked on a questionnaire that included the dependent variables and demographics.

The experiment followed a one-way between-subjects design. The statistical analyses included ANOVAs to identify main effects of the experimental factor as well as statistical procedures to test for mediation based on the classic stepwise approach (Baron & Kenny, 1986) and the bootstrapping approach (e.g., Preacher & Hayes, 2008).

3. Results

Zero-order correlations indicated a positive association between human-likeness and attractiveness ($r = .66$, $p < .001$) and a positive association between eeriness and harmful cognitions ($r = .59$, $p < .001$). Higher scores of human-likeness were related to lower feelings of eeriness ($r = -.50$, $p < .001$) and harmful cognitions ($r = -.61$, $p < .001$). Eeriness and harmful cognitions were both negatively related to attractiveness ($r = -.67$, $p < .001$; $r = -.72$, $p < .001$).

In line with our main assumptions, participants who read the science fiction story perceived the robot to be more humanlike ($M = 3.63$, $SD = 1.07$) than those in the informational leaflet condition ($M = 2.88$, $SD = 1.04$) or those in the control condition ($M = 2.95$, $SD = 1.15$), $F(2, 69) = 4.71$, $p = .012$, $\eta_p^2 = .12$ (Figure 3a). Human-likeness was significantly higher in the narrative condition than in the non-narrative condition ($p = .007$) or in the no-text condition ($p = .013$).

Substantial differences were also obtained for eeriness: Participants in the science fiction condition experienced lower eeriness when interacting with the robot ($M = 3.73$, $SD = 0.93$) than participants who read the informational leaflet ($M = 4.73$, $SD = 0.90$) or control group members

($M = 4.78$, $SD = 1.18$), $F(2, 69) = 7.95$, $p = .001$, $\eta_p^2 = .19$ (Figure 3b). The perceived eeriness

was significantly lower in the narrative condition than in the non-narrative condition ($p = .001$)

or the no-text condition ($p = .001$).

- Figure 3 around here -

We assumed that the influence of the science fiction story on the eeriness experience was

mediated by the perceived human-likeness of the robot. Our mediation analysis involved the

classic procedure by Baron and Kenny (1986), as well as the more recent bootstrapping

approach. Following the classic mediation test procedure introduced by Baron and Kenny, we

first conducted a set of stepwise regression analyses (see Figure 4). As indicated earlier, reading

a science fiction story in contrast to a non-narrative leaflet prior to the human-robot interaction

significantly predicted the level of eeriness that our participants experienced, $B = -.99$, $SE_B = .27$,

$p = .001$ (path c in Figure 4). Eeriness was also predicted by the human-likeness that the

participants attributed to the android, $B = .86$, $SE_B = .29$, $p = .005$ (path a). We subsequently

regressed perceived eeriness on both the text treatment and the attributed human-likeness. In this

analysis, human-likeness predicted eeriness, $B = -.41$, $SE_B = .12$, $p = .002$ (path b). At the same

time, the regression weight for the direct effect on path c diminished to $B = -.64$, $SE_B = .26$, $p =$

.02 (path c`). To formally test for mediation we ran a bootstrapping analysis based on the

recommended procedure and SPSS macro by Preacher and Hayes (2008) for indirect effect

analyses. We entered eeriness as the criterion, our experimental conditions as the predictor

variable, and human-likeness as the proposed mediator variable. As a result, the 95% confidence

interval for the indirect effect using 5,000 samples did not include zero (lower limit = -0.7625,

upper limit = -0.1234), which indicates a significant mediational role of human-likeness. In sum,

both the bootstrapping and the multiple regression analyses suggest that introducing an android

through science fiction induced higher human-likeness ratings, which in turn led to lower experience of eeriness while interacting with the robot.

- Figure 4 around here -

Further analyses focused on the additional dependent variables and showed that the science fiction story elicited higher attractiveness ratings ($M = 4.32$, $SD = 0.92$), as compared to the informational leaflet ($M = 3.54$, $SD = 1.01$) or the no-information condition ($M = 3.66$, $SD = 1.17$), $F(2, 69) = 4.16$, $p = .026$, $\eta_p^2 = .10$ (Figure 3c). The difference between the narrative condition and the non-narrative condition was significant ($p = .012$) as was the difference between the narrative condition and the no-text control condition ($p = .030$). Moreover, after reading the science fiction story, participants harbored less harmful cognitions ($M = 1.75$, $SD = 0.70$), than participants in the non-narrative leaflet condition ($M = 2.91$, $SD = 1.03$) or participants in the control condition ($M = 2.86$, $SD = 1.05$), $F(2, 69) = 11.38$, $p < .001$, $\eta_p^2 = .25$ (Figure 3d). The difference between the narrative group and either of the other groups was significant ($ps < .001$). For all four dependent variables, no significant difference was found between scores in the informational leaflet condition and the no-text control condition (all $ps > .30$).

4. Discussion

The uncanny valley hypothesis (Mori, 1970; Mori, MacDorman, & Kageki, 2012) suggests that robots whose appearance is modeled after that of humans likely yield a low level of acceptance. Especially when they come to resemble human beings to a very great extent but not completely, the robot is regarded as uncanny (eerie, creepy). In line with the social-psychological meaning maintenance model (Heine et al., 2006), we explained the uncanny valley experience as a violation of meaning frameworks. Based on the meaning-generating function of stories, we

assumed that a fictional text can engender a context of meaning for an android and thus reduce negative experiences in a human-robot interaction. A field experiment provided support for our hypotheses: A fictional story that was presented prior to a real-life human-robot interaction significantly reduced the experience of eeriness while interacting with the robot, as compared to a non-narrative informational text and a no-text condition. Thus, only the story was able to bridge the uncanny valley for our participants. This result supports our idea that readers can extend their existing meaning frameworks when they are transported into the fictional world of a story—and thereby prepare for otherwise potentially unsettling encounters with challenging technological innovations in robotics and beyond.

We assume that the meaning-generating function of science fiction regarding new technologies is not limited to robotics: Let's imagine that a multinational company has just revealed their latest market launch, a teleportation machine, named "the transporter". This machine is able to dematerialize a person who takes place on a special transporter platform and to send the information to any GPS target, where the person's body then gets reconverted into matter; a process they call "beaming". ― Sounds somewhat frightening? Maybe not so much for viewers of the TV series *Star Trek* (Roddenberry, 1966) who are familiar with the concept of beaming as an element of this series' narrative world. In line with our theory and findings, we suggest that by watching the fictional *Star Trek* stories, people around the world might have developed a mental representation of beaming which makes this future technology to appear less frightening. Likewise, anecdotal media reports about audience reactions to the humanoid service robot VGC-60L—one half of the starring duo in the movie *Robot & Frank* (Schreier, 2012)— point at a similar mechanism: Although the robot has been described as creepy when presented

outside the film context, viewers still wanted to get one for themselves after having followed its story on the screen (Connelly, 2012; Watercutter, 2012).

In addition to the contribution of the present research to the field of robotics and the responses towards new technologies, it contributes to the growing body of empirical literature that highlights the real-world implications of fictional stories. In previous experimental research, fictional stories changed recipients' knowledge (e.g., Dahlstrom, 2012; Marsh, Butler, & Umanath, 2012; Marsh, Meade, & Roediger, 2003), their attitudes, beliefs, and behavioral intentions (e.g., Appel & Mara, 2013; Appel & Richter 2007;2010; Green & Brock, 2000) as well as their self-concept (Richter, Appel, & Calio, 2014; Sestir & Green, 2010), and their theory of mind (e.g., Kidd & Castano, 2013; Mar & Oatley, 2008). We believe that the construction of meaning frameworks is an additional avenue for future research on narratives.

Limitations of the present research need to be noted. First, our method was a field experiment. We attempted to guarantee both a high external and internal validity of the experiment. Experimenting in the field, however, yields difficulties in controlling all incoming stimuli for participants. Thus, participants might have been distracted by other museum exhibits or visitors while interacting with the Telenoid. Moreover, the majority of participants were recruited among persons arriving as real visitors at the Ars Electronica Museum. This group of people might have shared a higher than average interest in science and technology, even if this museum typically addresses a very broad target group.

Second, regarding our two stimulus texts, we tried to manipulate the narrativity whereas other aspects of both texts were kept similar (e.g., in terms of text length or which information about the robot's technical features was embedded). However, the recipients' affective reactions to both texts might have differed. For example, the fictional story might have elicited more

positive mood, or more positive emotions such as elevation (Oliver et al., 2012; Oliver & Bartsch, 2010). Although this does not contradict our theory and interpretation (as meaning making is likely accompanied by positive affect), future research on the development of meaning frameworks through stories can profit from incorporating measures of positive affective states.

The uncanniness measurement is a third limitation to our research. We relied on self-reported ratings mostly based on items from the uncanny valley scales introduced by Ho and MacDorman (2010). Self-reports are common in the field, however, the adoption of non-obtrusive objective measures to assess the uncanny valley experience seems desirable in future research (e.g., psychophysiological measures).

Fourth, prior exposure to science fiction or different genre preferences of our participants have not been taken into account in our field experiment. We believe that such individual differences did not constitute a confounding factor due to our randomized between-subjects design. However, individual familiarity with science fiction may influence the effect of an android robot story on user variables. Future research is encouraged to examine individual media preferences as a moderating variable of the meaning generating effects of fictional stories.

Taken together, we believe that this piece of research adds to the literature on narrative experiences and effects as well as to the literature on user perceptions of humanoid and android robots. Robotics is a key field of technological progress, and service robots of more or less humanlike appearance are predicted to appear in more and more places in our everyday life. To date, however, personal experiences with robots are still limited. A recent *Eurobarometer* study (European Commission, 2012), for example, revealed that 87% of EU citizens report that they never have used a robot before. Given this lack of real-life encounters with robots, narratives and fiction instead might serve as practical sources to create meaningful frameworks for an otherwise

unknown and possibly uncanny technology whose prevalence is expected to increase

tremendously within the next decades.

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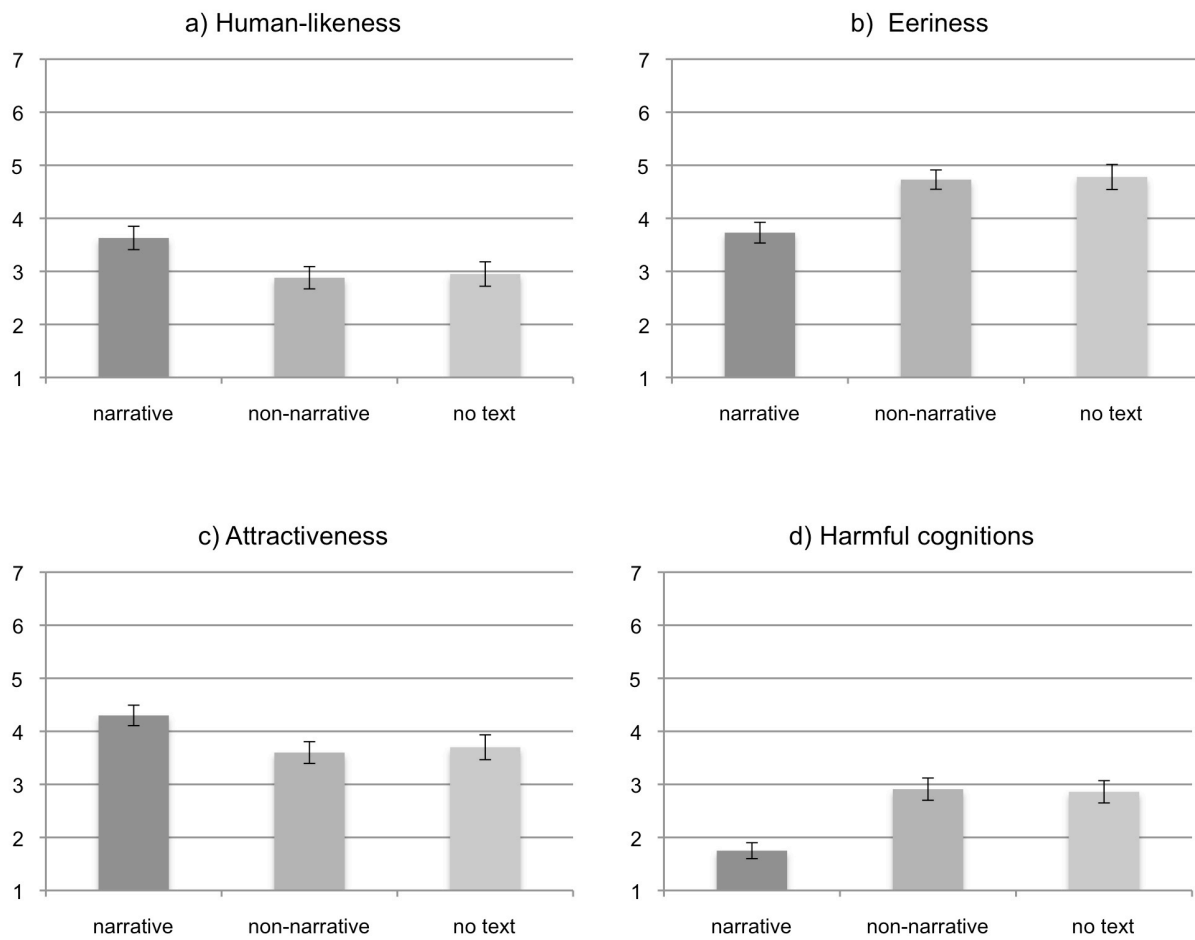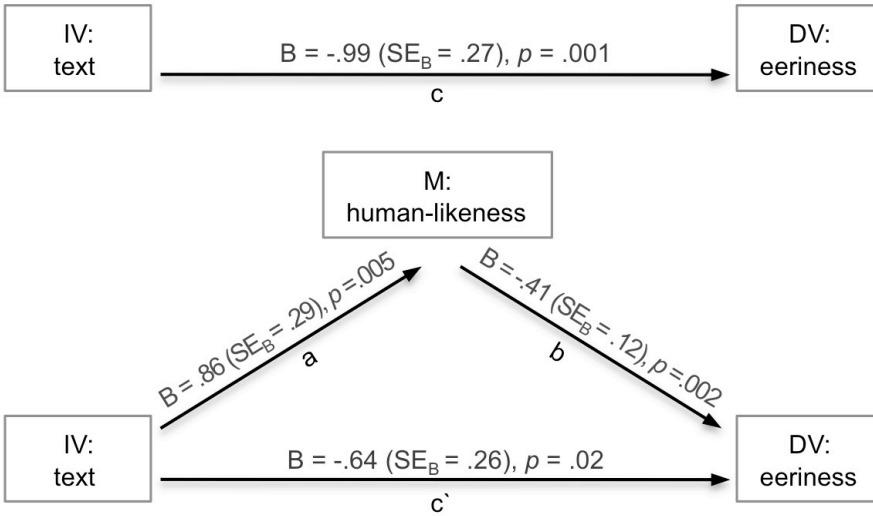
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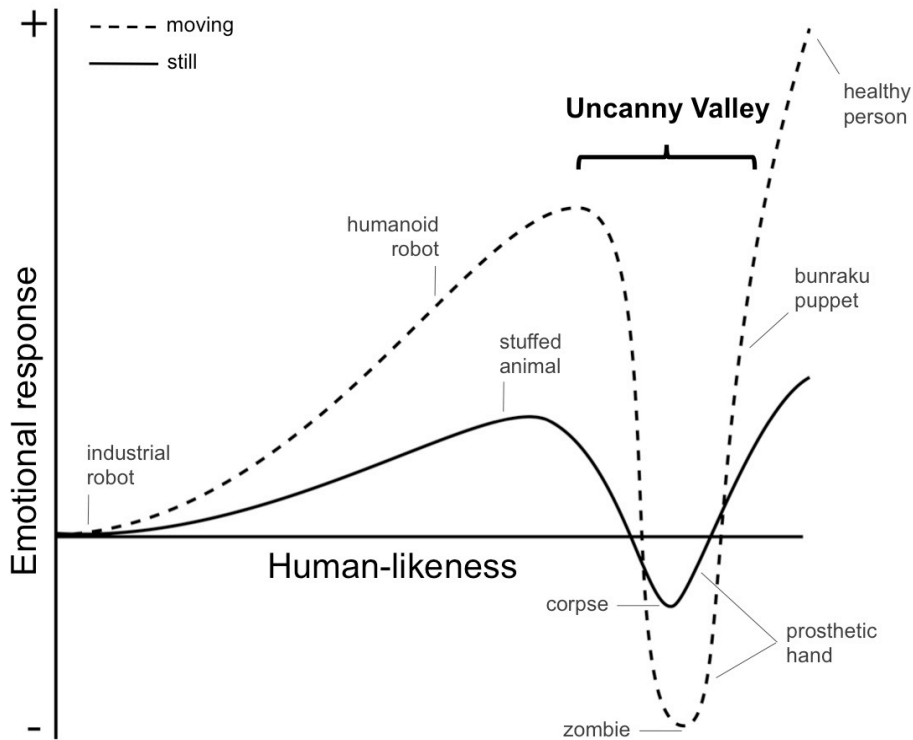
Figure 1. The uncanny valley as proposed by Mori (1970; Mori, MacDorman, & Kageki, 2012) and its hypothesized relationship between the human-likeness of artificial figures and emotional responses by human interaction partners.

Figure 2. In our field experiment, participants interacted with the android robot *Telenoid* (left), which was tele-operated by a museum employee (middle). While their interaction, participants sat on a sofa in one of the museum's exhibition halls (right).

Figure 3. Means and standard errors of the mean for human-likeness (a), eeriness (b),

attractiveness (c), and harmful cognitions (d) under the three experimental conditions.

Figure 4. The relationships between the text treatment (narrative versus non-narrative), attributed human-likeness, and eeriness of the android robot *Telenoid*. Regression weights for the total effect (upper part) and the model with human-likeness included as a mediator.