# Designing Authoritative Presence in Social Robots

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We define authoritative presence as letting people experience authority through human-made technology in sensory or non-sensory ways. Our goal is to design a robot that creates the impression of possessing capabilities worthy of respect as a source of authority, thereby enhancing compliance without attributing that authority to external sources, such as a specific person or organization. We hypothesized that strategies commonly used in the Wizard-of-Oz method could help manipulate authoritative presence as it strives to ensure that the robot is not perceived as having additional abilities beyond those introduced by the manipulations. Wizards typically need to maintain the robot's functionality and abilities at an appropriate level to minimize unwanted influence on participants' perceptions and interactions. By interviewing HRI researchers who have wizarded, we summarized their usual strategies, and implemented the opposite behaviors in a robot to investigate if this would contribute to authoritative presence. Based on the findings, we designed four behaviors that include (1) let the robot have an open-ended conversation with people, (2) randomize the robot's reaction delay timing, (3) let the robot move with inconsistent velocity, and (4) let the robot perceive people's status without looking at them. To evaluate the impact of these behaviors, we conducted a video-based online experiment with 942 participants, using a between-subjects design. The experiment aimed to determine whether the behaviors conveying authoritative presence would make people perceive the robot as having more authority and increase their likelihood of complying with its requests. A mediation analysis indicated that despite a decrease in perceived authority, the imply authoritative presence condition had a positive effect on participant compliance. Our study formally introduces the concept of authoritative presence, providing a proof-of-concept for how robots can create authoritative presence through specific behaviors. This work lays the groundwork for future research on authority and robotics.

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

Additional Key Words and Phrases: Human-robot interaction, authoritative presence, compliance, authority, presence

## 1 INTRODUCTION

As robots become increasingly integrated into our daily lives, they are taking on more authoritative roles where people are expected to comply with the robots' requests. This need for authority extends beyond formal roles like police officers and security guards to include robots performing everyday tasks. For example, robots may be required to prompt patients to take medication, monitor a food stand, or enforce rules in public spaces

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[25, 52, 61, 76]. However, simply being present is not enough for robots to ensure compliance. If robots are not perceived as conveying a sense of authority, they may be easily ignored or not taken seriously. Previous studies show that a robot asking people to keep a safe social distance was simply ignored [17]. Children were reported to abuse a robot, even though the robot technically delivered requests to them [13, 58]. Such improper behavior and disobedience toward robots not only hinders their ability to perform tasks but can also pose risks to both robots and the public.

To establish the perception of robots as an authority, some works use extrinsically conferred authority. This form of authority is associated with a person who holds a specific identity or granted the right to control others, such as formal [1] or legitimate authority [82]. Researchers often achieve this by assigning robots socially authoritative roles [19, 27, 36] or strongly associating them with specific authority figures [4]. For example, a robot might lead an experiment and prompt participants to follow its instructions [19, 27, 36] or make participants aware of its presence [38]. However, for these robots to be perceived as authoritative, they must first be introduced as a legitimate experimenter or connected to a human authority figure. In another example, an android robot designed to resemble a famous professor serves as an authority figure that people are likely to respect and follow [4]. The robot embodies the identity and achievements of the professor, thereby expressing expert authority. However, since the authority of these robots is externally derived (e.g., from a human experimenter who is the actual authority), their application in general contexts is challenging. Not every robot should be modeled after a specific authority figure or require prior introduction by another authority, especially in real-world field settings.

To address these challenges, we propose the concept of authoritative presence. Drawing inspiration from the definition of presence in communication theory [45], we define **authoritative presence** as "a human-made technology that lets people experience authority in sensory (e.g., sight, sound, smell, feel) or non-sensory (imagination, hallucination) ways". Our goal is to design robots that create an impression of possessing qualities deserving of respect as a source of authority. Unlike extrinsically conferred authority, we expect authoritative presence does not need to be linked to any specific person or organization. It is somewhat analogous to social engineering that leverages robot behaviors to convey authority, but without pretending to represent a particular organization or authority figure (e.g., [12]).

Although some previous studies have explored incorporating authoritative cues from human-human interactions to make robots appear authoritative, such as a low, deep voice [5] and taller height [26, 34], these admonishing or dominant methods have limitations in their applicability. For instance, some robots use low-pitched, dominating voices or physically block people with their arms to direct them to designated exits [2], or they adopt admonishing strategies similar to those used by professional security guards to prevent improper behavior [52]. However, research indicates that simply making a robot taller does not necessarily enhance the perception of authority [6], and not all robots may be able to be made taller. For admonishing or physically blocking behaviors, it may be challenging to apply such approaches in contexts such as education or medical environments, where strong and harsh behaviors may be deemed inappropriate or counterproductive. Instead of relying on authoritative cues or using strategies that might evoke fear, we propose exploring alternative approaches to convey a perception of authority more effectively and context-appropriately.

To explore alternative ways that contribute to robots' authoritative presence, we consider sources of authority beyond aggressive approaches. For example, people were more likely to follow suggestions offered by a robot using linguistic cues of expertise than from a robot that simply listed facts [3]. As AI is often seen as reliable and infallible, people try to involve the information provided by AI in the decision making process [84] or tend to follow its decision [42]. This influence can extend to robots as well [30], even in situations where explicit mistakes are made [83]. Therefore, we explore if a robot that is perceived to have high capabilities could encourage people to follow voluntarily [3, 42], rather than fear of punishment. Moreover, we consider that if a robot exhibits such capabilities, it may also be perceived as being human-intervened or guided by human input. Since people typically show more respect toward human presence compared to robots alone [25], this perception could further enhance the robot's authoritative presence. This notion aligns with psychological theory, which suggests that people are more likely to cooperate and behave prosocially when they feel observed or monitored [9, 59].

To explore ways to control and manipulate the possible authoritative presence from those sources (e.g., the perceptions derived from the robot's high capabilities or human intervention), we consider the Wizard-of-Oz method. While the Wizard-of-Oz method does not explicitly consider authoritative presence, we hypothesize that the Wizard-of-Oz method would unintentionally control authoritative presence related to those sources, particularly by minimizing additional authoritative cues that could affect interactions between the robot and participants.

The Wizard-of-Oz method [21, 31, 71] is widely utilized in HRI and HCI experiments to evaluate prototype systems during the design phase without requiring extensive development time. The method aims to ensure that a human-operated system is perceived as autonomous, with a suitable level of functionality and abilities. Our assumption that the Wizard-of-Oz method might unintentionally control authoritative presence arises from the observations that wizards must carefully manage the robot's social cues during wizarding. These cues can inadvertently influence the perceived authority of the robot. For example, if the robot's conversational abilities and content are not appropriately constrained, it may appear overly clever, highly intelligent, powerful, and possessing certain expertise [3, 30, 42, 81, 84]. Perceiving a robot as having high capabilities may lead to a sense of AI authority, encouraging people to follow its guidance even without concrete evidence of those capabilities [42, 84]. Moreover, participants might also suspect human intervention or monitoring [25], making them more inclined to follow the robot even if they perceive its authority as independent of any specific person or organization. Therefore, while the wizards' actions are not deliberately intended to manipulate authoritative presence, we suggest they may implicitly attempt to control it to minimize their impact on the experiment. This cautious approach is likely aimed at maintaining experimental neutrality and preventing unintended influences on participant behavior.

Though many works have discussed techniques for conducting the Wizard-of-Oz method, it remains unclear which of these techniques have the potential to help control robots' authoritative presence. Therefore, we aimed to investigate potential strategies by interviewing experienced HRI researchers. Our goal was to establish an authoritative presence in robots by implementing strategies that contrast with those typically used by wizards to minimize unwanted influence.

In this study, we first interviewed HRI experimenters about their Wizard-of-Oz strategies. Based on the insights gained, we designed robot behaviors aimed at demonstrating authoritative presence. Next, we conducted a video-based online study where participants watched videos of a Pepper robot displaying these behaviors. To assess whether the behaviors conveyed a stronger sense of authoritative presence, we measured the number of requests participants complied with when the robot instructed them to perform tasks that would typically an authority figure could require. Our findings revealed that participants tended to follow the requests more when using our behaviors to imply authoritative presence, even when they reported a weaker sense of perceived authority. We further analyzed potential reasons for this outcome and used these insights to refine our strategies for authoritative presence. This might suggest that authoritative presence—the perceived sense of authority conveyed through specific behaviors—can encourage compliance even people do not perceive it as true authority, which involves a legitimate right to direct or make decisions.

## 2 RELATED WORK

### 2.1 Authority and Authoritative Presence of Robot

To enhance motivation to follow a robot, various studies have focused on designing robots to function as formal or legitimate authority figures, based on the principle that people tend to obey such figures in human-human interactions [35, 51]. Since formal [1] or legitimate authority [72] is typically associated with a person or organization that possesses a specific identity, this type of authority generally needs to be conferred extrinsically. As a result, it is necessary to introduce the robot's identity in a way that clearly establishes its authoritative role.

An android robot designed to resemble a famous professor successfully conveyed the professor's authority, prompting participants to perform questionable acts such as retrieving a USB key from a hidden box or shredding documents. However, this effect relied on participants having prior knowledge of the professor's achievements and being convinced of the robot's credibility [4]. Similarly, an experimenter robot has been employed to encourage participants to follow its instructions, leveraging the concept that an experimenter is a social authority figure in a research setting. This robot effectively made participants continue tedious data labeling tasks, even when they expressed complaints or resistance [19]. A follow-up study found consistent results, demonstrating that participants continued to perform monotonous tasks under the robot's commands, although no significant effect was observed from the robot's embodiment or perceived autonomy [27]. Robot coaches have been shown to motivate participants to persist in practicing difficult tasks [64], regardless of the robot's human-likeness or embodiment, even after participants expressed a desire to quit [36]. Embodiment can also affect authority and compliance in robot customer service scenarios, though this may be linked to stereotypes [16]. Furthermore, a robot with an expressive head, introduced as an instructor and positioned in the same room as a human, was found to promote honest behavior [38]. In all these cases, the robots needed to be explicitly introduced as an experimenter or coach by a human researcher. Their authority was not inherent but rather conferred through an external source—namely, a human authority figure.

Another research direction in the field of human-robot interaction focuses on investigating the effects of robots' authoritative cues on people's compliance. These studies have mainly focused on specific scenarios and on modeling the behaviors of a specific authority figure. One example is a patrolling robot designed to stop people from using smartphones while walking. This robot employed an admonishing technique modeled after the behavior of a security guard when approaching pedestrians. At the end of its approach trajectory, the robot took a shortcut, abruptly positioning itself in front of the pedestrian to confront them directly [52]. In another study, a robot used aggressive techniques to direct people to an alternative exit route from a building. The robot followed people closely, spoke in a low-pitched, dominating voice, and even opened its arms to physically block their path, reinforcing its authority through physical presence and vocal dominance [2].

Beyond linking robots to specific authoritative figures or employing harsh authoritative cues, some studies highlight robot features that may contribute to authoritative presence. A robot equipped with monitoring and patrolling capabilities made about 90% of participants aware of its presence and discouraged arbitrary food taking. However, the effect was weaker compared to a human who merely sat quietly without actively monitoring or patrolling. Additionally, around 10% of participants still took food despite being aware of the robot's surveillance. Despite these limitations, the study suggests that robots have the potential to monitor the public [25].

Since AI authority and algorithmic authority can prompt compliance without requiring direct evidence of capabilities [42, 84], this influence may extend to robots as well. In one study, researchers examined the effect of decision-making authority in human-robot and human-only teams. They found that participants were inclined to rely on the robot worker and preferred to cede control authority to the robot equipped with advanced scheduling algorithms [30]. These findings suggest that robot capabilities, such as the movement pattern, and decision-making ability, may foster a sense of authoritative presence, even when not explicitly linked to a specific human authority figure.

## 2.2 Wizard-of-Oz and HRI experiment

The Wizard-of-Oz method is widely used in the HRI field for testing prototypes efficiently, minimizing development time. The primary goal is to create a human-operated system that is perceived as autonomous. Over the past several decades, Wizard-of-Oz techniques have been developed and refined to help operators facilitate smooth interactions with participants. These techniques have been applied to simulate a wide range of interactions, including natural language processing, nonverbal behavior, navigation, manipulation, and sensing (e.g., [4, 19, 27, 63, 67, 69, 73]). Some researchers have also developed custom tools to support the Wizard-of-Oz process, such as hot keys or GUI menus for quick responses [21, 23, 31], or have involved multiple wizards simultaneously to improve the stability of response time [68]. Some systems are operated based on pre-defined scripts and motions to streamline interactions [48]. To reduce the likelihood of a robot encountering unexpected situations where it cannot respond properly, the system is often triggered only when participants perform designated actions [69]. This approach helps maintain controlled and consistent interactions, preventing errors that might arise from unanticipated participant behavior.

## 3 DESIGN: BEHAVIORS IMPLYING AUTHORITATIVE PRESENCE

### 3.1 Interview

We considered when wizards conduct the Wizard-of-Oz method, they have to control the robot's functionality and abilities to an appropriate level [22, 39, 46], aligning with the expectations of typical people. If not carefully managed, the robot may be perceived as less than fully autonomous, exhibiting high intelligence that appears to stem from human control or advanced technology. It might also display human-like behaviors that are atypical for a machine, potentially fostering compliance [3, 30, 42, 78, 81, 84]. We assumed that these perceptions could enhance authoritative presence, as the robot's behavior might be interpreted as reflecting authority derived from perceived human involvement or advanced capabilities.

To investigate this, we conducted interviews with HRI researchers to understand their strategies for mitigating these perceptions when employing the Wizard-of-Oz method. We focused on four key questions aimed at identifying strategies to avoid suspicion of teleoperation, rather than directly addressing authority or authoritative presence. This approach was taken because the idea that Wizard-of-Oz behaviors may contribute to authoritative presence is based on our own assumptions:

*Question 1*: Describe a recent HRI experiment you performed when using the Wizard-of-Oz method.

*Question 2*: What strategy did you use to prevent participants from realizing that the robot was being controlled by someone?

*Question 3*: Have you ever encountered participants who attempted to determine whether the robot was being controlled by someone? If yes, what behaviors or actions did they exhibit?

*Question 4*: In your experience, under what circumstances do you think participants are most likely to suspect that the robot is being controlled by someone?

We recruited 11 researchers from university labs and research institutes across Japan, Taiwan, Canada, and the United States. The participants included three master's students (P1, P2, P5), five Ph.D. students (P4, P6, P7, P8, P11), and three researchers (P3, P9, P10). Each interview lasted approximately 30 min.

### 3.2 Interview Results

We applied thematic open coding on the interview results to identify overall themes and classify the researchers' responses. Comments from P4, P5, P7 were translated from Chinese.

The researchers utilized the Wizard-of-Oz method in three main scenarios:

1. Robot delivering instructions to participants (P1, P3, P11)
2. Robot engaging in conversations with participants (P2, P9, P10, P11)
3. Robot mediating between participants and their tasks (P6, P7).

In addition to these primary scenarios, researchers also applied the method in specific tasks such as admonishing people (P3), judging the positions of a topic in a discussion (P5), facilitating human-robot collaborations (P8), and entertaining people in a public space (P4).

Despite the diversity of scenarios, the researchers' techniques for regulating the robot's behavior can be categorized as follows:

1. Limiting the robot's conversation and response abilities (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11)
2. Ensuring the robot's reply delay is short and consistent (P2, P4, P5, P8, P9, P11)
3. Maintaining a consistent movement pattern for the robot (P3, P4)
4. Limiting the robot's sensing ability (P4, P5, P7)

We discuss each of these four techniques in detail in the following sections.

*3.2.1 Limiting robot's conversation and response abilities.* When a robot interacts with participants, researchers usually set strict rules or protocols to limit its conversation and response abilities aiming to avoid detection of human control. One common strategy is to use pre-defined scripts, which help researchers simplify conversations and ensure that interactions remain focused on the experimental topics. Five researchers mentioned that they would select the most appropriate statement from their scripts when responding to participants. For instance, P7 described how she chose a sentence from her pre-defined scripts according to a reply rule:

> I would choose the best-fit answer even if in some cases it didn't 100% fit the scenario. It might make the participants feel a little bit strange, but I had to stick to the operation rules. — P7

This situation often arises when participants attempt to engage in random conversations or test the robot's conversational abilities. Even in such cases, using pre-defined scripts helps researchers prevent the dialogue from becoming open-ended.

> If participants asked weird questions not related to the experiment, I would let the robot reply by using the pre-defined sentence "Sorry, I don't understand." — P8

> When participants said something unexpected, I still used feedback from the pre-defined scripts without typing up a more suitable reply. — P9

> I would try to keep the conversation on the current topic by having the robot say "We can talk about this later. Let's continue with the task." — P11

When we asked the researchers about what might make participants to suspect that the robot was being controlled (Question 4), several mentioned that free-form conversations could increase the likelihood of detection. They felt that when robots engage in open-ended dialogue, participants are more likely to recognize whether the responses come from pre-defined scripts or human intervention. P10 shared that she sometimes accidentally made the robot's responses closely match the participant's questions, which made the robot appear quite intelligent. As a result, some participants suspected that the robot was being controlled by someone, although they were not entirely certain. To minimize this risk, researchers emphasized the importance of carefully defining the robot's capabilities and responses. By maintaining the robot's interactions at a simple and consistent level, they avoid creating the impression of higher human-like intelligence. This strategy helps maintain the illusion of autonomy and simple robot intelligence and prevents participants from detecting the wizards' presence behind the scenes.

*3.2.2 Ensuring the robot's reaction delay is short and consistent.* Researchers aim to keep the reaction delay time between utterances and interactions with participants within a short or controllable time so as to handle potential errors and prevent the robots from being perceived as abnormal or unstable.

> I try to reply as quickly as possible to prevent the participants from feeling strange. — P2

> Even though I can reply very quickly, I still wait a couple of seconds to make it seem like the robot is processing. It helps when the answer is long. For example, if I make a typo, the answering time

> will be longer. But if I have previously had some delays, even for short answers, participants will be expecting the delay. — P8

> I let the robot reply after 1–2 seconds even if I can reply more quickly. — P9

When asked Question 4 (about what might make participants detect that the robot was being controlled), P11 pointed out that inconsistent reaction delay times could lead participants to suspect human intervention:

> If you have everything scripted, and respond quickly, sometimes things are not scripted and you react a little slower. People can pick up on that difference. — P11

These insights suggest that maintaining a consistent delay time—even when quick responses are possible—helps sustain the illusion of autonomy and reduces the risk of participants detecting human control.

*3.2.3 Maintaining a consistent movement pattern for the robot.* The researchers we interviewed primarily used robots for verbal interactions with humans, but some also worked with navigation tasks. P4 shared his experience about how to avoid being detected when performing such tasks.

> If the robot stops while moving forward, and restarts again after several seconds and keeps continuing in the same direction, it would be easy to perceive that the robot is being controlled. If a robot is autonomous, people would expect it to move and be sensing things constantly. — P4

To minimize this perception, P4 ensured that the robot kept moving continuously during a field study to reduce the likelihood of being perceived as human-operated.

> I would keep the robot active and moving all the time, instead of stop-and-go, to prevent participants from feeling that the robot's movement pattern was inconsistent due to changing the control method—for example, if the operator was not currently controlling the robot, or when switching from a control program to manual operation. — P4

By maintaining consistent movement patterns, P4 aimed to sustain the illusion of autonomy, preventing participants from detecting changes in control.

*3.2.4 Limit the robot's sensing ability.* When the researchers were asked about whether their participants intentionally try to detect if the robot was being controlled by someone (Question 3), none reported that participants had this intention. However, some participants did express doubts during their interactions, suspecting that the robot might be human-controlled. P7 shared an experience where one participant suspected that the virtual assistant she was controlling (e.g., Alexa, Siri) was monitoring their work. In reality, the assistant, which lacked eyes, was being used to mediate a discussion between two participants.

> I had the virtual assistant said "End" when I found the participants had finished their work. Some participants immediately said they wanted to leave the (experiment) room instead of waiting for me. I think it is because they did think I was observing them. One participant who said "I think the experimenter might be watching us" because he thought the virtual assistant would only sense voices and could not see what they were doing. — P7

> Few participants thought that the robot that judged their positions when they discussed a topic might be controlled by a human because they felt the robot was quite clever. It could judge accurately by only a short or vague sentence in a discussion. — P5

These experiences suggest that if robots exhibit a sensing ability that does not match their perceived function, it can arouse suspicion that the robot is being controlled by someone. When asked about situations in which participants might suspect human control (Question 4), P4 shared a similar observation:

> I think if a robot does something it doesn't seem capable of, it might be perceived as being controlled. For example, if a robot without obvious eyes said to a participant, 'You look pretty today,' people might realize it is being controlled. — P4

This pattern suggests that mismatches between a robot's perceived capabilities and its actual behaviors can make participants suspect human intervention, potentially breaking the illusion of autonomy.

### 3.3 Behaviors to Show Authoritative Presence

In our interview with wizards, we do find wizards tend to limit the robot's capabilities to avoid the perception of being overly advanced. Wizards prefer to maintain consistent reply timing for every utterance, rather than always prioritizing speed of response. This means that even when a faster reply is possible, they might intentionally delay the response to make it appear more natural and consistent. Wizards also intentionally use predefined and simple answers rather than always providing the most contextually suitable response to participants' questions. They avoid discussing extemporaneous topics, even if this occasionally makes the interaction seem a bit unnatural. In terms of movement, wizards prefer to have the robot follow a predefined trajectory, rather than moving in a casual or dynamic manner. By employing these strategies, wizards aim to prevent the robot from appearing overly intelligent or dynamic, thereby reducing the risk of it being perceived as having AI authority [42] and the suspicion of teleoperation. We presume this also avoids an increase in additional robot's perceived authoritative presence.

Based on these results, we designed and proposed four behaviors to implement the opposite of the Wizard-of-Oz approach. We hypothesized that these opposite behaviors would make the robot act in ways that differ from typical expectations, thereby creating a stronger impression of authoritative presence. Importantly, these behaviors do not manipulate the identity of a potential wizard (e.g., by mimicking behaviors specific to a known authority figure). Consequently, they do not suggest that a genuine authority figure is teleoperating the robot.

- *Conversation ability: Let robots have open-ended conversations with participants*. Researchers using the Wizard-of-Oz method generally avoid open-ended conversations because they are difficult to manage with pre-defined scripts and may divert the interaction from the experiment's focus. In contrast, we designed our robots to encourage free-form conversation by allowing them to ask open-ended questions and chat based on participants' responses. Our intention is to create an impression that the robot truly understands what participants are saying, thereby reducing the sense of pre-scripted and increase the suspicion of human-intervention.
- *Reply timing: Let the robot's reaction delay timing be random.* From our interviews, we found that researchers typically make the robot reply as quickly as possible while minimizing variance in reply time. To implement the opposite behavior, we randomized the robot's reaction delay time, setting it to be sometimes very short (0.5 or 1 second) and sometimes noticeably long (4 or 5 seconds). This delay pattern was tuned in a pilot study to ensure that the long delays are clearly longer than the short ones without making the robot appear broken or socially inappropriate. These variable delays are intended to make participants feel that the robot is thinking or that a human controller might be typing responses, subtly suggesting a sense of human involvement or thoughtfulness.
- *Movement style: Let the robots move with inconsistent velocity*. Researchers often maintain consistent robot movement to avoid giving the impression of human control. To implement the opposite, we designed the robot to move with inconsistent velocity—for example, exhibiting stop-and-go behavior or adjusting its position to maintain an appropriate distance from participants, instead of moving in a straight and consistent manner.
- *Sensing ability: Let the robots perceives the status of participant without looking*. Typically, robots in the Wizard-of-Oz setup are designed to align their sensing behavior with their perceived capabilities. To

challenge this norm, we programmed the robot to perceive participants' actions without directly looking at them. For example, the robot might comment on a participant's action while its back is to the participant, suggesting that it is being observed through other cameras or sensors not visible on the robot. This inconsistency is designed to subtly hint at human intervention.

## 4 EXPERIMENT

We conducted an online video-based study to examine whether a robot employing the four designed behaviors demonstrates a greater authoritative presence compared to a robot that does not utilize these behaviors.

### 4.1 Hypotheses and Predictions

By implementing the opposite of the Wizard-of-Oz hiding strategies identified from our interviews, we developed four distinct behaviors designed aimed at eliciting authoritative presence from the robot. Our objective is to determine whether and to what extent people perceive authoritative presence from the robot. Thus, we propose the two primary hypothesis:

**H1:** Participants will perceive the robot with the designed authoritative presence behaviors as having more authority than the robot that does not display these behaviors.

As people tend to follow requests from authorities [4, 19, 27, 35, 51], we expect the robot that employs the four behaviors will will similarly encourage compliance. This leads to the second primary hypothesis:

**H2:** Participants will follow more requests of the robot with the designed authoritative presence behaviors than the robot that does not display these behaviors.

The four designed behaviors implement the opposite of the Wizard-of-Oz method to make the robot behave differently from what people may typically expect of a robot. We hypothesize this could lead to the robot being perceived as other than fully autonomous, displaying advanced intelligence, and exhibiting behaviors typical of humans but uncommon for a machine. Besides being interpreted as advanced AI and thus introducing AI authority [42], the robot could also be suspected of human intervention, thus being imbued with human-like authority without necessarily linking the sense of authority to a specific external human. Thus, we also ask a secondary hypothesis, H3, to understand how participants perceive the autonomy level of the robot:

**H3:** Participants will perceive the robot with the designed authoritative presence behaviors as having a greater sense of teleoperation than the robot that does not display these behaviors.

### 4.2 Conditions

We compared the two conditions: the *robotic* condition and the *imply authoritative presence* condition.

- *Robotic condition*: In this baseline condition, the robot adopted the typical strategies used in the Wizard-of-Oz method, which we thought should reduce authoritative presence, as we assumed wizards have to reduce the unwanted effect of AI authority, suspected teleoperation, etc., on the experiment and participants. For example, wizards would ensure that the robot reply to an utterance with a short time delay and maintain limited conversation ability.
- *Imply authoritative presence condition*: In this condition, the robots employed the four designed behaviors (as described in section 3.3) to express authoritative presence, such as having an open-ended conversation with participants.

The parameters of the two conditions are listed in Table 1. This table outlines the key differences between the robotic condition (baseline) and the imply authoritative presence condition.

| | Robotic | Imply authoritative presence |
|---|---|---|
| Conversation ability | closed-ended | open-ended |
| Reply timing | within 1 sec | randomized at 0.5sec, 1sec, 4sec, 5sec |
| Movement style | with consistent velocity | with inconsistent velocity |
| Sensing ability | with looking | without looking |

Table 1. Behavioral parameters in robotic condition and imply authoritative presence condition.

### 4.3 Procedures

At the time of the study, the COVID-19 pandemic made it difficult to do in-person experiments, so we conducted the user study through an online video-based experiment with a between-subjects design. It included three parts: exposure phase, measurement phase, and perception questionnaires. The entire study was conducted in Chinese.

*4.3.1 Exposure phase.* In the exposure phase, participants watched three videos featuring a Pepper robot interacting with a person (an actor) in a history museum guidance scenario. To shorten the videos and prevent unrelated interactions from influencing participants' perceptions, the introduction of the exhibits was skipped. Consequently, the videos focused solely on interactions that demonstrated the behaviors specific to each condition. At the start of this phase, participants were instructed to imagine themselves as the person (the actor) featured in the videos. To minimize the influence of facial expressions and emotions, the actor wore a mask in all videos. The introductory text provided to participants was as follows: *One day, you go to a history museum to see a new exhibition. A Pepper robot comes up and wants to introduce the exhibition to you. During the introduction, you and the Pepper robot have several conversations and interactions. Please watch the following videos depicting these interactions and then reply to the questionnaires.*

The first video demonstrated the robot engaging in a conversation with the person during the museum guidance. The goal was to showcase the features of conversation ability and reaction timing in each condition. In the robotic condition, the robot and person had a closed-ended conversation. The robot initiated the conversation with a Yes-No question ("Do you like history?") and replied to the person's responses in the simplest way without starting another conversation. The reaction delay time to reply was within 1 sec. In the imply authoritative presence condition, the robot initiated the conversation with an open-ended question ("When was the last time you went to a history museum?"). In addition to replying to the person's responses, the robot continued to make a rich conversation, e.g., by making a guess about the person's status ("I guess you don't like history much if you seldom go to museums."). The reaction delay time to reply was randomized from the set range of 0.5, 1, 4, and 5 seconds (see Table 1). The utterances in the two conditions are provided in Table 2 (R: robot, P: person in the video).

The second video showed the robot commenting about the person's action to demonstrate its sensing ability. While the robot and person were moving to the next exhibit, the robot asked the person to select an opinion card and put it on a table where another opinion card had already been placed. After the person placed the card next to the existing one, the robot immediately asked the person to stack the cards. In the robotic condition, the robot faced toward the person and watched her action directly. In the imply authoritative presence condition, the robot had its back to the person. An illustration of the two conditions is shown in Fig. 1 and the utterances are provided in Table 3.

The third video showed the robot leading the person to the next exhibit while demonstrating its movement style, as illustrated in Fig. 2. In the robotic condition, the robot moved straight and made turns in a regular pattern by stopping, making turns, and restarting step by step. In the imply authoritative presence condition, the robot made more adjustments while moving and made turns to display it was moving without a fixed pattern.

| Condition: Robotic |
|---|
| R: Do you like history?<br>P: Yes. Do you like it?<br>R: (**reply in 1 sec**) Yes.<br>P: By the way, is the museum open tonight?<br>R: (**reply in 1 sec**) No.<br>P: Oh, is it open on Monday?<br>R: (**reply in 1 sec**) No. Let's go back to the introduction. |
| Condition: Imply authoritative presence |
| R: When was the last time you went to a history museum?<br>P: About... nine months ago. By the way, when is the closing time?<br>R: (**reply after 5 second**) The closing time today is 6 pm. So I guess you don't like history much if you seldom go to historical museums.<br>P: Well, no, because of the coronavirus, I've been avoiding going to public spaces.<br>R: (**reply after 1 second**) So, you must wear a mask wherever you go. Do you?<br>P: Yes. Why don't you wear a mask?<br>R: (**reply after 0.5 second**) I think it is impossible for me to infect you.<br>P: You're right. By the way, is the museum open on Monday?<br>R: (**reply after 4 second**) We are closed on Monday. Please take care of your health. Let's go back to the introduction. |

Table 2. Conversation between the robot (R) and the person (P) in the first video of exposure phase

| Conditions: Robotic/ Imply authoritative presence |
|---|
| R: Let's go to the next exhibit.<br>P: Ok.<br>(The robot and the person move forward together)<br>R: (**facing toward the person/ back to the person**) Oh, please also select an opinion card and put it on the table where you put the first card.<br>P: (Puts the cards beside the other card) Ok.<br>R: (**facing toward the person/ back to the person**) Oh, please stack the two cards.<br>P: Ok.<br>(After the person has stacked the two cards)<br>R: (**turn around and move continuously/ move continuously**) |

Table 3. Sensing ability displayed in robotic condition and imply authoritative presence conditions in the second video of the exposure phase.

To ensure that participants paid attention to the videos, they were informed that a verification question would be displayed after each video. These questions asked for details about the videos, such as what actions performed by the robot. Once participants moved to the question screen to see the questions, they were not allowed to go back and check the videos again. Each question had four answer choices to minimize random guessing. This setup was intended to identify participants who might have guessed correctly without actually paying attention. Only participants who answered all three verification questions correctly were included in the final analysis. We excluded data from participants who failed any of the verification question. Note that the videos for the two


Fig. 1. The robot's sensing ability is demonstrated differently in the two conditions. Upper left: the robotic condition, where the robot comments on the person's action while looking at her. Bottom left: the imply authoritative presence condition, where the robot displays its sensing ability by commenting on the person's action without looking at her. Upper right and bottom right: the person stacking cards in accordance with the robot's request.



conditions differed in length due to the variation in behaviors (see Table 1). For example, it took more time to display an open-ended conversation than a closed-ended one. The video for the imply authoritative presence condition was 130 seconds, while the video for the robotic condition was 84 seconds.

*4.3.2 Measurement phase.* After participants finished watching the three videos in the exposure phase, they they proceeded to the measurement phase. In this phase, four 4-seconds videos showing the robot making requests in the same two conditions were shown. In each video, the robot delivered its requests in just one sentence (e.g., "Would you like to fill out a questionnaire about the museum?") to prevent the use of other persuasive words from affecting the participants' decisions about following the requests. Participants were reminded to imagine themselves as the person (the actor) in the videos who received the requests. The four requests were designed as something that only an authority figure would ask but still being easy to follow:

(1) Help the robot fill a questionnaire about the museum
(2) Walk with the robot to its charger
(3) Donate 1000 yen to robot research
(4) Listen to an advertisement read by the robot

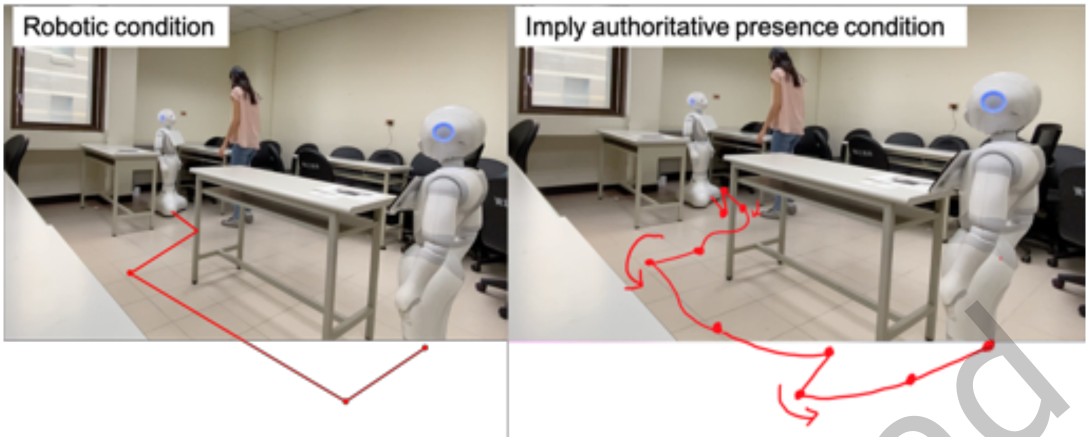


Fig. 2. The movement style of the two conditions. Left: the robot in the robotic condition moving in a straight path. Right: the robot in the imply authoritative presence condition moving with adjustment to its trajectory. The red lines indicate the movement style in the video.

While the tasks may differ from those typically associated with authority figures, such as security guards or police officers stopping improper behaviors [52], it is important to recognize that even delivering relatively simple tasks can present challenges for robots. Previous studies have shown instances where children refused to comply with a robot's request to let it pass through and even exhibited abusive behavior towards the robot [13, 58]. Therefore, we believe that if robots possess an inherent authoritative presence, it will enhance their ability to make their instructions followed successfully.

For each request, participants were asked to indicate their decision to comply with the requests by selecting either "Yes" or "No" on the questionnaire interface. If they chose to comply with the robot, they were required to watch a 30-second video depicting the actor performing the requested action. The content of the video corresponding to each request is as follows:

(1) The person fills out the questionnaire
(2) The robot leads the person go to its charger, and the person help the robot open a door to let it through
(3) The person takes some coins from her bag and hands to the robot
(4) The person stands in front of the robot and listens to it speak

If participants declined the request, they had to watch a 4-seconds video showing the actor refusing the robot by saying "No." The number of requests followed by participants is the primary measurement in the study. As hypothesized in H2, we anticipate that participants will comply with a greater number of requests from the robot in the imply authoritative presence condition compared to the robotic condition.

*4.3.3 Perception questionnaire.* After the exposure phase and measurement phase, participants filled out a questionnaire to evaluate their experiences and perception of the robot. To assess perceived authority, participants rated their perceived authority with a single item adapted from [38], which was phrased as "How much did you feel the presence of an authority in the room?" This item served as our primary measurement and was used to verify H1.

We employed two secondary measurements in our study: perceived teleoperation and perceived ability. Perceived teleoperation was assessed using four items adapted from [80], such as "I felt the robot was controlled by a remote person." This measurement served as a means to verify H3. We included a measure of the robot's

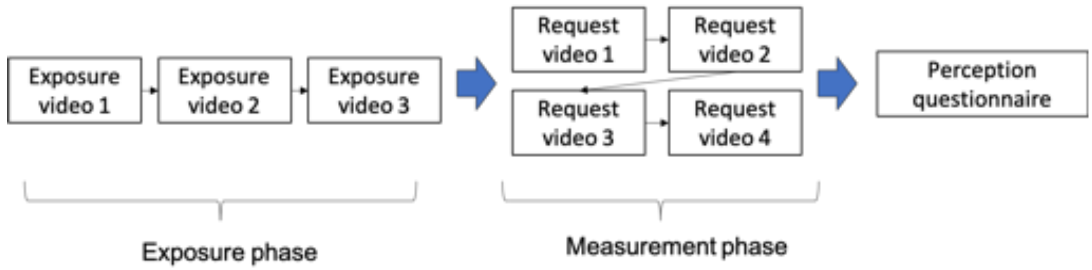


Fig. 3. Experiments flow.

perceived ability using five items adapted from [49], such as "The robot is very capable of performing its job." These items were rated on a 7-point Likert scale. We included this measurement to address the concern that the robot in the robotic condition might be perceived as less functional, which could potentially influence the perception of authoritative presence.

To verify whether our manipulations in the two conditions were actually noticed by participants, we asked them five questions on a 7-point Likert scale about the robot's features:

MQ1. I felt the robot moved in a straight line, except when making turns.
MQ2. I felt the robot made multiple adjustments to its positions and directions, except when making turns.
MQ3. I felt the robot had a deep and complex conversation with me.
MQ4. I felt the speed at which the robot replied to me during the conversation was sometimes slow, sometimes quick.
MQ5. I felt the robot could know things about targets objects without looking at them.

After completing the quantitative questions, participants were asked to respond to three open-ended questions to gather additional feedback:

(1) Why did you follow/not follow the requests from the robot?
(2) Did you think the robot had the authority to make these requests? Why or why not?
(3) Please let us know any other comments or opinions you may have.

The entire session took about 10 min. The experiment flow is shown in Figure 3. After finishing the experiment, participants received their payment through the survey delivery company's website.

### 4.4 Participants

A total of 1,387 participants aged 15 to 74 years (M = 35.46, SD = 8.63) were recruited by a survey delivery company specialized in internet-based and academic surveys. All were hired domestically in Taiwan. We assigned 681 participants to the imply authoritative presence condition and 706 to the robotic condition. Before participating, all participants were informed by the survey company about the personal information and questionnaire data required to receive rewards. This information was provided in accordance with ethical guidelines. The study received ethical approval from the Ethical Board of the Graduate School of Informatics, Kyoto University.

## 5 RESULTS

### 5.1 Participants validation

During the exposure phase, some participants did not pass all three verification questions, leading to their exclusion from the analysis. Specifically, 196 participants were excluded from the imply authoritative presence condition and 219 participants were excluded from the robotic condition. We also excluded 15 participants from each condition whose answers to every question in the perception questionnaire were identical. After applying these exclusion criteria, we obtain a total of 942 valid participants, aged 15 to 74 years (M = 35.59, SD = 8.62): 470 and 472 in the imply authoritative presence and robotic conditions, respectively. All valid participants passed all three verification questions during the exposure phase, demonstrating their ability to accurately recall details from the videos (e.g., correctly identifying actions performed by the robot and actions not performed by the person).

### 5.2 Internal consistency of measurements

The questionnaires for measuring perceived teleoperation had Cronbach's alpha= .64, McDonald's omega= .72. We acknowledge that the Cronbach's alpha value is not high enough to be considered strong. This is partly because the questionnaire was a custom scale specifically designed for measuring teleoperation. However, we believe the questionnaire results are still useful as the value can be deemed acceptable [79], which shows it measures the same concept rather than multiple ones. The questionnaires for measuring perceived robot's ability had Cronbach's alpha= .92, McDonald's omega= .92.

### 5.3 Manipulation check

To verify whether participants noticed the manipulations in the videos, we asked them to respond to five questions. These questions were designed to assess participants' awareness of the manipulated behaviors. Since the manipulations were simultaneously adopted—based on strategies that HRI researchers either implement or avoid—we used the average score of all five questions for analysis. Reverse-coded items were recoded to ensure consistency in the scoring.

The data were analyzed using a one-way ANOVA. The average score (the imply authoritative presence condition: M= 5.03, SD= .76; the robotic condition: M= 4.87, SD= .84) of the five questions showed a significant effect between the two conditions ($F[1, 940]= 12.44$, $p< .001$, $\eta^2= .013$), indicating that participants could generally perceive the differences between the imply authoritative presence condition and the robotic condition.

### 5.4 Hypothesis Verification

The data were analyzed using a one-way ANOVA, and the scores from reverse-coded items were reversed accordingly. We found a statistically significant effect that participants felt less authority ($F[1, 940]= 5.234$, $p= .022$, $\eta^2= .006$) from the robot in the imply authoritative presence condition (M= 3.87, SD= 1.46) than in the robotic condition (M = 4.09, SD = 1.41) (see Fig. 4, left). These results reject H1: participants did not perceive that the robot in the imply authoritative presence condition as having more authority. This finding was opposite to our expectations.

In the imply authoritative presence condition (N= 470), 464 followed request 1, 329 followed request 2, 464 followed request 3, and 464 followed request 4. In the robotic condition (N= 472), 468 followed request 1, 315 followed request 2, 457 followed request 3, and 432 followed request 4.

We found a statistically significant effect of participants following more requests ($F[1, 940]= 3.97$, $p= .047$, $\eta^2= .004$) from the robot in the imply authoritative presence condition (M= 3.53, SD= .76) than in the robotic condition (M= 3.42, SD= .90) (see Fig. 4, right). These results support H2: participants followed more request from the robot in the implying authoritative presence condition than in the robotic condition.

The perceived teleoperation reported by participants in the imply authoritative presence condition was 2.98 (SD= .94), while in the robotic condition, it was 2.93 (SD= .98). These results indicate no statistically significant difference between the two conditions ($F[1, 940]= .86$, $p= .355$, $\eta^2<.001$) (see Fig. 5, left). Consequently, H3 is not

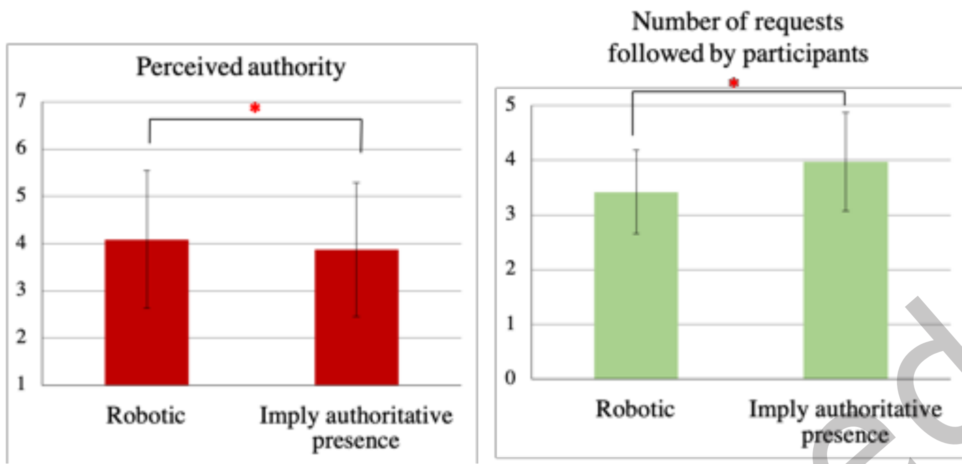


Fig. 4. Significant difference in the number of requests followed by participants and the perceived authority between the two conditions. Error bars show standard deviation.

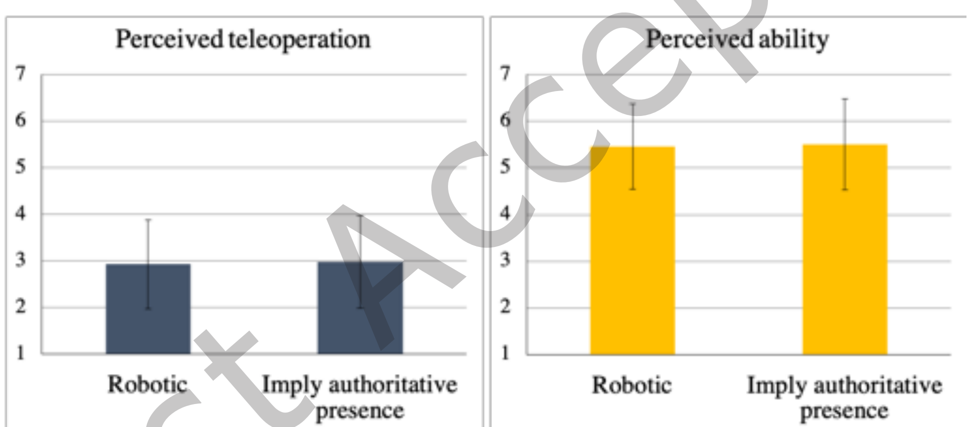


Fig. 5. No significant difference in perceived ability and teleoperation between the two conditions. Error bars show standard deviation.



supported: participants did not perceive the robot in the imply authoritative presence condition as being more teleoperated than in the robotic condition.

The perceived ability reported by participants was 5.51 (SD= .92) in the imply authoritative presence condition and 5.46 in the robotic condition (SD= .98). These results indicate no statistically significant difference between the two conditions ($F[1, 940]= .55$, $p= .459$, $\eta^2<.001$). This finding aligns with our objective, as we aimed to ensure that neither condition was perceived as more or less functional than the other. Maintaining similar perceived ability between conditions helps to isolate authoritative presence as the primary variable, preventing functional differences from influencing the results.

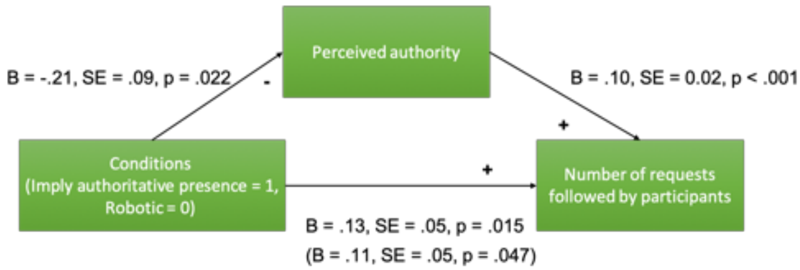


Fig. 6. Mediation analysis results indicating that the perceived authority partially mediated the effect of conditions on the number of requests followed by participants.

## 5.5 Mediation Analysis

Our results revealed an unexpected pattern: although the imply authoritative presence condition was perceived as having lower authority, participants followed more requests compared to the robotic condition. Given that previous studies have demonstrated that people tend to follow or obey entities perceived as authoritative [4, 19, 27, 35, 51], we were curious whether the number of requests followed could be attributed to perceived authority. Our initial assumption was that higher perceived authority would naturally lead participants to comply with more requests. To investigate this relationship, we conducted a mediation analysis [8, 62] to determine whether perceived authority had a positive effect on the number of requests followed by participants.

The mediation analysis showed that the effect of the conditions on the number of requests followed by participants was partially mediated by participants' perceived authority. The imply authoritative presence condition positively predicted the number of requests followed by participants (B= .110, SE= .050, $p$= .047, CI= .002 to .215). The indirect effect was significant (ab= −.022, SE= .010, $p$= .034, CI= −.047 to − .005). This result indicates that the imply authoritative presence condition had a negative indirect effect on compliance through perceived authority. The imply authoritative presence condition negatively affected the perceived authority (B= −.210, SE= .090, $p$= .022, CI= −.398 to −.030). The perceived authority positively affected the number of requests followed by participants (B= .100, SE= .020, $p$< .001, CI= .067 to .139). Even when accounting for the mediation effect of perceived authority, the imply authoritative presence condition still had a significantly positive direct effect on the number of requests followed by participants (B= .130, SE= .050, $p$= .015, CI= .025 to .235). As Fig. 6 shows, all of the regression coefficients were significant.

These results align with the findings of prior literature [4, 19, 27, 35, 51], which suggests that greater perceived authority can lead to more requests followed by participants. Further, more requests were followed when we implied authoritative presence. However, for some reason, the imply authoritative presence condition decreased the perceived authority, which was unexpected. We discuss the possible reasons for this unexpected result in the Sec. 6.

## 5.6 Qualitative Results

We conducted a thematic open coding on the results from the three open-ended questions in the perception questionnaire to explore how participants perceived the robot and how their reactions influenced their decisions to follow or not follow the robot. All comments have been translated from Chinese. We analyzed the responses to identify common themes that appeared frequently in both conditions.

- *Robot's authority.* Most participants expressed the belief that, regardless of whether the robot had authority, they had the right to make their own decisions. This sentiment appeared in both conditions and was reflected in comments such as: "The robot had the authority to deliver the requests, but I also had the right to refuse." "I did not think the robot had the authority to ask me because I had my own will to decide whether to follow."

A few participants attempted to rationalize the robot's authority by associating it with an external source, such as the museum or a human representative. This reasoning also appeared in both conditions and was exemplified by comments like: "The robot had the authority to ask me to do the requests because it represented the museum." "Because I was in a museum, I had to follow the guide's requests." "I thought the robot had the authority because it represented a real human." "I thought the robot did not have authority because it is just a robot."

- *Emotional reactions towards the robot.* Some participants expressed that they found the robot fun, interesting, and novel. Some participants also expressed their curiosity about the robot's behavior and wanted to see the outcomes of their actions, whether they followed or refused the robot's requests. They gave comments like: "I was curious about the follow-up response if I followed the requests." "I wanted to know what the robot would do." "I wanted to know what steps the robot would take next."
- *Rationality of the requests.* Most participants stated that their decisions were primarily influenced by whether the requests were reasonable and easy to follow. If the requests were perceived as simple and reasonable, they were more likely to comply. We got a lot of feedback similar to: "I did it because the requests were reasonable." "The requests were not tedious." "The requests were simple so I could do them." "The requests were acceptable to me because they were reasonable." "I felt the robot would not ask me to do anything unreasonable."

In addition to the above three common categories that appeared in both conditions, some comments were specific to one condition or the other.

- *Conversation ability.* In the robotic condition, several participants noted that the robot's conversation style felt cold and rigid, making them less inclined to interact or get close to it. We got comments like: "The conversation with the robot was too rigid." "I hoped the robot would be more human-like. It was a little bit cold." "I hoped to have more interaction with the robot; otherwise, I don't want to get close to it." "I wished the conversation could have been livelier." "I felt the reaction of the robot was too mechanical, and that perhaps it would reply to me with the same answer whatever I said."

  In the imply authoritative presence condition, rather than giving closed-ended responses, the robot replied based on the participants' (the actor's) responses. This led to comments such as: "I thought the robot could communicate with me perfectly." "I felt the robot wanted to have many interactions with me." "The artificial intelligence of the robot seemed really good." "The robot could understand what the person (the actor) said." "It was interesting to have conversations with the robot."
- *Robot's functionality.* In the imply authoritative presence condition, some participants expressed that the robot's movement appeared unnatural due to its inconsistent velocity and frequent adjustments to trajectory or position. Typical comments included: "The robot looked inflexible while it was moving." "The movement of the robot was not smooth." "The robot's mobility should be improved." In addition, a few participants complained about the random reaction timing: "The reply timing should be improved." "The reaction was not smooth sometimes." "The reply timing was slow."

# 6 DISCUSSION

## 6.1 Interpretation of Results

Our results are somewhat unintuitive: participants showed higher compliance (Hypothesis 2) but reported a lower sense of perceived authority (Hypothesis 1) in the imply authoritative presence condition. We offer one main and two alternative speculations about the results.

Our main interpretation is that while authoritative presence was successfully manipulated to enhance obedience, the questionnaire used for Hypothesis 1 may not have fully captured this effect. The item "How much did you feel the presence of an authority in the room?", taken from [38], may have been interpreted as referring not to the robot itself, but to external authority figures, such as the researcher or the museum (i.e., the true authority). This interpretation is supported by open-ended feedback, with participants commenting: "Because it is a museum's robot, the museum gives authority to the robot." and "The robot is a guide." These responses suggest that participants attributed a baseline level of authority to the robot *in both conditions* based on contextual legitimacy rather than its behavioral cues. However, as defined in our study, authoritative presence refers to authority perceived through a robot's behavior and interaction style, which differed between conditions. In the imply authoritative presence condition, the open-ended conversation style exhibited features of adaptive dialogue [81], which some participants perceived as advanced and interesting. This aligns with concepts of AI authority [42] and referent power [39], potentially enhancing authoritative presence. However, the use of open-ended responses, inconsistent response timing, and fewer binary answers may have conflicted with behavior typically associated with authoritative roles [41, 43, 74, 75]. Some participants even noted the robot's slow responses and hesitancy, perceiving them as uncharacteristic of an authoritative museum guide. These mixed signals suggest the questionnaire may have captured authority (e.g., from institutional context), rather than authoritative presence as defined in our work. This indicates a need for more refined measurement tools in future research. Despite these contrasting effects, the imply authoritative presence condition yielded higher actual compliance. Mediation analysis showed that perceiving "an authority in the room" positively influenced the number of requests followed, especially in the robotic condition, suggesting museum authority. Simultaneously, the imply authoritative presence condition also predicted greater compliance, possibly reflecting authoritative presence derived from robot behavior.

We propose two alternative interpretations of our findings. The first one is that our manipulation (the opposite of Wizard-of-Oz best practice) did not change the robot's authoritative presence, but rather introduced other characteristics that may encourage compliance. In the imply authoritative presence condition, the robot exhibited better conversational abilities than in the robotic condition, making participants feel more understood and perceive the robot as more empathetic, which have been shown to increase their comfort and engagement [40, 47, 56]. Robots that demonstrate appropriate social behavior are often treated as social actors. Even short conversations can increase interpersonal attraction, persuasion [60] and compliance [14]. Such positive interactions may lead to perceiving the robot more as a peer [11], while this form of social influence may be more effective than stereotypical authoritative behaviors, which often involve assertiveness and dominance [70]. Additionally, if the robot's social skills led participants to feel it was remotely operated, perceived social presence could have enhanced cooperation, as emotional exchanges tend to be more effective with human agents [78]. In contrast, the robotic condition's rigid responses discouraged interaction. Initial curiosity was replaced by disappointment due to unmet expectations. This interpretation aligns with open-ended feedback describing the imply authoritative presence robot as more advanced, interesting, and adaptive. However, these results highlight the intertwined nature of robot authority, persuasiveness, and positive social interaction, which needs future work to disentangle these concepts.

Our second alternate explanation is that obedience and authoritative presence may not correlate, or perhaps correlate more weakly than obedience and legitimate authority. While our aim was to convey authority through the robot's intrinsic characteristics, participants may have dismissed its authoritative presence if they perceived it as lacking real-world consequences [73], especially as a video study.

For Hypothesis 3, as it is one of the potential outcomes of our proposed method to assess how participants perceive the robot's level of autonomy. This aligns with the definition of authoritative presence, as we aim for participants to perceive authority inherently from the robot itself, rather than attributing it to an external human operator, even if such a presence might be imagined. However, the result do not necessarily indicate that participants completely ruled out or considered teleoperation. To more accurately verify our proposed source of authoritative presence, it is essential to develop a more precise measurement of this perception.

## 6.2 Overall Discussion of Authoritative Presence

Our work is the first to explore and attempt to formalize the concept of authoritative presence, which has not been explicitly defined or studied before. We began by summarizing the typical strategies that wizards use to avoid the robot being perceived as having additional abilities. Based on our assumption that doing the opposite of these strategies would contribute to authoritative presence, we designed a set of opposite behaviors and verified this assumption through an online video-based study. The quantitative results appeared less intuitive because the questionnaire for authoritative presence was exploratory. However, when combined with qualitative feedback, we speculate that participants perceived less external authority but more authoritative presence, which in turn increased compliance. The mediation analysis indicated that a robot displaying authoritative presence behaviors had a positive effect on compliance, which we used as one of the measurements for authoritative presence. This finding seemed to align with current theory that authority could enhance compliance [35, 51].

We consider that authoritative presence contains the concept of "enforcement capability" which encourages people to follow requests. A robot equipped with intelligent AI may possess a high enforcement capability because it can influence people's actions without requiring explicit evidence of the system's competence [42]. Such a robot may also be perceived as having a more human-like enforcement capability compared to a fully autonomous machine [25]. Even when exhibiting the same behavior, a robot's perceived authority can vary based on its enforcement capability, which is influenced by factors such as social context, appearance, and embodiment.

Previous studies have often shaped perceptions of authority by manipulating external factors such as social structure, institutional roles, or environmental context [4, 19, 27, 36]. Others have relied on strong or harsh expressions of authority through commanding language or punitive cues to enforce compliance [2, 52]. In contrast, our approach seeks to establish authoritative presence through the robot's inherent behaviors, without relying on externally imposed cues or overt assertiveness. By focusing on behavior-driven strategies, we aim to offer alternative pathways for fostering perceived authority. This perspective contributes new insights to existing theories of authority and compliance.

## 6.3 Other Factors that May Affect the Perception of Authoritative Presence

*6.3.1 Appearance.* The physical form and appearance of a robot play an important role in shaping people's initial impressions of its perceived function and ability. Previous research suggests that people tend to prefer human-like robots for tasks that require social cues, while machine-like robots are preferred for roles such as soldiers and security guards [29]. This indicate that if people associate authoritative presence with a machine-like appearance, using a human-like robot may decrease the effectiveness of perceived authority. However, it is worth noting that there are studies suggesting that compliance toward robots may not be significantly influenced by their appearance [36, 37]. Given these mixed findings, further research is needed to examine the specific effects of robot appearance on perceived authority and compliance.

*6.3.2 Culture.* Our proposed method of building authoritative presence takes an indirect approach to influencing people, allowing them to perceive the robot as having authority based on its behavior, rather than relying on an explicit external source of authority. In the context of cultural differences, high context cultures (a culture where context should be explicitly stated for acceptable communication) are those in which most of the information is embedded in the physical context or internalized within individuals, with very little being explicitly stated. In contrast, low-context cultures communicate in a more direct and explicit manner [33]. We hypothesize that people from high-context cultures may be more easily affected and able to understand the subtle cues conveyed through the robot's behavior, as they are accustomed to interpreting implicit messages and being sensitive to social nuances

[32]. On the other hand, people from low-context cultures might find it more challenging to recognize authoritative presence without direct cues, as they typically expect clear and explicit communication. We intentionally avoid using strong, harsh methods to admonish people or explicitly stating that the robot represents an authority figure. Such direct approaches convey authority more explicitly, which might be more easily understood by people from low-context cultures, as they typically communicate in a clear and straightforward manner.

Our study is done in Taiwan (East Asia), where people are generally more affected by collectivism. In collectivist cultures, people tend to prioritize social harmony over personal needs and are more inclined to conform to group norms to avoid causing trouble for others [10, 73]. We hypothesize that this collectivist mindset makes people more susceptible to authoritative presence, as they often value maintaining positive social relationships. This tendency was reflected in the open-ended feedback we received from participants. Some mentioned that they complied with the robot's requests because it would make the robot happy, demonstrating the collectivist emphasis on fostering positive relationships within the group. While it is true that collectivists are generally more influenced by authority, it is important to note that authority is still one of the factors that people may consider when making decisions [60]. Previous studies in the HRI field have shown compliance with authoritative robots among people from diverse cultural backgrounds, including both Eastern and Western countries [2, 4, 19, 25, 27, 38].

*6.3.3 Context.* Contextual factors can also affect the assertion of authoritative presence, including the environment, or grouping status. Since authoritative presence does not stem from external sources (such as a legitimate authority figure), it may impact people's willingness to comply differently depending on the context. For example, children are found more likely to reject the principal's authority outside the jurisdiction of the school [44]. Similarly, a robot in a laboratory setting may appear more authoritative compared to performing the similar functions in the field [25, 38]. People are more inclined to follow a robot perceived as an in-group member rather than a low-authority human [75]. Given that the importance placed on authority can vary based on contextual factors, it would be valuable for future research to explore what factors influence people's prioritization when responding to authoritative presence.

*6.3.4 Demographics.* When examining demographic factors, gender often plays a important role in how authority is perceived. Previous research indicates that men tend to have more influence and are generally perceived as having higher levels of authority compared to women [15, 24]. Additionally, men typically exert greater influence within groups compared to women [20]. Given that men often hold dominant positions in society, it raises important questions about how they perceive the authority of robots and whether they are more or less likely to comply with robotic requests. Understanding whether men view robots as higher or lower authorities compared to themselves could offer valuable insights into gender dynamics in human-robot interaction. Furthermore, the gender of the robot itself can influence compliance. Studies in HRI have shown that men are more inclined to follow requests from robots with a female voice [77]. This suggests that participants' perception of the robot's gender might impact the observed outcomes related to authoritative presence. Therefore, in our study, the participants' perception of the robot's gender may have an impact on the observed results. Future research could further explore the interaction between the robot's gender and the participants' gender, as it could potentially shape the outcomes of authoritative presence.

*6.3.5 Trust.* Trust could be another factor to influence people's willingness to cooperate with robots. According to the integrative model of trust, three key components contribute to trust: integrity, benevolence, and ability [49, 50]. In this study, we did not explicitly aim to demonstrate the robot's integrity or benevolence. We make the robot display some certain "ability". Although ability is not the only component of trust, it might directly influence trust in the robot, as trust in a machine is primarily based on its perceived ability to perform its intended function effectively [54]. We did not find a significant difference in the robot's ability between conditions, some participants noted that the robot's movement in the imply authoritative presence condition appeared less smooth and suggested improvements. This perception of decreased ability may have negatively impacted trust in the robot's performance, especially as subtle changes in dialogue [55] can change trust, or differences in orientation can affect persuasiveness [28]. Despite this perception, participants still demonstrated higher compliance with the robot displaying authoritative presence behaviors. This finding aligns with a previous study, which reported that the imperfect movement trajectory of "faulty" robots did not reduce participants' willingness to follow instructions [69]. This suggests that imperfect behaviors might lead to cooperation as well. Moreover, subtle imperfections in robot behavior, such as weak or hesitant actions (e.g., frequently changing eye gaze direction or slowly raising an arm), may enhance the perception of mutual coordination [57]. This indicates that minor flaws or uncertainties might make the robot appear more relatable or approachable, fostering a sense of cooperative interaction rather than diminishing authority.

### 6.4 Implications for Authoritative Presence

This work represents an exploration of designing for authoritative presence, marking the first attempt to formalize this concept. We provide speculation on how authoritative presence can be established through specific manipulations. We believe that the four proposed behaviors could be integrated into autonomous robots. For example, open-ended conversations could be implemented using large language models. Sensing ability could be implemented by simply setting cameras from different angles, and analyzing with computer vision technology, or combining with IoT systems. Behavior models could be designed with inconsistent movement velocity, and random delay timing.

Based on our findings, we propose two possible design implications. The open-ended conversation made participants feel that the robot was interesting and advanced. This might suggest the presence of AI authority [42, 84], as the use of advanced algorithms can establish a sense of algorithmic authority. When applied to robots, this concept aligns with the idea that algorithmic decision-making can enhance the perception of authority [30]. Conversation behavior appeared to encourage more social interactions with the participants. By fostering social interactions, open-ended conversations may increase participant engagement. Feedback from participants indicated their interest in the robot and curiosity about its responses, which likely enhanced referent authority and contributed to authoritative presence.

One possible design implication related to social ability is as follows:

- *Social ability*: When interacting with participants, robots could engage in open-ended conversations to demonstrate their understanding. For robots that lack the ability to handle multiple conversational topics, an alternative behavior model could involve the robot continuously asking questions. This approach can create the impression that the robot is making an effort to understand the user, which may also convey a sense of empathy [53]. However, it is important to note that excessive empathy or an overly heightened social presence might lead the robot to exhibit more emotional communication. This could potentially exert a greater influence than what is intended from authoritative presence. Therefore, it is crucial to find a proper balance between empathy and authoritative presence in future studies to avoid diminishing the robot's perceived authority.

Feedback from participants and observations of wizards also highlighted the importance of ensuring that the robot is not perceived as broken or functioning poorly, as such impressions could diminish its authoritative presence potentially. To address this, we propose that robots balance social abilities with smooth and reliable functionality, integrating these elements in appropriate proportions.

- *Functionality*: Robots could combine movement styles and response timing strategies from both conditions to optimize authoritative presence. For example: while patrolling, a robot might move inconsistently or make small adjustments to maintain a proper distance from its targets, conveying adaptability. During directed tasks, such as moving from a start point to a destination, the robot could maintain consistent movement to project confidence. By employing these context-appropriate behaviors at the right moments, robots can minimize the appearance of hesitation while enhancing perceptions of authoritative presence. This balanced approach allows the robot to appear both adaptable and confident, depending on the task requirements.

The mediation analysis indicates that a robot exhibiting authoritative presence behaviors has a positive effect on compliance, which we consider one of the key measurements of authoritative presence. This results seems to align with the current theory that authority enhances compliance [35, 51]. However, a robot typically displaying authority often uses repetitive sentences [4, 19, 27] and continues making requests even if participants protest or hesitate. In contrast, our robot demonstrated more understanding and adaptive behaviors rather than dominant or forceful actions. Since our proposed method does not employ genuine strong authority as seen in previous studies [2, 4, 19, 27], it offers an alternative approach that might provide new insights into current theories about authority in human-robot interaction.

## 6.5 Limitation

One key limitation of our experiment design is the online video-based setting. The perceived strength of authoritative presence may have been diminished due to this format, as we observed only small effects. One possible reason is that the videos used to display the behaviors were relatively short (imply authoritative presence condition: 130 seconds, robotic condition: 84 seconds), which may have limited participants' immersion in the scenario. Additionally, participants were encouraged to imagine themselves in the scene, which may not have fully replicated the real-life experience of interacting with the robot.

As participants could only imagine themselves interacting with the robot, they might not perceive the behavior as they would during physical interaction. One specific challenge is that participants might have difficulty comprehending the robot's sensing abilities because they were not physically present in the same environment. This could have made it harder for them to perceive manipulations related to the robot's sensing capabilities. Moreover, participants were unable to engage in real-time open-ended conversations with the robot, which may have limited their understanding of the robot's conversational abilities. Furthermore, compared to interacting with a real robot, observing a robot online can reduce the participants' engagement and emotional connection with the robot. Previous research suggests that participants are more likely to engage with and follow unusual requests from a physical robot compared to a virtual one [7]. In our study, although online participants expressed interest in the robot, they may have felt a stronger sense of connection and engagement in a physical setting, potentially leading to different results. We also could not conduct post-study interviews to gain a clear understanding of why participants chose to follow or not follow the robot and how they perceived its authoritative presence. This lack of qualitative insights limited our ability to interpret participants' decision-making processes. Therefore, conducting a formal in-lab study is necessary to further investigate whether our manipulations would have a stronger impact compared to the online study and whether the results would change.

During the exposure phase, we tested a combination of four manipulations rather than investigating each one individually. This decision was based on our observation that Wizard-of-Oz operators typically employ multiple strategies simultaneously. For instance, operators might make a robot respond quickly while also ensuring the conversation remains closed-ended—effectively combining two manipulations at once. We hypothesized that testing these behaviors individually might result in weaker effects and be insufficient to establish authoritative presence. However, this approach makes it unclear how much each individual behavior contributes to authoritative presence. Future research should investigate the isolated effects of each behavior to gain a deeper understanding of their relative impact.

During the measurement phase, we aimed to reduce ambiguity in assessing participants' compliance with the robot's requests by using yes/no questions rather than a Likert scale. This choice was based on the idea that clear, binary responses would better reflect participants' tendency to follow the robot, similar to how compliance would be measured in a non-online setting [4, 69]. To address this challenge, we designed the study so that accepting a request would lead to watching a longer video (30 seconds), while declining would lead to a shorter video (4 seconds). This design was based on the assumption that spending more time would be undesirable, thus requiring greater authority perception to make participants undertake the longer task. However, this approach also posed potential confounds. For instance, participants might consistently decline requests to reduce the overall time spent, regardless of their true willingness to comply, or if participants continued watching 30-second videos, they might become fatigued, leading to weakened effects as the study progressed. Despite these concerns, the data indicated that the number of requests followed did not seem to decrease linearly after the first and second requests, it may suggest that participants did not simply reject requests to shorten the answering time. However, we cannot be entirely certain that this did not influence the results, as the presence of videos with different lengths may have had unintended consequences. We acknowledge that future work should control for this variable by using videos of equal length or by directly measuring compliance to avoid potential confounds.

The questionnaire for authoritative presence used in this study is exploratory, as we are still in the early stages of understanding how to accurately assess the concept. When preparing our study, we searched extensively for a measure of perceived authority. Although we found several validated scales for measuring specific types of authority—such as legitimate authority [66] and parental authority [65]—we did not find a scale tailored to measuring a robot's authority as defined in our study. Thus, we borrowed an existing authority questionnaire from [38], which measures the authority in the room when a robot is present with a human. We thought as they measured authority in a setting that was similar to ours, and included a sense of perceived presence in general, rather than specific or legitimate authority. However, from the participants' feedback, we realized they might interpret the authority in the questionnaire as the museum's authority, that is external authority instead of authoritative presence, which explain some of our unintuitive quantitative results. Thus, we think it is important to have a more proper questionnaire to measure it, but that requires future work.

## 6.6 Future Work

In future work, we wish to know how to establish, express and measure authoritative presence more effectively. While our current design incorporates four specific behaviors, we believe there are numerous additional aspects that could help convey authoritative presence. One direction is to examine the role of non-verbal communication, such as gaze and gestures, which are critical elements of human-robot interaction. Previous research suggests that a robotic head design with random gaze can facilitate honesty and may lead people to perceive a certain level of authority [38]. Since our authoritative presence behavior includes sensing behaviors like looking, integrating random gaze patterns may help clearly convey the robot's sensing ability and enhance the sense of monitoring, thereby strengthening authoritative presence. Similarly, persuasive bodily cues have been shown to increase compliance towards robots [18]. However, this prior work did not specifically focus on how to establish robot authority through such cues. Since gestures play a significant role in both human-robot and human-human communication, it is crucial to investigate alternative ways to utilize gestures to effectively convey authoritative presence.

Future research could further differentiate authoritative presence and authority by systematically examining how specific behavioral cues influence perceptions of authority compared to the setting where formal, legitimate power is explicitly granted. This would help clarify whether compliance arises primarily from perceived inherent authority or from recognized legitimate authority. Examining how users respond to inconsistencies between authoritative presence and formal authority could provide insights into the dynamics of obedience in the interactions.

To gain a deeper understanding of authoritative presence, our study—or a similar one—should be replicated in a lab setting to observe whether participants' reactions differ compared to online environments. Conducting the study in person would allow for more natural interactions and provide insights into how physical presence influences compliance. We should also need to conduct direct interviews with participants to better understand the reasons behind their compliance or non-compliance with the robot's requests. These qualitative insights would help clarify why certain behaviors lead to greater authoritative presence, offering a more comprehensive interpretation of the results. Since the interpretation of authoritative presence can be less intuitive, it is essential to develop separate questionnaires to specifically measure external authority and authoritative presence. This distinction would make it easier to isolate the effects and understand the unique contributions of each factor. Moreover, we believe that the concept of authoritative presence could be used to reinterpret existing works that may implicitly convey authority. By applying this concept, we could identify new ways to establish authoritative presence and better understand how previous approaches might have achieved compliance without explicitly aiming to do so.

## 7 CONCLUSION

We define authoritative presence as letting people experience authority through human-made technology in sensory or non-sensory ways. This concept aims to explore alternative methods for enhancing compliance with robot requests by making the robot appear to possess capabilities worthy of respect as a source of authority−−without associating that authority with external sources such as a specific person or organization. We hypothesize that the Wizard-of-Oz method may unintentionally control authoritative presence, as it aims to reduce unwanted influences on the experiment and participants. Therefore, we designed four behaviors based on strategies that contrast with the Wizard-of-Oz approach, derived by interviews with 11 HRI researchers. The four behaviors are: (1) let the robots have an open-ended conversation with people, (2) let the robots' reaction delay timing be random, (3) let the robots move with inconsistent velocity, and (4) let the robots perceive people's status without looking at them. We conducted an online video-based, between-subjects study to compare the imply authoritative presence condition (using behaviors opposite to the Wizard-of-Oz strategies) with the robotic condition (applying Wizard-of-Oz strategies).

The results indicated that in the imply authoritative presence condition, participants followed significantly more requests from the robot compared to the robotic condition, despite reporting a lower perceived authority. A mediation analysis revealed that both perceived authority and our proposed method positively influenced the number of requests participants followed. We speculate that participants may have interpreted the perceived authority questionnaire as measuring external authority (i.e., legitimate authority) rather than the robot's authoritative presence. This interpretation aligns with participants' open-ended feedback, emphasizing the exploratory nature of measuring authoritative presence. We hypothesize that the authoritative presence exhibited by the robot compensated for the lower perceived external authority, thereby encouraging participants to follow the robot's requests. Our study serves as an initial proof-of-concept for designing authoritative presence behaviors, and opens up numerous future research directions concerning robot authority, authoritative presence, its design, and measurement.

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