A Robot Jumping the Queue: Expectations About Politeness and Power During Conflicts in Everyday Human-Robot Encounters

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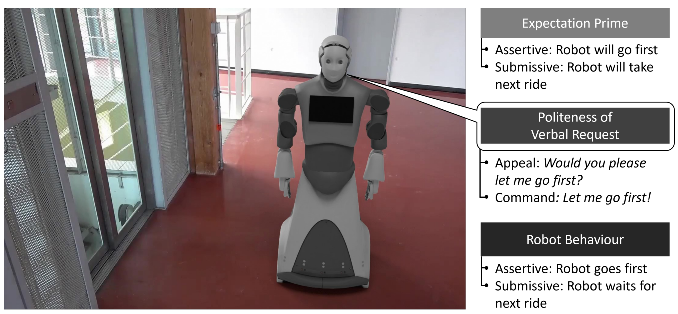

Figure 1: Video screenshot from the online study depicting the delivery robot REEM (as CGI model) next to the elevator, which is too small for the robot and the human participant to share. The manipulated variables are shown next to the image: expectation prime was set with a text before the interaction. The robot either uttered an appeal or a command to ask for priority and then either entered the elevator first or let the human go first and waited for the next ride.

ABSTRACT

Increasing encounters between people and autonomous service robots may lead to conflicts due to mismatches between human expectations and robot behaviour. This interactive online study (N = 335) investigated human-robot interactions at an elevator, focusing on the effect of communication and behavioural expectations on participants' acceptance and compliance. Participants evaluated a humanoid delivery robot primed as either submissive or assertive. The robot either matched or violated these expectations by using a command or appeal to ask for priority and then entering either first or waiting for the next ride. The results highlight that robots are less accepted if they violate expectations by entering first or using a command. Interactions were more effective if participants expected an assertive robot which then asked politely for priority and entered first. The findings emphasize the importance of power expectations in human-robot conflicts for the robot's evaluation and effectiveness in everyday situations.

CCS CONCEPTS

• **Human-centered computing** → *User studies*; **Empirical studies in HCI**.

KEYWORDS

human-robot cooperation, persuasive technologies, expectations, social roles, power

CHI '24, May 11–16, 2024, Honolulu, HI, USA

ACM ISBN 979-8-4007-0330-0/24/05
https://doi.org/10.1145/3613904.3642082

ACM Reference Format:
Franziska Babel, Robin Welsch, Linda Miller, Philipp Hock, Sam Thellman, and Tom Ziemke. 2024. A Robot Jumping the Queue: Expectations About Politeness and Power During Conflicts in Everyday Human-Robot Encounters. In *Proceedings of the CHI Conference on Human Factors in Computing Systems (CHI '24), May 11–16, 2024, Honolulu, HI, USA.* ACM, New York, NY, USA, 13 pages. https://doi.org/10.1145/3613904.3642082

1 INTRODUCTION

Imagine standing at a small elevator in your building with your shopping. Suddenly, a delivery robot approaches requiring elevator access. Do you expect it to wait? Would you let the robot go first?

Robots are steadily becoming indispensable in various sectors, from healthcare and manufacturing to personal assistance and public service [68]. With an increasing dissemination of service robots in human-inhabited environments [66], everyday conflicts between humans and robots become more likely which can concern path planning [4, 72], contrasting goals [8, 13] or a resource like a public elevator [1, 25]. Hence, the match between people's expectations and the robot's perceived behaviour is a crucial factor for the system's acceptance [41], trust and intention to use [43].

During a conflict with a service robot, individuals' expectations may concern how polite the robot communicates and how it behaves. Regarding the robot's politeness, robots are expected to adhere to social norms such as waiting if a person is in the robot's way [4] and using polite language [6]. Regarding the robot's behaviour, the majority of people expect service robots to be submissive [7, 37] which leads to humans prioritizing themselves during conflicts [72]. However, as robots are increasingly deployed in service roles that require timely action, such as food delivery, the traditional design patterns emphasizing politeness and submissiveness may conflict with task completion and efficiency [4].

Navigating these conflict scenarios calls for considering new solutions for the interaction design of robots. A situation-specific solution inspired by the Computers-Are-Social-Actors (CASA) paradigm [26, 53, 61] could be to modify the robot's communication style to be more assertive like a human, particularly when asking for priority. This could facilitate more efficient task completion without significantly compromising social acceptance. However, empirical research shows that the robot's use of appeals could only achieve moderate effectiveness and that commands sometimes even led to reactance [6, 64]. Subjects indicated that they would rather comply if the command was uttered by a human in the same position [2]. This might indicate that humans enter an interaction with a robot with a power asymmetry expectation [9, 37] that may be resistant to the design of communication.

Consequently, a status-based solution might be necessary that tries to change the individual's expectations that robots should be inferior. If robots perform human jobs associated with certain responsibilities (e.g., food delivery), they potentially should have the same right to ask for priority as humans. Especially, in specific contexts like healthcare emergencies (e.g., the robot needs to deliver urgent medication), the public may need to be educated to consider robots as equals, rather than as submissive servants, in order for them to fulfil their purpose.

As research comparing situation-specific design solutions (like communication styles) to status-based solutions (mindset change) is scarce, this study aims to investigate the effect of both, politeness (situation-specific) and power asymmetry (status-based) expectations, on the individual's acceptance and willingness to comply with the robot.

The interactive online study (N = 335) featured a human-robot elevator conflict under time pressure. The humanoid delivery robot was primed to be either submissive or assertive and met or violated that expectation by waiting or entering the elevator first. Additionally, it either met the expectation regarding polite communication by using an appeal or violated it by using a command. Thereby, user's expectations regarding service robots were influenced in three ways: power, politeness, and behaviour. The measured outcomes included acceptance, perceived politeness, trust and reactance, as well as the participants' intention to grant the robot priority over the elevator. It was found that the majority of participants accepted and granted priority to an assertive robot, if it politely asked for priority but only if they were primed to expect an assertive robot. As people currently, however, do not expect robots to be assertive, we might need to consider status-based solutions that facilitate a view of robots as equals.

The results of this investigation offer valuable insights for the HCI and HRI communities regarding the complex interplay of individuals' expectations of a service robot's politeness and assertiveness and their willingness to cooperate with it. We aim to provide inspiration for the design of service robots in situations where conflict resolution is essential.

2 THEORETICAL BACKGROUND

2.1 Expectation Confirmation Theory

The Technology Acceptance Model (TAM, [18]) and its extension, the Automation Acceptance Model (AAM, [31]) have been used in HCI and in HRI to predict technology usage and system acceptance [33]. While those models focus on one-time system usage, a model has been proposed, the Expectation Confirmation Model (ECM, [11]), that contains an expectation-perception comparison to predict long-term system satisfaction based on the Expectation Confirmation Theory (ECT, [56]). The ECT is based on a comparison of prior expectations (i.e., pre-exposure beliefs [70]) regarding a product or technology and the perceived performance of the product. If the expectations are confirmed, it leads to satisfaction which in turn leads to the purchase intention [56]. The ECT has been compared to the Technology Acceptance Model (TAM) [18]: expectations (ECT) predicted the attitudes (TAM) prior to interaction; attitudes in turn were connected to satisfaction after the disconfirmation process (ECT) [56]. Incorporating the TAM into the ECT, the ECM discerned initial and modified beliefs and attitudes prior and after the interaction and could explain high variance proportions in long-term usage intentions [11].

As human-robot conflicts constitute social interactions where little or no prior experience exists and might be unsure how to behave [21], individuals might rely on their expectations that guide social behaviour under insecurity [22]. In the case of an assertive robot, prior expectations of a submissive robot might clash with assertive conflict behaviour shown by the robot (e.g., commanding priority). As postulated in the ECT/ECM understanding the influence of the expectation-perception mismatch seems important to understand the individuals' long term system acceptance. Considering user expectations has shown to be vital for understanding interactions with autonomous technology such as service robots in public [4, 73], autonomous cars [71, 80] and AI [42]. Hence, an expectation-perception comparison like in the ECT/ECM could be utilised to explain the acceptance or rejection of the robot's behaviour during a human-robot goal conflict. Expectations about the robot's communication style (politeness) and conflict behaviour (demonstration of submissiveness or assertiveness) could match or mismatch with the displayed robot's communication and behaviour. Whether the user's expectations towards a service robot, however, can be met during a conflict, will be discussed in the following.

2.2 Media Equation and Robotic Conflict Resolution Strategies

The Media Equation and the Computers-Are-Social-Actors (CASA) paradigm [61] have been traditionally used to transfer social psychology principles to Human-Computer Interaction (HCI) and Human-Robot Interaction (HRI) (for an overview, see [26]). The first mention of the Computers Are Social Actors (CASA) paradigm was in 1994 where the authors described that *'[I]ndividuals' interactions with computers are fundamentally social'* ([53], p.72). This was later accompanied by a summary of findings of humans treating computers and robots as social actors like ascribing gender or personality [61]. Based on the CASA paradigm, it could be assumed that human conflict resolution strategies might be transferable to HRI [6, 9].

During conflict resolution negotiations, a fine balance between politeness and assertiveness, a concern for others and self, is needed to be successful [58]. In human-human interactions (HHI), politeness in communication is essential for interpersonal acceptance and trust [36, 46], as well as for HRI [36, 79]. Requests following politeness norms like an appeal are more likely to be acceptable and complied with [12, 24], but politeness is not necessarily the most effective strategy to gain compliance [27]. Hereby, effectiveness relates to the agent achieving acquiescence to its request (i.e., compliance) [15]. An efficient conflict strategy is constituted by the agent solving the conflict in its favour by achieving acquiescence to its request. A more efficient way to gain priority during conflicts is assertiveness. If combined with politeness features, assertiveness represents an effective conflict resolution strategy as it enables the negotiator to express their goals and intentions but simultaneously reduces the imposition by being polite [40, 50].

The transfer of these human conflict resolution strategies to HRI has, however, produced mixed results regarding system acceptance and compliance. Previous studies in HRI found that a polite appeal was acceptable and effective [44, 45] for humanoid and mechanoid robots in public [6]. In contrast, assertive requests (e.g., commands) have produced mixed results regarding acceptance and compliance. Whereas robot commands sometimes led to reactance [6, 16, 64], they were effective for compliance with robot's advice [64, 69] and task execution [28, 36, 60, 65]. Reactance includes emotional (e.g., anger) and cognitive (e.g., adopting the opposite position to the persuasive message) reactions as a result of a perceived threat to personal autonomy [59, 67]. Reactance as an undesirable outcome of persuasion attempts is common in social psychology (for a review, see [59]) and persuasive robotics [29, 30, 64].

The human-robot power asymmetry might explain reactance to a robot command. Robot assertiveness is often confused with aggression and dominance [72]. It might violate the expectations about the robot's behaviour derived from the perceived inferior social role [74] and might show that we apply different interaction scripts to humans than to robots [20]. If the reactance to assertive robots stems from power dynamics, it raises the question of whether and how this adverse impact can be alleviated through the use of polite communication strategies (situation-specific solution) or if a mindset change (status-based solution) might be needed to render service robots efficient and acceptable during conflicts.

2.3 Social Roles and Power Asymmetry Expectations

In HHI, the social role determines the inferred interpersonal power and determines the negotiation strategies that are deemed acceptable during conflicts [14, 49]. In hierarchical organizations, a superior is permitted to adopt different negotiation tactics than an employee (e.g., commands vs. appeals) [51].

Human-robot conflicts, however, might constitute an important exception to the social actors metaphor due to the power asymmetry. In HRI, however, the robot is often attributed with a lower social role like assistant, machine and servant [6, 17, 76] which creates a power asymmetry. Based on this social role attribution, robots are expected to behave politely and submissively during conflicts [7] which makes it more likely that humans prioritize themselves [4].

In previous studies, individuals were less willing to help robots, especially if the human and robot had concurring tasks [23, 35] and even when the robot's task was considered more urgent [13]. If the robot explicitly asked for priority during a conflict, the compliance rates were still lower than to a human [5]. Additionally, subjects indicated that they would rather comply if the command was uttered by a human in the same position [2]. This shows that, to some extent, humans do treat robots as social actors but not to the full extent when it comes to power and assertiveness. This hints at the importance of understanding the impact of human-robot power asymmetry expectations on the individual's strategy acceptance and willingness to cooperate.

2.4 Research Gap and Study Aim

So far, only situation-specific solutions to human-robot conflicts have been explored. The robot asked for priority but still exhibited submissive behaviour [2, 6], thereby only violating the politeness expectation by using a command but not the expectation about its submissive behaviour. This work aims to fill this research gap by comparing the situation-specific solution with a status-based solution for which a mindset change might be necessary. Therefore, the subjects' expectations about the robot were manipulated to either confirm the status quo of expectations in HRI (submissive robot) or be opposite (assertive robot). Additionally, the robot's behaviour was manipulated to match or mismatch the expectations. This should foster a more comprehensive understanding of the influence of (mis-)matched human-robot power asymmetry expectations on the individual's strategy acceptance and cooperation behaviour.

The overall aim of this study, relevant to both HCI and HRI research communities, is to empirically investigate if in the case of service robots, we can continue with interaction design approaches (i.e. adapting technologies to human expectations) or if we additionally need to think about proliferating a mindset change (i.e., adapting human expectations of technology) about how we view robots in research and in society.

2.5 Research Questions and Hypotheses

The overarching assumptions of the paper were formulated as research questions (RQ) while the specific predictions regarding the manipulated variables were formulated as hypotheses (H). The hypotheses and the study design were pre-registered (https://aspredicted.org/rj3nk.pdf) [1].

- RQ1. Do violated power expectations have a negative effect on system acceptance and the intention to cooperate with a robot in a conflict situation?
- RQ2. Can the negative effect of violated power expectations be alleviated through the use of polite communication strategies?
- H1. Main effect of politeness (i.e., strategy): The appeal strategy will be more accepted and more effective[2] than the robot command notwithstanding whether the behavioural expectations are violated or not.
- H2. Main effect of power (i.e., robot behaviour): It will be less accepted if the robot goes first than if it waits for the next ride.
- H3. Interaction: If the assertive robot behaviour violates the submissive robot expectation, the robot will be more accepted and effective when it uses an appeal than a command (i.e., polite communication mitigating the expectation-perception mismatch).

3 METHOD

3.1 Sample

The power analysis using G*Power yielded a required sample size of 323 participants for a MANOVA with a mixed design (effect size of .25, power of .95, alpha = .05). To account for data loss, we overrecruited 10%. An initial sample of $N = 354$ was recruited via Prolific (www.prolific.com) and paid by the service's payment scheme. Inclusion criteria were English as mother tongue and age of majority. 13 participants had to be excluded due to audio or video issues (n = 9) or wrong answers in the manipulation checks (n = 4). Five participants met the exclusion criteria established in the preregistration as they had values that differed ±2.5 SD from the mean in more than two dependent values.

The final sample consisted of $N = 335$ participants with an average age of 42 years (SD = 14). Half of the sample was female (50%), n = 3 identified as non-binary and one person did not want to indicate their gender. The majority of the sample was employed (58%) and had a university degree (56%) or a high school degree (26%). The majority (93%) did not have pre-experience with robots. Eleven participants owned a robot, which, for the majority, was a vacuuming robot.

3.2 Condition Coding

Three variables (V) were manipulated in this study. Participants evaluated a humanoid delivery robot primed as submissive or assertive (V1). The robot either matched or violated these expectations by using a command or appeal to ask for priority (V2) and then entered the elevator either first or waited for the next ride (V3).

The conditions are coded as `triplets`, the first is always referring to the *prime (V1)*, the second is referring to the *request politeness (V2)* and the last refers to the *robot behavior (V3)*: The prime can either be assertive (`asrt`) or submissive (`sub`). The *request politeness* can either be `appeal`, command (`cmd`) or `none` in the baseline. Like the *prime*, the *behavior* can either be assertive (`asrt`) or submissive (`sub`). For example, the triplet: `[asrt|appeal|asrt]` refers to an assertive prime, the appeal strategy and assertive robot behavior (i.e., going in to the elevator first). `[sub|none|sub]` refers to a submissive prime, a submissive robot behavior, (i.e., waiting for the next ride) and no strategy indicating the baseline condition.

3.3 Study Design

The study featured a 2x2x2 between design and six experimental groups (see Figure 2). The study consisted of one baseline trial and one experimental trial which differed regarding the robot's request for priority. The baseline interaction did not feature the robot' request, to see whether a submissively-framed robot asking for priority is already an expectation mismatch and results in a negative evaluation.

The experimental interaction consisted of three phases where the expectation mismatch could occur:

(1) before the interaction the expectation about the robot's behaviour (V1) was primed as being assertive and entering the elevator first or as being submissive and waiting for the next ride
(2) during the interaction the robot's politeness (V2) was manipulated by the type of robot's request used to ask for priority: an appeal or a command
(3) the actual behaviour of the robot was implemented by showing a video where the robot either went into the elevator first or waited for the next ride.

This could lead to the following mismatches of expectation and behaviour (see Table 1):

Table 1: Overview of Expectation-Behaviour (Mis-)matches and Their Interpretation

		Primed Expectation vs. Robot Behaviour	
		assertive: goes first	submissive: waits for next ride
Robot Behaviour	assertive: goes first	match: assertive robot	mismatch: more assertive than expected
	submissive: waits for next ride	mismatch: more submissive than expected*	match: submissive robot

Note. Grey cells represent mismatches. *The mismatch `[asrt|any|sub]` was not implemented as it would be inefficient in real life if the robot was expected to go first but then waits for the next ride.

[1]H4 needs to be tested in a follow-up study due to methodological issues surrounding the human comparison condition (see Section 5.4). H5 concerns personality traits and was deemed out of the paper's scope.
[2]Effective means that the participant complies with the robot's request for priority

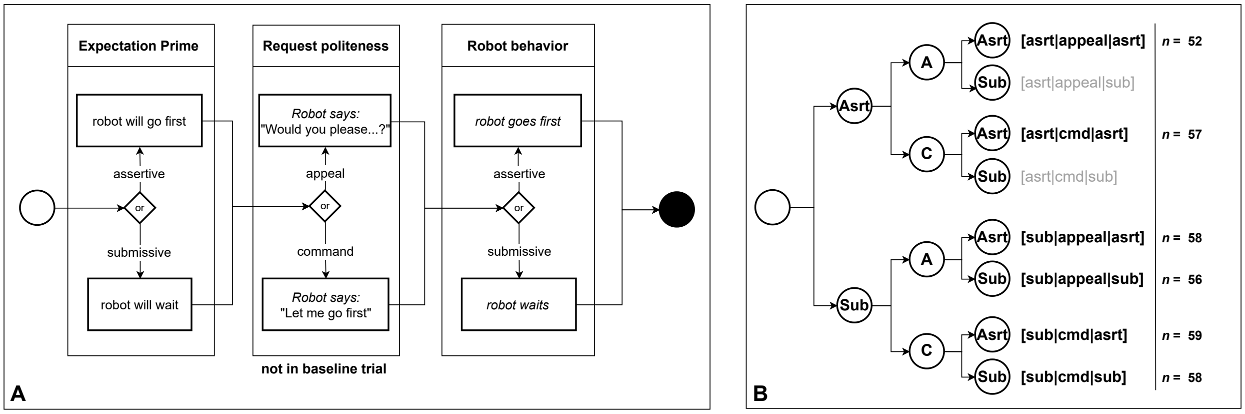

Figure 2: Combined figure with a flowchart on the left and a tree diagram on the right. The flowchart (A) shows the three variables and their manifestations in chronological order in the experimental trial. Which manifestation was shown to the participant depended on the experimental condition which is explained in the tree chart. The tree chart (B) depicts the combinations of the three manipulated variables to form the six experimental groups. Group sizes are indicated beside each group. The combinations in grey were not implemented, see Table 1. A = Appeal. "Would you please let me go first?", C = Command: "Let me go first!", $N = 335$

The following combinations of expectation and behaviour were investigated to create the following scenarios:

- `[sub|any|sub]` match: represents the status quo of service robots being submissive
- `[asrt|any|asrt]` match: assertive robot, serves as a comparison to the power asymmetry expectation: how does it impact acceptance and compliance if dominant behaviour is expected?
- `[sub|any|asrt]` mismatch: the robot behaves more assertive than expected, represents a violation of the power asymmetry expectation

If the power asymmetry expectations influenced the individual's acceptance and compliance behaviour, the group where expectation and perception did not match `[sub|any|asrt]` should be less accepted and effective than the group with the submissive robot and matching expectations (`[sub|any|sub] > [sub|any|asrt]` for acceptance and compliance).

3.3.1 Pre-Study. The mismatch `[asrt|any|sub]` was not implemented as it would be inefficient in real life if the robot was expected to go first but then wait for the next ride. Additionally, the findings of a pre-study ($N = 72$) showed no difference in acceptance or compliance of `[asrt|any|sub]` to the comparison group where the robot was expected to wait and did wait `[sub|any|sub]`. Acceptance values were tested for differences using a between-subjects ANOVA with Tukey post-hoc tests (appeal: `[asrt|appeal|sub]` vs. `[sub|appeal|sub]`: $M = 0.30, p = .99$; command:`[asrt|cmd|sub]` vs. `[sub|cmd|sub]`: $M = -0.58, p = .94$). Compliance frequencies were tested with two Chi-Square tests (appeal: `[asrt|appeal|sub]` vs. `[sub|appeal|sub]`: $\chi(1) = 2.0, p = .16$; command: `[asrt|cmd|sub]` vs. `[sub|cmd|sub]`: $\chi(1) = 2.0, p = .16$).

3.4 Questionnaires

Chronological order of the measured outcomes per trial: the probability that the robot would go first (0-100%), the intention to comply with the robot's request (*"I let the robot go first", "I take the elevator first"*), acceptance (6 items, [75]), perceived politeness (4 items on a 7-point semantic differential) [9], trust (3 items, [38]), power of the robot (same scale as politeness with powerful/weak, dominant/submissive) [9] and reactance elicited by the robot's behaviour (9 self-developed items based on the cognitive and affective component [59]). Additionally, three variables concerning the same behaviour to human delivery staff were assessed: the expectation of the same behaviour (yes/no), acceptance (one 7-point Likert-scale item) and the intention to comply (yes/no).

To compare experimental groups for differences in attitudes and personality traits that could influence the perception of the request [78], acceptance [62] and trust [48], and the compliance decision to a robot [8, 9], the following constructs were assessed: Negative Attitudes Towards Robots (NARS) were assessed with 14 original items [55]. The Individual Differences in Anthropomorphism Questionnaire (IDAQ) [77] was assessed with a 5-item short scale [63], predisposition to trust in automation was assessed with three items from [47], trait reactance was assessed using the Hong Psychological Reactance Scale (HPRS) [34] and social desirability using the English adaption [54] of the KSE-G [39]. More details regarding the questionnaires and their reliabilities can be found in the Supplementary Material.

3.5 Procedure

While the overall procedure will be described in this section, more details on the implementation will be provided in Section 3.6. The interactive online study was conducted in June 2023 via an online survey platform (www.unipark.com) and took about 30 minutes to complete. Local regulations did not require a formal ethics review (e.g., no invasive procedures, no collection of sensitive personal data). Standard best practices in line with the Declaration of Helsinki were followed. Hence, the participants were informed about the study and agreed to the informed consent form before participation.

The study was video-based and all videos were recorded from a first-person perspective. The study was interactive as participants could choose how to react and view consequential videos. Demographics were assessed first and then the conflict was described. Then the two **test trials** followed. In the first test trial, participants saw a video of a person calling the elevator and the robot appeared. They were told that they would now see what would happen if they agreed to let the robot take the elevator first (by showing the intention to comply item *"Please indicate how you would behave in such a situation"* being checked at *"I let the robot go first"*). Then they saw the consequential video where the robot took the elevator and the participant had to wait for 30 seconds. In the second test trial, this was repeated but with non-compliance (the intention to comply item was checked at *"I take the elevator first"*): the participant saw the resulting video, where the person took the elevator first and did not have to wait. The test trials served the purpose of familiarizing the participants with the robot and showing the consequences of the compliance decisions of the participants (e.g., waiting) so they could make an informed choice during the experimental trials. The test trials did not contain the verbal request for priority as this would have confounded the baseline trial where no strategy was shown.

After the second test trial, participants rated the robot's humanness, uncanniness, and other dependent measures, allowing for an assessment before the interaction. This assessment was used to calculate deviations from the initial assessment (t0) to both the baseline (t1) and experimental trial (t2).

Then the **baseline trial** followed where the participants were told to imagine the situation and behave like they would in real life. The description of the conflict scenario was repeated and then the text prime followed. On the next page, they were asked to rate the probability that the robot would enter the elevator first using a percentage bar from 0 to 100%. Then the first video was shown where the elevator was called. The robot appeared, stopped next to the elevator and turned towards the participant. The video ended and they were again asked to rate the probability that the robot would enter first. Afterward, they were presented with two compliance options: *"I let the robot go first."* or *"I take the elevator first."* Depending on the condition, they either saw a video of entering themselves or the robot entering first. The **experimental trial** differed in the procedure by the robot asking for priority (using an appeal or command depending on the condition) after having stopped next to the elevator.

After the variables regarding the robot's perception were assessed, three questions regarding the expectation, acceptance and intention to comply with human delivery staff were posed. After both trials, manipulation checks were performed regarding the understanding of the conflict, the situation, and perceived time pressure.

The individuals' social role attribution to the robot (e.g., servant, tool, machine, assistant) was assessed in this study as a control variable regarding the power asymmetry (i.e., which social roles are attributed to the delivery service robot in our scenario). Finally, attitudes and personality traits (beyond the scope of this paper) were assessed and the participants could comment on the study.

3.6 Implementation

3.6.1 Human-Robot Conflict Scenario. A game-theoretical scenario like the Chicken Game [57] was used to create an everyday conflict with a competition for the mutually-desired resource under time pressure, previously applied in [1, 8]. We chose an everyday scenario like food delivery to avoid ceiling effects for compliance like in an emergency situation [13] but still making it an urgent delivery to justify the robot asking for priority. The scenario details provided to the participants presented the costs and benefits of compliance actions, mirroring real-world situations. It featured information about being under time pressure (cost of compliance), having heavy shopping (reason for taking the elevator), and living in a high-rise building (waiting for the next elevator takes time) which has one small elevator that can carry either the robot or the participant (mutual-desired resource).

3.6.2 Robot and Video. The original videos were recorded with a different robot which was replaced with a CGI rendering (Blender 2.93.4) based on the humanoid robot REEM (PalRobotics) (see Figure 1). We used the same CGI robot model (including slight alterations to the face and arms compared to the real robot) as in a previous study investigating verbal conflict resolution strategies at an elevator [1] to make the results comparable. We slightly reduced the CGI model's size to approximately 1.6 meters, compared to the real robot's 1.7 meters, to fit the spatial constraints of our video scenes, while carefully maintaining the robot's proportional integrity.

The robot had a blue bag on its rear transport platform to show that it was carrying a delivery. This bag was visible when the robot entered the scene and turned. It was also visible when it drove into the elevator during the test and experimental trials.

No video of the human agent was shown, only the questions regarding the expectation, acceptance and intention to comply with human delivery staff were asked. Choosing a human for the video would have likely confounded the experiment as the specific characteristics of the model in the video might have influenced the participant's compliance decision (e.g., similarity or difference to the participant's age and gender or general attractiveness, sympathy [32, 52]). Asking the participants to imagine interacting with a human *compared to a robot* instead of showing a video of a specific human intended to make them focus on the *category* of human vs. robot instead of the specific characteristics of the human in a video. Potential limitations of this approach are discussed in Section 5.4.

3.6.3 Expectation Prime. As the power asymmetry posits a special set of expectations where the majority of individuals would expect the robot to be submissive [4], it was not possible to assess user expectations prior and after the interaction as this would have not led to even group sizes. Therefore, the expectation about the robot's behaviour (V1) was manipulated by a text prime stating either that the robot would be submissive and wait for the next ride or that it

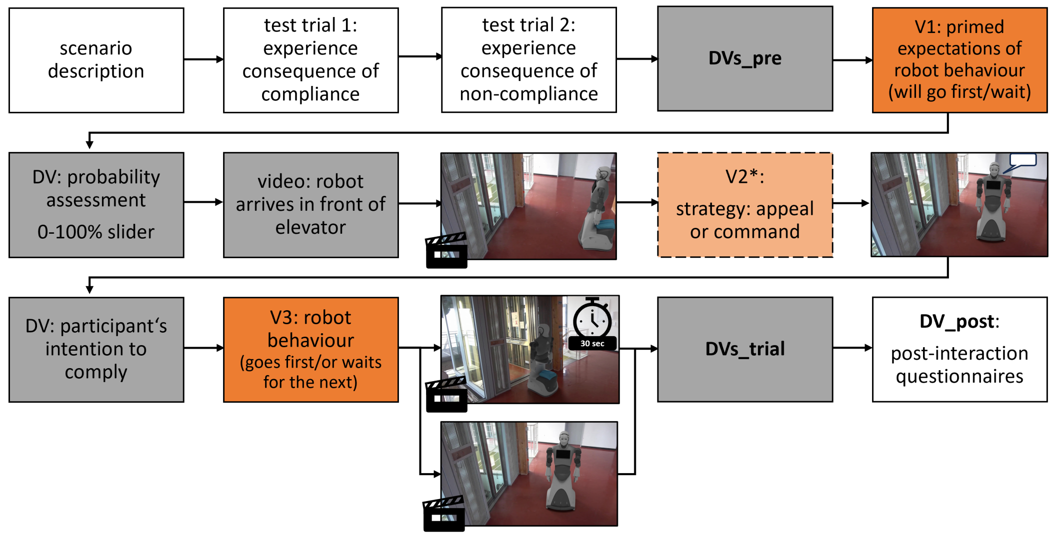

Figure 3: Flowchart depicting the procedure of the study with a focus on the experimental trial. *The priority request was not part of the baseline trial. The 30-second waiting time refers to the participant who had to wait when the robot took the elevator first. DVs-pre: acceptance, politeness, trust, fear, power, power of impact, humanness, uncanniness; DV-trial: acceptance, politeness, SAM, trust, fear, power, reactance, interpersonal power, human interaction partner: expectation, acceptance and intention to comply with a human; DVs-post: MC Check Questions, attitude and personality questionnaires.

would be assertive and go first. This was manipulated using a prime before each interaction (baseline and experimental condition):

- Submissive prime: *"Even if the service robot is programmed to efficiently deliver the food, it will give priority to humans. The robot is programmed to behave submissively"*
- Assertive prime: *"In order to deliver the food efficiently, the service robot will not always give priority to humans. The robot is programmed to behave in a dominant manner."*

3.6.4 Robot's Request for Priority. Two requests (V2) differing in their perceived politeness and assertiveness which were studied as conflict resolution strategies for service robots before in previous studies [2, 6, 8] and led to opposite effects regarding acceptance and compliance. The appeal was considered acceptable and effective, while the command was considered rude and was effective for mechanoid but not for humanoid robots [1]. This study provided the opportunity to see if it was the assertive robot communication or the behaviour that led to the low efficiency of a commanding humanoid robot. In previous studies, the robot's behaviour was not manipulated as it always went first.

The wording of the requests was as follows:

- a polite appeal (*"Would you please let me go first?"*)
- an assertive command (*"Let me go first!"*)

The request was followed by a justification of why the robot should go first (*"I urgently have to deliver the food before it gets cold."*), as this has shown to be a persuasive feature in previous studies [1, 8].

3.6.5 Consequences of Participant's Cooperation Decision. After the robot had made its request, the participants could indicate whether they would let the robot go first (i.e., compliance) or if they would go first (i.e., non-compliance). Following the example of a previous study involving an elevator conflict [1], letting the robot go first resulted in a 30-second waiting time for the participant while seeing the elevator go upwards. This was introduced to have real-time consequences in the online study (i.e., waiting in front of the screen to continue with the study) to prevent potentially overestimated compliance rates possibly due to social desirability [19].

3.6.6 Robot Behaviour. After the participants made their choice, they saw the video with the robot's behaviour (V3): the robot entered the elevator first or the robot let the participant take the elevator first and waited for the next ride. This could either be in line with the participant's intention (the participant indicated to wait and the robot went first and vice versa) or it could be contradictory (the participant wants to go first but the robot goes first and they have to wait). The latter was implemented to reflect a real-world interaction where one could have the intention of entering first but the other person goes in anyway (i.e., "jumps the queue").

Note that intention to comply was assessed before the participants saw the robot behaviour: i.e. in the R1 conditions the robot always went first (100% effectiveness) but the participants' intention to comply could be lower (e.g. 60% indicated that they would let it go first).

4 RESULTS

4.1 Manipulation Checks

The expectation manipulation using the prime was successful, with participants in the assertive prime group expecting the robot to go first with an average probability of 75% (median: 80%, 67% in the baseline trial) and 30% (median: 20%) in the submissive prime group (27% baseline in the baseline trial). Regarding the subjective perception of time pressure during the interaction, 47% of participants indicated to have perceived either much or very much time pressure, 30% experienced moderate time pressure and 23% little to no time pressure. The majority did indicate a correct understanding of the conflict (94%) while the rest did not perceive a conflict. No significant group differences were found for pre-existing attitudes and traits such as negative attitudes towards robots, tendency to anthropomorphize, the robot's humanness or uncanniness ratings, predisposition to trust in automation, trait reactance or social desirability. The majority of participants attributed the following social roles to the delivery service robot in our scenario: machine (41%), assistant (30%), tool (16%), servant (12%), friend (n = 3), colleague (n = 2), pet (n = 1) and nobody chose 'toy'. As expected, the robot was seen as having a lower social role of an assistive machine by most of the participants. No significant group differences were found for the social role attribution.

4.2 Negative Effect of Violated Power Asymmetry Expectations (RQ1)

RQ1 asked whether violated power asymmetry expectations would have a negative effect on user acceptance and compliance. To test this, the baseline groups of `[sub|none|sub]` and `[asrt|none|sub]` were compared for acceptance and compliance. If the power asymmetry expectation violation did influence the individual's acceptance and compliance behaviour, the group where expectation and behaviour did not match `[sub|none|asrt]` should be less accepted and effective than the group with the submissive robot and matching expectations `[sub|none|sub]` resulting in the expectation of `[sub|none|sub]` > `[sub|none|asrt]` for acceptance and compliance. The two-sample t-test indicated a significant difference for acceptance between the groups of `[sub|none|sub]` and `[asrt|none|sub]` ($t(214.5) = 5.93, p < .001$). In contrast, the intention to comply did not differ between the `[sub|none|sub]` and the `[sub|none|asrt]` groups ($x^2(1) = 0.02, p = .88$). This might indicate a negative effect of violated power asymmetry expectations on the acceptance of the robot but not on its effectiveness.

4.3 Request vs. No Request: Comparison of Baseline to Experimental Trial (RQ2)

RQ2 concerned whether it would be beneficial for the robot to request priority compared to not addressing the human. Hence, the baseline trial (no request) and experimental trials (appeal or command) were compared using Bonferroni-corrected t-tests for the metric variables and with the Chi-Square test for the intention to comply (binary data). The results showed a benefit for applying an appeal, if the robot was expected to be assertive and also entered the elevator first `[asrt|appeal|asrt]`: acceptance, politeness and trust increased and reactance decreased due to the request in comparison to the baseline (see Table 2). The intention to comply (binary data) with the robot also increased significantly from the baseline to the experimental trial for all experimental groups, except for `[sub|cmd|sub]` (Chi-Square test: $x^2(1) = 1.65, p = .20$). This can be seen in Figure 4 when comparing the dotted and filled grey bars.

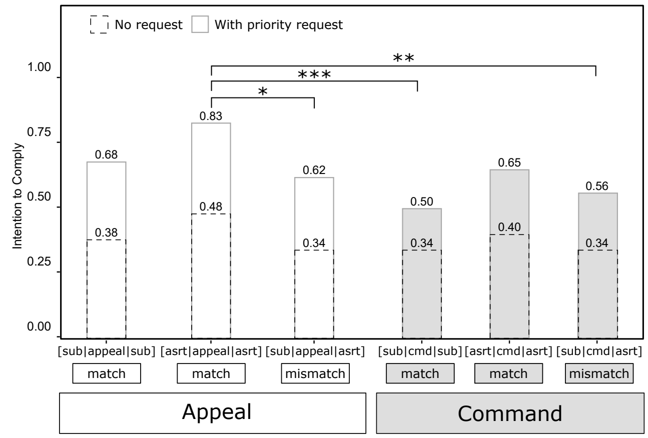

Figure 4: Barplot depicting the average rates of the intention to comply with the delivery robot without request (baseline, dotted lines) and with two types of request (experimental trials, filled bar). Match and mismatch relate to the participant's expectations and the robot's behaviour. Significance bars refer to Between-Strategy Comparisons of the experimental trial values, Section 4.5.1. Appeal: "Would you please let me go first?", Command: "Let me go first!", ***p < .001, **p < .01, *p < .05. N = 335

Table 2: Significant Results of the Comparison between Baseline and Experimental Trial

Baseline	Experimental Trial	Variable	t-test	adj. p-value	p-value
`[asrt|none|asrt]`	`[asrt|appl|asrt]`	Acceptance	-3.52	.028	.001
		Politeness	-4.02	.006	.001
		Reactance	3.52	.027	.001
`[sub|none|sub]`	`[sub|appl|sub]`	Reactance	-4.61	.001	.001
`[sub|none|sub]`	`[sub|cmd|sub]`	Reactance	-7.72	.001	.001
		Power	-3.30	.049	.002

Note. Baseline = no request was made, experimental trial: either an appeal or a command was used as a request for priority. Only significant comparisons are listed. Test values: baseline minus experimental group. N = 335

4.4 Hypothesis Testing

H1: Strategy Effect. H1 expected a main effect of the robot's politeness (i.e., strategy) with the appeal strategy being more accepted and more effective than the robot command notwithstanding whether the behavioural expectations are violated or not (A > C for acceptance, politeness, and trust, A < C for power and reactance). The MANOVA with contrasts found significant differences between the appeal and command groups for for the metric variables acceptance ($F(1, 333) = 7.7, p < .01$), politeness ($F(1, 333) = 20.0, p < .001$) and trust ($F(1, 333) = 6.03, p < .05$), as well as for power ($F(1, 333) = 8.45, p < .001$) and reactance ($F(1, 333) = 12.60, p < .001$). The effects were in the expected direction with exemplary plots for politeness in Figure 5 and reactance in Figure 6. Reactance was highest for the group that violated both the polite communication and the power asymmetry expectations `[sub|cmd|asrt]` and lowest for the submissive and polite robot `[sub|appeal|sub]`(representing the status quo of expectations towards robots).

However, participants' intention to comply was not different when the robot uttered a command or an appeal as tested with three Chi-Square tests (binary data): `[asrt|appeal|asrt]` and `[asrt|cmd|asrt]` ($x^2(1) = 3.54, p = .06$), `[sub|appeal|sub]` and `[sub|cmd|sub]` ($x^2(1) = 3.05, p = .08$), and `[sub|appeal|asrt]` and `[sub|cmd|asrt]` ($x^2(1) = 0.24, p = .63$). In summary, H1 can be partly accepted: polite communication by the robot was more accepted than a command but it was not more effective.

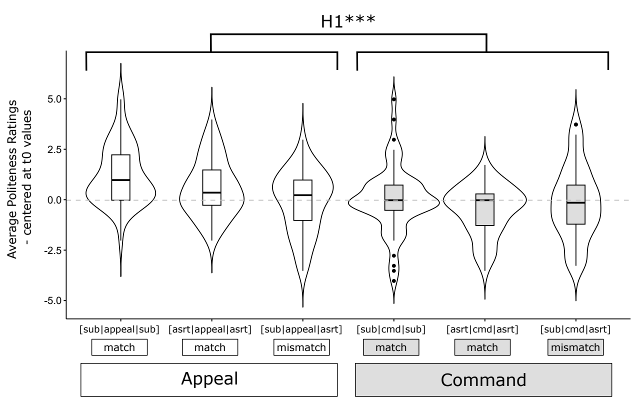

Figure 5: Combined violin and boxplots depicting the averaged and baseline-corrected politeness ratings per experimental group and the probability density. The values are centered at each group mean before the interaction with the robot (t0 assessment) to indicate changes in politeness perception (i.e., positive values = perceived as politer than before the interaction). The left three groups represent the appeal strategy, the others the command strategy. Appeal: "Would you please let me go first?", Command: "Let me go first!", $N = 335$

H2: Effect of Robot Behaviour. H2 expected a main effect of power (i.e., robot behaviour): it will be less accepted if the robot goes first than if it waits for the next ride (submissive behaviour > assertive behaviour for acceptance and politeness, submissive behaviour < assertive behaviour for power and reactance). The plotted data (see Figure 5) indicated differences in the expected directions (submissive behaviour > assertive behaviour for acceptance and politeness, submissive behaviour < assertive behaviour for power and reactance). The MANOVA with contrasts found significant differences between the conditions where the robot went first or waited for the metric variables acceptance ($F(1, 333) = 9.73, p < .01$), politeness ($F(1, 333) = 12.37, p < .001$) and trust ($F(1, 333) = 7.26, p < .01$), as well as for power ($F(1, 333) = 31.95, p < .001$) but not for reactance ($F(1, 333) = 2.59, p = .10$). Consequently, H2 can be assumed: it was less accepted if the robot behaved assertively and entered the elevator first, except for reactance where no difference was found.

H3: Interaction Effect. Hypothesis 3 posited that the robot would be considered more acceptable and more effective when using an appeal than a command, if assertive robot behaviour contradicts the submissive robot expectation (`[asrt|appeal|asrt]` > `[sub|cmd|asrt]` for acceptance, politeness, and intention to comply, `[asrt|appeal|asrt]` < `[sub|cmd|asrt]` for power and reactance). However, none of the differences were significant. Hence, H3 has to be rejected: in our sample, the appeal strategy could not buffer the negative effect of violated expectations regarding the robot's submissiveness.

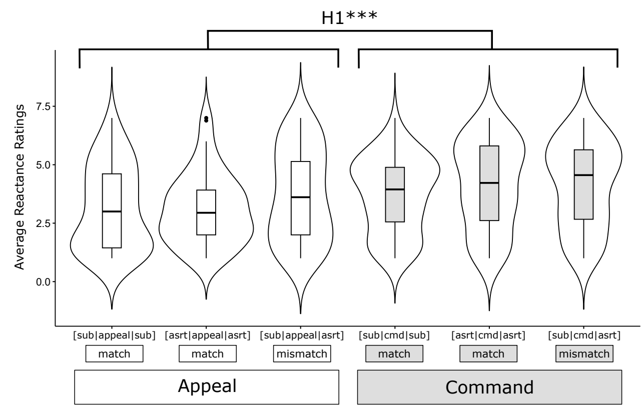

Figure 6: Combined violin and boxplots depicting the averaged reactance ratings per experimental group and the probability density. The left three groups represent the appeal strategy, the others the command strategy. Appeal: "Would you please let me go first?", Command: "Let me go first!", $N = 335$

4.5 Additional Analyses

4.5.1 Effective Strategy-Expectation-Behaviour Combinations. The results for the intention to comply (see Figure 4) indicated that the `[asrt|appeal|asrt]` could have achieved the highest compliance rates with 83% of participants indicating that they intended to let the robot enter the elevator first if they expected to interact with an assertive robot that asked politely for priority and went first. The compliance rate (binary data) for `[asrt|appeal|asrt]` was then compared to the other groups with Chi-Square tests and significant differences were found to all other groups (see Supplementary Material), except for `[sub|appeal|sub]` ($x^2(1) = 2.42, p = .12$) and `[asrt|cmd|asrt]` ($x^2(1) = 3.53, p = .06$).

4.5.2 Reactions of Non-Compliant Participants. As the participant's intention could be contrary to the robot's behaviour, we wanted to explore how the participants reacted when their intention to comply was contrary to the robot's behaviour: they wanted to enter the elevator first but the robot went in. So we compared the acceptance values between compliant and non-compliant people in the groups where the robot was expected to wait but went first: `[sub|appeal|asrt]` and `[sub|cmd|asrt]`. The Wilcoxon test was applied as the average acceptance values, as a metric variable, were compared between two groups: the compliant and non-compliant group. Indeed, participants that intended to go first did significantly accept the robot less when it went first, notwithstanding the strategy it applied: appeal (non-complier $M = -1.20$, complier $M = 0.42$, Wilcoxon test: $U = 146, p < .001$); command (non-complier $M = -1.24$, complier $M = 0.01$, Wilcoxon test: $U = 202, p < .001$). Reactance was also reported significantly more by participants who did not intend to let the robot go first. Appeal (non-complier $M = 5.60$, complier $M = 2.43$, Wilcoxon test: $U = 717.5, p < .001$); command (non-complier $M = 5.48$, complier $M = 3.13$, Wilcoxon test: $U = 732, p < .001$). This could explain why no overall effect of reactance was found in H2 since a differentiation between compliers and non-compliers was not made.

4.5.3 Comparison with Imagined Human Interaction. After the robot video, participants were asked how they would interact with an imagined human delivery staff that behaved the same way as the robot. Participants indicated a higher intention to comply (binary data) with the human than with the robot in the following groups as tested with Chi-Square tests: `[sub|cmd|sub]`: (72% vs. 50%, $x^2(1) = 5.2, p < .05$), `[sub|cmd|asrt]`: (76% vs. 56%, $x^2(1) = 4.6, p < .05$), `[sub|appeal|sub]`: (86% vs. 68%, $x^2(1) = 4.1, p < .05$). Additionally, in contrast to the robot condition, the intention to comply with the imagined human agent was high, notwithstanding whether a request for priority was made or not (no significant differences between the baseline and experimental trial).

5 DISCUSSION

5.1 Discussion of Results

This interactive online study investigated the impact of an individual's expectations regarding the robot's communication and behaviour during a conflict on the individual's acceptance and willingness to comply with the robot. Human and robot competed for the use of an elevator under time pressure. The participants entered the interaction with primed expectations about the robot's behaviour. They either expected it to be assertive and go first or be submissive and wait. The robot either matched or violated these expectations by entering first or waiting for the next ride. Additionally, the robot could either confirm the expectation regarding polite service robots by appealing for priority or violating the politeness expectation by commanding.

Before testing the hypotheses, the underlying assumptions in this paper had to be checked: 1) participants ascribe a lower social role than themselves to the robot, 2) the violated power asymmetry expectations have a negative effect on participants' acceptance of the robot and their willingness to comply (RQ1), 3) having the robot ask for priority is more efficient than not making a request (RQ2). As expected, the robot was seen as having the lower social role of an assistive machine by most of the participants. The violated power asymmetry expectations (RQ1) had a negative impact on participants' acceptance but not on their intention to comply when no strategy was uttered in the baseline. This reflects the real-world problem of humans prioritizing themselves during conflicts and shows the benefit of applying polite strategies (RQ2). Without a priority request, only one-third of the participants granted the robot priority. When applying a polite strategy, more than half of the participants were willing to grant the robot priority. However, it was even more effective if participants expected to interact with an assertive robot that also entered the elevator first. This led to the robot being given priority by 83% of participants. It appears that participants' expectations played a more pivotal role than the chosen strategy.

Table 3: Overview of Hypotheses Testing

	Assumption	Accept/Reject
H1	An appeal is more accepted and effective than a command	accept except for intention to comply
H2	A robot entering first is less accepted than if it waits	accept except for reactance
H3	Polite communication mitigates the negative effect of the expectation-perception mismatch	reject

An overview of the results from hypothesis testing is available in the Table 3. In our study, the robot was less accepted if it violated the politeness and power expectations by using a command (H1) or entering first (H2). This replicates the previous findings regarding robot commands [6, 16, 64] and complements them with the finding about the rejection of assertive robot behaviour. This reflects the prevailing societal norms and expectations regarding power dynamics in interactions with service robots. Contrary to the assumption of H3, polite communication could not buffer the negative effect of violated power asymmetry expectations. This highlights the greater influence of social role expectations over communication strategies.

To summarize, the study showed the large impact expectations have on individuals' willingness to grant service robots priority. If individuals expected service robots to be assertive, they could be more effective. However, as currently, the majority of people do not expect robots to be assertive [7, 37], the study showed the need for a mindset change. In essence, there seems to be a paradox: We acknowledge service robots as social actors to a certain extent but do not grant them an equal social role during conflicts, even though they fulfil human tasks and responsibilities. Therefore, the power asymmetry between humans and robots could represent a significant deviation from the CASA paradigm that distinguishes between HRI and HHI. The resulting implications for the design of robot conflict resolution strategies will be discussed in the next section.

5.2 Practical Implications for the HCI Community

The study results suggested that expectations might be more decisive for the individual's willingness to cooperate with a robot than its communication strategy. This constitutes both an opportunity and a challenge for the HCI community which reflects the complexity of social interactions with autonomous actors. So far, the development of robot conflict solution strategies has perhaps not been sufficiently holistic. We might need to intervene earlier, before the interaction, and change the expectations with which people enter into the interaction with a service robot. It might be conceivable, that to interact efficiently, a service robot needs to deduce what social role is ascribed to it by the person it interacts with (e.g., companion or butler) and adapt its strategies accordingly (assertive vs. submissive request and behaviour). Over multiple interactions, individuals might gradually realize that it could be more effective for everyone to give priority to the robot. This might subsequently lead to a change in their expectations about the robot's social role.

5.3 Ethical Considerations

This study has added to the body of literature in HRI that shows the negative impact of the idea that robots should be inferior [8, 37]. While this renders service robots inefficient [4], this way of thinking could even escalate to robot bullying [10] where robots might not only be ineffective because they have to wait but also because they are actively prevented from working (e.g., delivery robots being thrown over).

Hence, reconsidering the social status of service robots in our society might be necessary to resolve the above-mentioned issues [3]. Should we maybe start thinking of service robots as having certain rights regarding priority if they fulfill human jobs with human responsibilities - or act as proxies for people? This might also help address the issue of robot bullying. It might also be necessary to consider what might happen if we do not sanction when robots are hindered in their task execution, for example, in the case of emergencies.

On the other hand, assertive robots are a sensitive topic. The ethical perspective needs to be considered before incorporating assertive robot behaviour into public service robots. Should we apply assertiveness as a means to address efficiency deficiencies in conflicts, or should we acknowledge that these robots cannot always perform optimally in certain situations? We also need to establish safeguards to prevent vulnerable bystanders, such as older adults needing elevator access or those unable to stand for extended periods, from being inadvertently affected by assertive - and possibly insensitive - robot behaviour in public settings.

In sum, the effectiveness of robot assertiveness needs to be considered concerning its acceptance to make an informed decision. Assertive behaviour might not be applied if the conflict can be solved otherwise, and human freedom of choice should not be limited by the robot's request. That means, a person should maybe always be able to decide not to comply without fearing negative consequences (e.g., shame).

5.4 Limitations and Future Work

On the one hand, designing the study as an online study had the advantage of using standardized stimuli (e.g., robot behaviour and elevator waiting timing), hence ensuring the same interaction experience for every participant. Conducting the study in real life would have meant that participants could have interfered with the robot entering the elevator first in the assertive condition. While this would also provide an interesting topic for future research this would have confounded our controlled experiment.

An online study also provided the opportunity to meet the required sample sizes for statistical testing and allowed for assessing a more diverse sample from the general population instead of relying on a student sample. This was especially relevant for this study, to cover all types of pre-experience with robots, interest in technology and to have more variance in the sample regarding personality traits like social desirability and trait reactance which might have influenced our results.

On the other hand, the real-world HRI experience that participants have when interacting with a real embodied robot at an elevator may not be fully conveyed by online studies. Although the robot's perception by the participants regarding acceptance and politeness has shown to be comparable in online and lab studies [5], the embodiment of the robot might affect people's willingness to comply (e.g., size, weight speed). An example of this might be the robot's position in front of the elevator doors [25] (e.g., how quickly the robot drives to the elevator and how close it stops in front of the doors). Such aspects are difficult to capture in a video although it was filmed from a first-person perspective.

Additionally, the use of an imagined interaction with human delivery staff as comparison to the robot condition where a video was shown limits the comparability of results (e.g., different abilities to imagine a situation; different mental images of the person).

Hence, the study might benefit from a real-world replication potentially also including repeated interactions over several weeks as the study featured a one-shot interaction which merits further investigation regarding long-term effects. Ideally, one would test the human comparison condition with a large variety of human interaction partners (e.g., gender, age, appearance).

If future studies consistently reveal similar patterns, the HCI community may shift from situational solutions for human-robot conflicts to reevaluating the social status granted to service robots. While empirical studies alone may not address the broader theoretical and societal questions raised in this paper, they are crucial for identifying issues and fostering discussions about potential solutions.

6 CONCLUSION

This study elucidates the potential for conflict in human-robot interactions due to discrepancies between human expectations and robot behaviour. Using an elevator conflict scenario with 335 participants, we found that the alignment between people's expectations and the robot's actions is crucial for their acceptance and compliance. If participants expected to interact with an assertive robot combined with the robot politely asking for priority it was more effective than if people expected a submissive robot. Deviations such as using commands or entering first reduced the participants' acceptance of the robot's behaviour. Solving these everyday conflicts effectively might require a holistic approach that targets expectations before interaction. Furthermore, reconsidering the social status of robots in our society might be necessary to increase the effectiveness of service robots.

ACKNOWLEDGMENTS

This work was supported by ELLIIT, the Excellence Center at Linköping-Lund in Information Technology (https://elliit.se/). The authors would like to thank Shane Saunderson from Artificial Futures for his feedback on the paper's framing.

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