Role-Playing with Robot Characters: Increasing User Engagement through Narrative and Gameplay Agency

Spencer Ng
The University of Chicago
Roblox
spencerng@uchicago.edu

Ting-Han Lin
The University of Chicago
tinghan@uchicago.edu

You Li
The University of Chicago
youli21@uchicago.edu

Sarah Sebo
The University of Chicago
sarahsebo@uchicago.edu

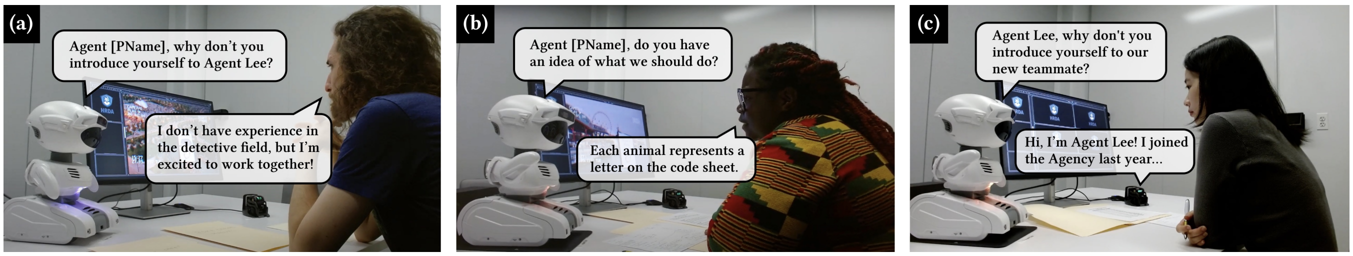

Figure 1: We created an immersive experience where participants solved crimes with two detective robot characters, a Misty II advisor robot and a Vector peer robot. We evaluated if (a) increased *narrative agency* or (b) increased *gameplay agency* would improve user engagement compared to (c) a *control* where robots engaged users without directly prompting their input.

ABSTRACT

Live entertainment is moving towards a greater participatory culture, with dynamic narratives told through audience interaction. Robot characters offer a unique opportunity to mitigate the challenges of creating personalized entertainment at scale. However, robots often cannot react to audience responses, limiting opportunities for audience participation. In this work, we explore methods to increase user agency in live entertainment experiences with robot characters to improve user engagement and enjoyment. In a between-subjects study ($N = 60$), we create an immersive story where users role-play as detectives with two distinct robot characters. Users either (1) have greater involvement and self-identification in the story by talking with the robots in-character (*narrative condition*), (2) have a more active role in solving puzzles (*gameplay condition*), or (3) follow along without being prompted by the robots for input (*control condition*). Our results show that increasing user agency in a role-playing experience, in either its narrative or its gameplay, improves users' flow state, sense of autonomy and competence, verbal engagement, and perceptions of the robot characters' engagement. Increasing narrative agency also led to longer unprompted reactions from participants, while gameplay agency improved feelings of immersion and relatedness with the robots. These findings suggest that creating either narrative or gameplay agency can improve user engagement, which can extend to broader robot interactions where gameplay elements and role-playing in stories can be incorporated.

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CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**; *Collaborative interaction*; • **Applied computing → Media arts**.

KEYWORDS

user agency, engagement, robot characters, entertainment robots

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1 INTRODUCTION

In today's experiential economy, live immersive entertainment is becoming increasingly popular. Audience members are surrounded by physical set pieces, and in-person actors interact with them to create emergent narratives. Live action role-playing experiences such as *Star Wars: Galactic Starcruiser* cast participants as heroes in a story who complete missions with costumed characters to create unique narrative arcs [108]. However, these role-playing experiences often have limited capacity; one way to make them more accessible is to use robots [19, 61] or virtual avatars [28, 84] as characters to enable meaningful interactions with audience members at scale, similar to how robots have been used in entertainment contexts like theater [12, 21] and storytelling [52, 70, 96]. While both virtual avatars and robots can engage people in immersive entertainment contexts, robots have several advantages over avatars. Robots have the ability to directly engage with the physical environment, instead of potentially lowering users' immersion by requiring them to focus on both a real-world environment and avatars displayed on screens [50]. Robots also have greater perceived social presence than virtual avatars [26], which can contribute to key aspects of live role-playing experiences such as social interaction, enjoyment, emotional engagement, and player collaboration [18, 59]. We therefore focus on the design of embodied robot characters in this work as an engaging solution to scale live role-playing experiences.

We also explore how robot characters can be used to create novel interactive entertainment experiences that are personalized, scalable, and enjoyable by manipulating the degree of agency that users have. Murray defines agency as the "satisfying power to take meaningful action and see the results of [player] decisions" [69]. This is an improvement to mere interactivity and can be created through simple structural changes to an experience to encourage engagement [69], as opposed to more complex engagement mechanisms such as dynamic robot movements [83, 97] or user modeling [79, 80].

Narrative and gameplay are considered the two fundamental dimensions to create rich player experiences through agency [1, 68, 82]. *Narrative agency* is created when players are involved in the story's world, such as through social interactions with characters [82], open-ended dialogue with dynamic responses [66], and changing one's personality in the story [68]. Narrative agency thus makes players feel that the environment is highly reactive and they can make meaningful choices, which can lead to greater enjoyment and moral engagement [25, 65]. On the other hand, *gameplay agency* involves modifying a game's state based on established mechanics and player skill, such as roaming around in an open-world video game or moving pieces freely in a board game [1, 69]. Gameplay agency increases as games offer greater control and a larger possibility space of outcomes [90], which immerses players in a highly-engaging experience paralleling the real world and can be leveraged for educational and social outcomes [3, 24, 34].

While increasing user agency tends to increase enjoyment in interactive digital media [27], asking users to role-play with robots with high levels of agency may cause them to initially feel uncomfortable and awkward [47, 74]. Users may be unsure how to role-play in unfamiliar narrative situations or prefer not to participate if they do not associate with their narrative role [5, 67]. Open-ended interactions with robots may also lead to turn-taking dynamics that feel disjointed and interrupt user flow [10, 37]. Instead of directly engaging with robots as characters, users may prefer to watch robots talk with each other, similar to watching a play or theme park robot performers. We are interested in seeing if the sense of awkwardness associated with role-playing with robots can even be overcome to design natural interactions with embodied robots in the growing medium of live immersive experiences.

Therefore, in this work, we investigate the effects of increasing narrative and gameplay agency on human-robot interactions in entertainment contexts. We place participants in a live role-playing scenario, where they are detectives who solve mysteries alongside two robots (see Figure 1). We then adopt techniques from interactive digital storytelling to increase participants' opportunities to participate in either the narrative or the gameplay of the experience from a baseline experience with minimal user prompting from robots. By comparing participant responses to either increased narrative or gameplay agency against a control condition, we show how encouraging user participation in a live action role-playing scenario with robots influences users' flow state, experience of need satisfaction, verbal engagement, and perceptions of the robot characters.

2 BACKGROUND

We review literature related to user engagement in HRI and robot characters in entertainment and storytelling contexts.

2.1 Engagement in Human-Robot Interaction

User engagement is critical for creating successful human-robot interactions. Robots can engage people through verbal and nonverbal behaviors [2, 91], aesthetic appeal [71], anthropomorphic appearances [11, 49], and encouragement of user participation in tasks [40]. Given its importance, a growing body of work has examined how robots can increase user engagement. Rodriguez-Lizundia et al. found that, in a hotel setting, users engaged more with embodied robots who look awake compared to those who look asleep with no embodiment [83]. Similarly, Szafir et al. employed a robot that adjusts its speech volume and performs gestures such as nodding and gazing to regain users' attention when it detects drops in user engagement [97]. Other research has focused on adding expressive voices to robots to enrich children's learning and engagement [54], having robots deliver rapport-building speeches [53], matching robots' language levels to children's abilities [52, 106], having robots assign personalized breaks to children [80], and using Markov decision models in robots for tailored assistance [81]. In research exploring human-robot interactions with older adults and people with dementia, Fasola et al. found that robots can motivate the elderly to do physical exercise through relationship-building discourse [31], and Feng et al. discovered that pairing visual stimuli with audio can lead to more positive engagement from people with dementia [33]. While much literature has explored ways for robots to increase user engagement, no work to our knowledge has investigated increasing engagement via simple changes in interaction scripts that increase users' narrative and gameplay involvement.

2.2 Robots in Entertainment and Storytelling

In entertainment contexts, social robots have been used as music and dance companions [39, 72], interactive game facilitators [35, 46, 102], theater performers [12, 45, 105], and sports partners [51]. Lin et al. found that users solving puzzles had more fun and felt less judged when playing with a robot game master that provided verbal hints compared to a human actor in the same role [61]. Other research has used multiple robots simultaneously to entertain audiences [22, 73, 107]. For instance, Hayashi et al. designed a robot comedian duo who adjusted their jokes based on audience feedback and discovered that the robots' comedy was more entertaining than that of human comedians [38].

Robot characters with personalities have used gestures, human-like gaze [48, 70], and lighting effects [94] to engage people in storytelling contexts. These robots have improved computational thinking in college students [41] and offered occupational therapy to older adults [76]. Research on robot storytelling has also focused on enhancing children's education and enjoyment [20, 53, 54]. Robots matching children's language fluency helped them to use more diverse vocabulary [52, 106], while robots that allow children to co-create branching stories increased their attention and enjoyment [9, 60, 96]. Prior work also explored using multiple robots in storytelling experiences [16, 57, 99]. For example, Vázquez et al. created a robot lamp sidekick that was co-located with a robot shaped

Table 1: We highlight example story beats with differences between the experimental conditions.

Beat Type	Control Condition	Narrative Condition	Gameplay Condition
Role-playing	The advisor robot asks the peer robot to introduce itself.	The advisor robot **asks the participant to introduce themself**.	The advisor robot asks the peer robot to introduce itself.
Puzzle solving	The peer robot solves puzzles without asking for participant input.	The peer robot solves puzzles without asking for participant input.	The peer robot **asks the participant for puzzle progress**, then provides either confirmation or the solution.
Branching narrative choices	The peer robot decides the neighborhood to explore and order of visiting a location.	The peer robot **prompts the participant to choose** the neighborhood to explore and order of visiting a location.	The peer robot decides the neighborhood to explore and order of visiting a location.

like a chest of drawers, which increased children's attention to verbal interactions [103]. While prior work has investigated robots in entertainment and storytelling contexts with varying degrees of interaction, no work to our knowledge has systematically studied how increasing narrative and gameplay agency can increase user engagement and enjoyment in live interactive entertainment.

3 METHODS

We conducted a between-subjects study where participants role-played as detectives in an immersive experience with two robot characters: an advisor robot and a peer robot. Participants experienced either (1) a baseline version of the experience (**control condition**), (2) a version where they had more agency to influence the story (**narrative condition**), or (3) a version where they had more agency in providing solutions to puzzles solved with the robots (**gameplay condition**). This study was approved by the University of Chicago's Institutional Review Board (IRB22-1970).

3.1 Hypotheses

Interactive narratives that enable user agency (e.g., choose-your-own-adventure books) engage and immerse readers by making them part of a fictional setting. This often induces a *flow state* associated with psychological benefits such as the ability to extend skills to meet new challenges and remove distractors [27]. Users who experience flow also tend to enjoy experiences more and have increased intrinsic motivation to continue engaging with an experience [27, 44]. Achieving this motivation is associated with *player experience of need satisfaction* (PENS), which includes the needs of *autonomy*, *competence*, *relatedness*, and *immersion* [85, 87]. Because our experience incorporates narrative agency, we hypothesize that the positive effects of narrative agency in interactive narratives will translate to a live experience we create with robot characters:

> $\mathbf{H}_1$: Increasing user **narrative agency** in interactions with robot characters will lead to increased **(a)** flow state and enjoyment, **(b)** player experience of need satisfaction, and **(c)** verbal engagement compared to a control with minimal narrative agency.

Similarly, having agency in gameplay-based interactions (e.g., shooting video game enemies) can lead to a flow state and greater enjoyment due to players having a sense of control over the challenges they encounter and freedom to explore that they generally do not have in the real world [23]. For games, this pleasurable flow state is also predicted by player need satisfaction [8, 98]. However, gameplay agency does not necessarily provoke greater verbal or social engagement [13, 89], in contrast to increasing narrative involvement. We therefore hypothesize that affording players the agency to control the gameplay state in our experience will lead to effects similar to traditional games:

> $\mathbf{H}_2$: Increasing user **gameplay agency** when playing with robot characters will lead to increased **(a)** flow state and enjoyment and **(b)** player experience of need satisfaction compared to a control with minimal gameplay agency.

Increasing the amount of agency and thus potential to interact with robots may also affect users' perceptions of the robots both positively and negatively. While prior work has shown that playing collaborative games with a robot increases its perceived likeability [74], other work has shown that participating in an interactive narrative could be awkward or uncomfortable if users are unsure of how to interact with characters or cannot identify with their in-world character [67]. We therefore hypothesize that manipulating user agency when interacting with robots could have both positive and negative social effects:

> $\mathbf{H}_3$: Increasing user agency will cause players to feel more awkward, watched, and vulnerable in a role-playing experience with robots compared to a control with minimal agency.

> $\mathbf{H}_4$: Increasing user agency in an experience will cause players to feel that robot characters are warmer and more engaged with them compared to a control with minimal agency.

3.2 Conditions

We investigated three conditions in our study:

(1) **Control Condition**: the participant experiences a baseline story structure, where the peer and advisor robots encourage the participant to engage with puzzles and follow along with the story, but they do not directly prompt the participant for input. This condition represents a typical experience in a theme park or theater show with robots, where characters engage with audience members without requiring their direct participation.
(2) **Narrative Condition**: the participant experiences increased narrative agency and is given opportunities to role-play in the context of the story (e.g., describing why they want to join the detective agency). They are also given co-authorship of the work by making branching narrative choices (e.g., choosing one of three restaurants, exploring environments), which are common opportunities for agency in immersive theater [30].

(3) **Gameplay Condition**: the participant experiences increased gameplay agency, and their puzzle-solving ability affects dialogue with the robots. The peer and advisor robots ask the participant for their progress on two multi-step puzzles at set times and either confirm that the participant is correct or guide them toward the solution. This interaction gives participants the perception that their skill level would impact the mission's success, though the experience progresses even if they are wrong. We equate this interaction with gameplay agency, following [63].

These conditions manipulate how a series of story "beats" progress, each associated with either narrative agency or gameplay agency (see Table 1). Participants in the control condition experience the baseline versions of each beat, while those in the narrative and gameplay conditions have modified prompts that correspond to their experimental condition. Aside from these opportunities for narrative or gameplay agency, dialogue was held constant between conditions. The small differences in the robots' dialogue between conditions did not significantly change their level of engagement with participants. In the narrative condition, the peer robot asks participants questions with a set of expected answers and pre-scripted responses, replacing dialogue between the peer and advisor robots. In the gameplay condition, the peer robot asks participants for puzzle solutions after each step, then briefly confirm or reject them. The robots' dialogue remained consistent otherwise.

3.3 Immersive Experience Design

We designed the user study as an immersive experience similar to those in theme parks with animatronics. Drawing from interactive theater design techniques (e.g., balancing agency with structure, providing context before participants make difficult decisions) [58], we wrote a script (see supplemental documents) that follows a pre-scripted trajectory with moments where audience interaction could lead to alternate dialogue paths. Users then develop a sense of agency through opportunities to self-identify with their role as a new detective in the story, personalized gameplay based on player ability, and discrete narrative choices as described in [55] and [15].

3.3.1 *Character Design.*

We used two social robots with distinct personalities in our study, casting them as a senior detective in an "advisor" role and a junior recruit in a "peer" role. Using multiple robots allowed us to design robot interactions focused on the plot and characters similar to those in theme parks, without exerting pressure on participants to drive the story forward with interaction. The peer robot (named Agent Lee) is played by a small Anki Vector robot who is prone to mistakes and reckless decisions and is more emotive towards the events of the story. Following design principles in [62], the peer robot provides positive affirmations and suggests alternate paths if participants make mistakes. The advisor robot (named Agent Jay) is played by a larger Misty II robot who conveys a greater image of trust and authority. The robots' appearances matched their social roles to help increase user acceptance [100]. When solving crimes, the advisor robot directed questions toward both the peer robot and the participant as a team, moving its head to address different team members similar to a theme park animatronic. The juxtaposition of the peer and advisor robots, both in appearance and personality, created a dynamic story while diegetically inserting the participant as a contributing member of the team.

3.3.2 *Story & Game Design.*

The experience tells the story of the participant joining the Human-Robot Detective Agency, onboarded by the advisor robot and working with the peer robot, to solve crimes from a control center. The plot followed a conventional three-act story structure, while gameplay drew from escape room puzzle design principles and had a smooth difficulty progression.

Act 1. The peer robot introduces itself, and the team decodes a hidden message on a monitor. Participants in the narrative condition choose a city location to investigate, while those in the gameplay condition take the lead on decoding the message compared to watching the peer robot solve it in the control condition.

Act 2. The team searches for evidence in a restaurant and finds a stolen ingredient by solving a three-step cryptic puzzle. In the narrative condition, participants continue role-playing as themselves (e.g., recommending restaurants) and directly participate in the story (e.g., leaving a voicemail to the restaurant), while participants in the gameplay condition took an active role in solving the puzzle.

Act 3. Players defuse a bomb by asking questions about it, similar to solving a logic puzzle, then settle a debate between the two robots by deciding if the team should leave the bomb defused or use it in retaliation. This act was the same in all conditions and allowed all players to experience some narrative and gameplay agency.

Design elements such as dramatic lighting, physical dossier props, background music corresponding to different locations, and videos stylized as security camera footage complemented the script, puzzles, and robot characters to enhance the immersive experience.

3.4 Technical Implementation

Our study software controlled a Vector robot, a Misty robot, and a monitor displaying graphics through a Python web server to execute scripted story beats.[1] In the study introduction, offline speech recognition [17] listened for keywords in the experimenter's speech to autonomously execute corresponding story beats. Afterward, the experimenter monitored participants through a webcam and used a Wizard of Oz interface built in PyQt to classify participants' verbal responses to branching dialogue and manually execute story beats. There were minimal delays and inconsistencies when using the Wizard of Oz interface, as operators clicked buttons to quickly execute corresponding pre-scripted robot responses. There were no instances where participants went off-script, and they answered the robots' questions as expected. Prompts either had a clear set of discrete answers (e.g., "which location is the most ripe for cyber-crime?" after showing three labeled locations on the monitor) or were open-ended with the same pre-scripted response regardless of what participants said. Unprompted participant utterances (e.g., thinking aloud, expressing surprise) were not acknowledged by the robots, such that we anticipated a range of scenarios and designed the experience to have a tightly controlled script.

3.5 Study Protocol

A researcher began the study by obtaining informed consent from a participant and introducing them to the role-playing scenario and the two robots, who autonomously briefed participants on the story's conflict. Participants were told that they should verbally respond to the robots when directly asked questions, though the

[1] See our code and media at github.com/SeboLab/role-playing-robots

robots would not always respond to them. The researcher then left the room, and the study proceeded into the immersive experience (see Section 3.3). Participants spent an average of 20.6 minutes (SD = 1.40m) in the experience (control condition: M = 19.84m, SD = 0.64m; narrative condition: M = 19.92m, SD = 0.91m; gameplay condition: M = 22.25m, SD = 0.96m). The researcher then re-entered the room, and the participants completed a survey about their experience, receiving a $6 Amazon gift card as compensation.

3.6 Measures

We measured participants' perceptions through a post-experiment questionnaire and analyzed their verbal engagement.

3.6.1 Short Flow State Scale. We administered the short-form version of the Flow State Scale, which assesses nine dimensions of flow: challenge-skill balance, action-awareness merging, clear goals, unambiguous feedback, concentration on task, sense of control, transformation of time, loss of self-consciousness, and autotelic experience [44]. Statements were rated on a 5-point Likert scale, from 1 (*strongly disagree*) to 5 (*strongly agree*). We calculated an overall flow score by averaging the score of the nine scale items [43].

3.6.2 Player Experience of Need Satisfaction. We used the subscales of autonomy, competence, relatedness, and immersion from the Player Experience of Need Satisfaction scale [87]. Participants rated their sense of autonomy (e.g., "the game provides me with interesting options and choices"), competence (e.g., "I feel very capable and effective when playing"), relatedness (e.g., "I find the relationships I form in this game fulfilling"), and immersion (e.g., "exploring the game world feels like taking an actual trip to a new place") using a scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

3.6.3 Player Social Perceptions. We captured the degree to which participants felt awkward, vulnerable, and watched on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

3.6.4 Robotic Social Attributes Scale. We measured participants' perceptions of the two robots' warmth using the corresponding dimension of the RoSAS scale [14] on a 7-point Likert scale.

3.6.5 Additional Robot & Experience Perceptions. For each robot, we asked participants if they felt the robot was "actively engaged" with them. We also asked participants to rate if "[they] would participate in this experience in [their] free time." Questions were asked using a scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

3.6.6 Coded Free-Response. In free-response questions, we asked participants to share their impressions of their overall experience and the advisor and peer robots. Two independent coders classified each response into a set of pre-selected labels describing overarching themes, and both coders classified all participant responses. We calculated inter-rater reliability as Cohen's kappa for each response type. For comments on participants' impressions of the peer robot ($\kappa = 0.73$) and impressions of the advisor robot ($\kappa = 0.84$), coders classified responses as one the following labels: *positive*, *negative*, *neutral*, or *positive/negative* (mixture of positive and negative attributes). Participants' responses on their overall experience were classified as either belonging or not belonging to each of the following labels: feeling *positive* ($\kappa = 0.94$), *ignored* ($\kappa = 0.86$), or *not immersed* ($\kappa = 0.91$). If there was disagreement between the coders, we analyzed results using the classification from the primary coder.

3.6.7 Personality & Prior Experience. To test potential experiment covariates, we asked participants to rate their extraversion and openness to new experiences from 1 (*definitely not associated*) to 7 (*definitely associated*) using the Ten-Item Personality Inventory [36]. Participants also rated if they had "*significant experience*" with role-playing, puzzles, interacting with robots, and programming on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

3.6.8 Verbal Engagement. We annotated the duration of participants' utterances from study videos and classified them into either (1) utterances *prompted* by the robots (e.g., responding when the peer robot directly asks participants how to solve a puzzle) or (2) *unprompted* reactions from participants (e.g., thinking aloud to solve a puzzle, expressing surprise). We also report (3) *combined* utterances, which aggregates the length of prompted and unprompted utterances. We assessed inter-rater reliability by asking two independent coders to categorize utterances for an overlapping set of 12 participants (20% of total), and they agreed on 93.7% for prompted, 88.4% for unprompted, and 94.8% for combined utterances.

3.7 Participants

We recruited 61 participants from the University of Chicago community via direct recruitment, flyers, and social media. Data from one participant was discarded due to robot malfunction. Of the 60 participants who were analyzed, 23 identified as White, 34 as Asian, 4 as Black or African American, and 5 as another ethnicity. Participants who identified as two or more ethnicities were double-counted. We balanced the gender of participants between our three conditions, beyond which we randomly assigned participants to a condition. 20 participants (10 male, 8 female, and 2 non-binary) were in the control condition, 20 participants (10 male, 9 female, and 1 declined to identify) were in the narrative condition, and 20 participants (9 male, 9 female, and 2 non-binary) were in the gameplay condition. Participants ranged in age from 18 to 34 (M = 22.0, SD = 3.04), and there was no significant difference in age between conditions. We also found no significant differences between conditions in potential covariates related to participants' past experiences in role-playing (M = 4.13, SD = 2.12), puzzles (M = 4.48, SD = 1.75), interacting with robots (M = 2.90, SD = 1.74), or programming (M = 4.78, SD = 2.27). There were also no differences between conditions in participants' self-evaluation of extraversion (M = 3.64, SD = 1.41) and openness to new experiences (M = 5.23, SD = 1.08).

4 RESULTS

We used Kruskal-Wallis tests for our analysis, as some of our data were not normally distributed, reporting the test statistic as chi-squared (χ^2) and effect size as eta-squared (η^2). We conducted post-hoc pairwise comparisons using Wilcoxon rank-sum tests with a Bonferroni correction. To analyze the coded labels of free response answers, we used Chi-Square tests of independence and conducted post-hoc pairwise comparisons with a Bonferroni correction.

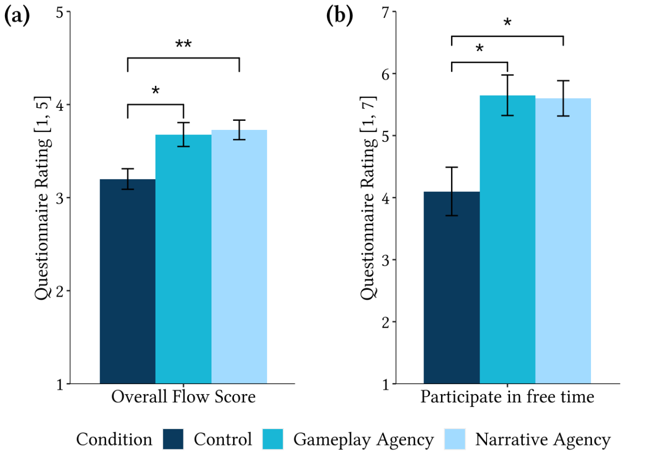

Figure 2: Increasing either narrative or gameplay agency improved participants' (a) flow state and (b) desire to participate in immersive experiences in their free time compared to the control. (*) denotes $p_{adj} < 0.05$, and (**) denotes $p_{adj} < 0.01$. Error bars show one standard error from the mean.

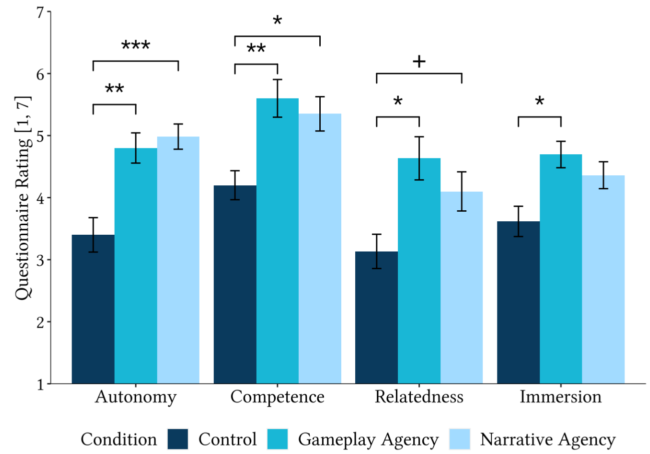

Figure 3: Participants in the narrative and gameplay conditions felt greater autonomy and competence than those in the control condition. (+), (*), (**), and (***) denote $p_{adj} < 0.10$, $p_{adj} < 0.05$, $p_{adj} < 0.01$, and $p_{adj} < 0.001$, respectively. Error bars show one standard error from the mean.

4.1 Flow State & Enjoyment

We found that increasing user agency had a significant effect on participants' overall flow state ($\chi^2 = 11.25$, $\eta^2 = 0.16$, $p = 0.004$), as shown in Figure 2a. Participants in both the narrative ($M = 3.73$, $SD = 0.47$, $p_{adj} = 0.003$) and gameplay conditions ($M = 3.68$, $SD = 0.57$, $p_{adj} = 0.038$) reported a significantly higher flow score than those in the control condition ($M = 3.20$, $SD = 0.49$).

Within the nine dimensions of flow, we found that increasing either narrative or gameplay agency had a significant impact in participants' ratings of having *clear goals* ($\chi^2 = 10.76$, $\eta^2 = 0.15$, $p = 0.005$), *unambiguous feedback* ($\chi^2 = 10.79$, $\eta^2 = 0.15$, $p = 0.005$), and an *autotelic experience* ($\chi^2 = 9.70$, $\eta^2 = 0.14$, $p = 0.008$) when role-playing. Participants in both the narrative condition ($M = 4.10$, $SD = 1.07$, $p_{adj} = 0.013$) and the gameplay condition ($M = 4.00$, $SD = 0.86$, $p_{adj} = 0.021$) believed they had *clearer goals* compared to those in the control condition ($M = 3.15$, $SD = 0.93$). Participants in the gameplay condition experienced more *unambiguous feedback* ($M = 4.30$, $SD = 0.87$) than those in the control condition ($M = 3.10$, $SD = 1.25$, $p_{adj} = 0.005$). In addition, participants in the narrative condition had a greater *autotelic experience* ($M = 4.05$, $SD = 0.61$), feeling that the experience was more intrinsically, rewarding compared to those in the control condition ($M = 3.10$, $SD = 1.02$, $p_{adj} = 0.006$). All other pairwise comparisons for these three flow dimensions were not statistically significant.

Because greater flow can lead to greater enjoyment [27], participants also rated how much they would want to participate in the experience during their free time if given the chance (see Figure 2b). We found that increased narrative and gameplay agency had a significant influence on participants' responses ($\chi^2 = 10.83$, $\eta^2 = 0.16$, $p = 0.004$), where participants in both the narrative condition ($M = 5.60$, $SD = 1.27$, $p_{adj} = 0.015$) and the gameplay condition ($M = 5.65$, $SD = 1.46$, $p_{adj} = 0.015$) reported a significantly greater desire to participate in immersive experiences in their free time than those in the control condition ($M = 4.10$, $SD = 1.74$).

In participants' free-response answers regarding their overall experience, participants in the narrative condition described the experience as "*interesting and fun*," citing its "*novelty and humor*." A participant in the gameplay condition described the robot interaction as similar to "*talking to real people and helping them solve a real crime*," highlighting the immersive structure of the experience. On the other hand, some participants in the control condition felt that "*communication was stilted*" between them and the robots, which "*made the team element feel less genuine*." They were also frustrated because the robots "*spent the majority of the time conversing with one another*," making them feel less engaged.

Overall, we find strong support for $H_{1(a)}$ and $H_{2(a)}$, that increasing user agency through interacting with robots in either the narrative or gameplay of an experience will increase flow and enjoyment.

4.2 Player Experience of Need Satisfaction

Using the Player Experience of Need Satisfaction scale [87], we found that increasing narrative and gameplay agency had a significant impact on participants' ratings of *autonomy* ($\chi^2 = 18.06$, $\eta^2 = 0.28$, $p < 0.001$), *competence* ($\chi^2 = 11.58$, $\eta^2 = 0.17$, $p = 0.003$), *relatedness* ($\chi^2 = 9.77$, $\eta^2 = 0.14$, $p = 0.008$), and *immersion* ($\chi^2 = 8.94$, $\eta^2 = 0.12$, $p = 0.011$), shown in Figure 3. Participants felt they had significantly greater *autonomy* in both the gameplay condition ($M = 4.80$, $SD = 1.09$, $p_{adj} = 0.002$) and the narrative condition ($M = 4.98$, $SD = 0.91$, $p_{adj} < 0.001$) compared to those in the control condition ($M = 3.40$, $SD = 1.24$). Participants also felt significantly more *competent* in the gameplay ($M = 5.60$, $SD = 1.36$, $p_{adj} = 0.007$) and narrative conditions ($M = 5.35$, $SD = 1.24$, $p_{adj} = 0.021$) compared to the control condition ($M = 4.20$, $SD = 1.05$). Significantly more participants felt greater *relatedness* with the robot characters in the gameplay condition ($M = 4.63$, $SD = 1.56$) compared to the control condition ($M = 3.13$, $SD = 1.24$, $p_{adj} = 0.013$). Participants in the narrative condition ($M = 4.10$, $SD = 1.41$) also rated their feelings of relatedness higher than those in the control condition, though with a marginally significant difference ($p_{adj} = 0.078$). Finally, participants felt greater *immersion* in the narrative ($M = 4.36$, $SD = 0.97$, $p_{adj} = 0.174$) and gameplay conditions ($M = 4.70$, $SD = 0.95$, $p_{adj} = 0.012$) than the control condition ($M = 3.62$, $SD = 1.09$), with a significant difference between the gameplay and control conditions.

We find strong support for $H_{1(b)}$ and $H_{2(b)}$, that increasing narrative or gameplay agency is associated with players better satisfying their needs of autonomy, competence, relatedness, and immersion.

4.3 Verbal Engagement

We analyzed participants' utterances during the experience and categorized them into those *prompted* by the robots (e.g., responding to the peer robot when asked about a step in a puzzle's solution) and those that were *unprompted* (e.g., expressing surprise, thinking aloud when solving puzzles). We report *combined* utterances as an aggregate of *prompted* and *unprompted* utterances (see Figure 4).

We found that the experimental conditions had a significant influence on the average total length of participants' prompted utterances ($\chi^2 = 37.23$, $\eta^2 = 0.62$, $p < 0.001$), unprompted utterances ($\chi^2 = 9.30$, $\eta^2 = 0.13$, $p = 0.010$), and combined utterances ($\chi^2 = 22.03$, $\eta^2 = 0.35$, $p < 0.001$). For prompted utterances, participants in both the narrative ($M = 100.85$s, $SD = 24.85$s, $p_{adj} < 0.001$) and gameplay conditions ($M = 105.65$s, $SD = 32.63$s, $p_{adj} < 0.001$) spent significantly more time responding to prompts from the robots than those in the control condition ($M = 40.40$s, $SD = 14.47$s). Interestingly, participants in the narrative condition ($M = 78.00$s, $SD = 49.23$s) had significantly longer unprompted utterances than those in the gameplay condition ($M = 36.18$s, $SD = 40.22$s, $p_{adj} = 0.017$). Though participants in the narrative condition also had longer unprompted utterances than those in the control condition ($M = 46.24$s, $SD = 51.36$s), the difference was only marginally significant ($p_{adj} = 0.068$). We also found that the length of combined utterances for participants in both the narrative ($M = 178.85$s, $SD = 58.66$s, $p_{adj} < 0.001$) and gameplay conditions ($M = 141.83$s, $SD = 64.60$s, $p_{adj} = 0.002$) significantly exceeded those in the control condition ($M = 86.64$s, $SD = 58.00$s).

Overall, we find strong support for $H_{1(c)}$, that increasing user narrative agency also increases their verbal engagement. Of particular interest, while other outcomes (e.g., flow, enjoyment, player need satisfaction) were similar between the narrative and gameplay conditions, this analysis reveals that participants in the narrative condition exhibited uniquely higher amounts of unprompted verbal speech than those in the gameplay condition, highlighting a key difference between interactions that increase gameplay agency and those that increase narrative agency.

4.4 Player Social Perceptions

Participants rated how awkward, watched, and vulnerable they felt during the experience. We found no significant differences between the three conditions for these ratings. Participant responses across conditions were mixed, with some participants saying they "*felt uncomfortable talking to the robots*" because they were "*intruding on a private conversation*," while others "*felt comfortable with [their] interaction*." One participant with no prior experience with robots found the experience initially "*confusing*" because they "*didn't know when [they were] supposed to talk with the robots*," yet they "*got the hang of it*" by the end. We therefore reject H_3, that increasing agency and opportunities to role-play with robots will make people feel more uncomfortable.

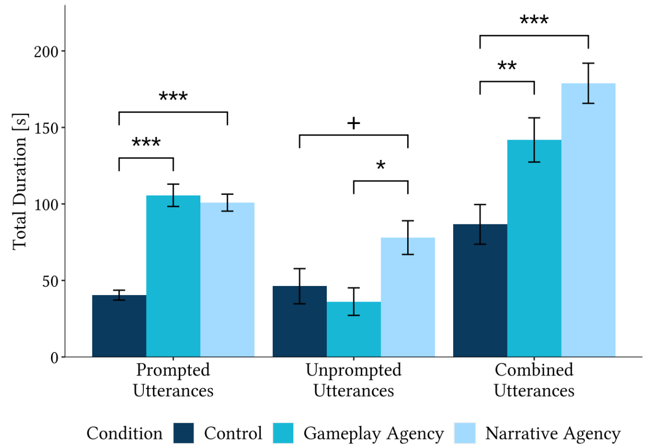

Figure 4: The total duration of participants' prompted and combined utterances significantly increased as participants experienced greater agency. (+), (*), (**), and (***) denote $p_{adj} < 0.10$, $p_{adj} < 0.05$, $p_{adj} < 0.01$, and $p_{adj} < 0.001$, respectively. Error bars depict one standard error from the mean.

4.5 Relationship with Robot Characters

Participants rated how much they felt each robot character was actively engaged with them and evaluated their warmth using the RoSAS subscale [14]. We found significant differences between ratings of the peer robot's active engagement across conditions ($\chi^2 = 10.84$, $\eta^2 = 0.16$, $p = 0.004$). Participants viewed the peer robot as more engaged in both the narrative ($M = 5.40$, $SD = 1.19$, $p_{adj} = 0.036$) and gameplay conditions ($M = 5.60$, $SD = 1.23$, $p_{adj} = 0.008$) compared to the control ($M = 3.80$, $SD = 2.02$), with no significant difference in ratings between the narrative and gameplay conditions. We did not find any significant differences between conditions for ratings of the peer robot's warmth. Participants also evaluated the active engagement and warmth of the advisor robot, but we did not find any significant differences across conditions. However, coded qualitative responses from participants indicated that the experimental conditions had a significant effect on whether participants viewed the advisor robot as *positive* ($\chi^2 = 8.28$, $p = 0.016$). A significantly greater proportion of participants in the narrative condition (80%) viewed the advisor robot as *positive* ($\chi^2 = 8.28$, $p_{adj} = 0.029$) compared to those in the control condition (35%).

When coding participant free-responses about their overall experience, experimental conditions also had a significant impact on how *ignored* participants felt ($\chi^2 = 10.10$, $p = 0.006$). Significantly more participants (70%) felt *ignored* by the robots in the control condition ($\chi^2 = 10.10$, $p_{adj} = 0.011$) compared to those in the gameplay condition (20%). We therefore find some support for H_4 across our measures, that increasing user agency will lead to people feeling like they have a more social relationship with the robot characters.

5 DISCUSSION & CONCLUSION

We demonstrated that when people participate in a live role-playing entertainment experience with multiple robot characters, simple interactions that provide agency in either its narrative or gameplay subsequently improve people's flow state, need satisfaction, verbal engagement, and perceptions of the robots' engagement.

Adding narrative agency increased users' feelings of autonomy and competence, flow state, and desires to participate in similar experiences. Drawing from digital media interaction design [32], allowing users to make branching decisions likely improved user enjoyment [68]. This paradigm can be applied to general role-playing dialogue with robots (e.g., asking users to make decisions based on their preferences). Narrative agency was also created by encouraging self-identification with one's character as a detective (e.g., players are asked why they want to be a detective), which is consistent with self-identification influencing social relations in digital games [7] and likely led to greater perceived engagement from the peer robot and positive perceptions of the advisor robot. Users with narrative agency also talked more to the robots compared to those in the control condition. We therefore reject the idea that open-ended role-play with robots may cause discomfort, as opposed to prior work with social robots in different contexts [88, 95]. Narrative-based interactions can thus be used to sustain engagement in future human-robot interactions, such as creating a role-play backstory for robot tutors working with children [4] or engaging users in small decision points during their treatment for healthcare robots [29].

Increasing gameplay agency by asking participants for their puzzle-solving progress similarly increased users' flow and satisfaction of their needs of autonomy, competence, relatedness, and immersion, thus improving their overall enjoyment. This suggests that regularly inviting player feedback on objective game tasks and giving positive feedback with robots in live entertainment scenarios such as escape rooms or role-playing game quests would be beneficial. Increasing flow and satisfaction of player needs through gameplay agency is also supported by prior work [8, 23] and can lead to greater engagement, player motivation, and wellbeing [27, 87, 104]. Because gameplay agency is also associated with participants thinking the peer robot is more actively engaged and that they are less ignored by both robots, centering interactions around passive gamification mechanics (e.g., asking users to move game props) could be a low-barrier method to build trust in short-term human-robot interactions (e.g., walkaround robot characters in theme parks).

Differences between the narrative and gameplay conditions highlight how designing narrative interactions alongside participatory gameplay is crucial when creating immersive experiences with robots. While both the narrative and gameplay conditions prompted users to verbally engage more with the robots compared to the control condition, the narrative condition had significantly longer *unprompted* utterances compared to the gameplay condition. User behaviors like admonishing the peer robot when they suggest retaliation or "helping" the robots solve puzzles without being asked to suggest that narrative interactions encourage greater emotional engagement with the robot characters and the story's world, as opposed to self-directed feelings of excitement that gameplay agency creates [86]. Experiencing greater flow in terms of autotelic experience for only narrative agency and unambiguous feedback for only gameplay agency compared to the control also suggests that narrative agency creates intrinsically satisfying interactions because it allows users to freely "play" in the story [78], while gameplay agency creates a sense of cooperative play with the robots that is otherwise missing when the peer robot solves puzzles by itself [56].

Our study also supports using flow theory and player experience of need satisfaction to improve human-robot interactions. Our finding that gameplay agency satisfies the need for autonomy and competence aligns with prior work in digital games [6, 42] and educational robots [101], which suggests that other robot interactions that influence user autonomy or competence (e.g., personalization options, dynamic task difficulty [77]) may similarly affect users' motivation and thus engagement. Following [64], evaluating users' flow state from a robot interaction may also be helpful in determining their sense of engagement beyond observable behavior.

While our results show the benefits of increasing opportunities for narrative and gameplay interactions with users in entertainment contexts with robots, we acknowledge the limitation that our results cannot distinguish whether increased user agency or increased user interactivity led to our results. Game scholars define interactivity as when a computer responds to user input, while agency is the level above that where players feel like they take "meaningful action" to fundamentally change their character's path [75, 93]. Because our control condition was designed to mirror how robots are currently used in entertainment settings with minimal required user input, the narrative and gameplay conditions were both more interactive (via robots asking users questions) and provided a sense of agency (via branching paths or changing the game state). Future work could better disentangle the factors of interactivity and agency in live entertainment experiences with robots, though our results do demonstrate that increasing opportunities to participate in the narrative or gameplay of an entertainment experience is beneficial compared to robots engaging users without asking for their input.

Overall, our work demonstrates a novel use case of robots as interactive actors in a role-playing entertainment context similar to immersive theater. While prior work has shown how robots can be effective as a passive-social medium similar to television actors [38] or that robots can be used as an interactive game master in a closed-form escape room interaction [61], people may be more uncertain about unexpected, open-ended social interactions with robots [92]. However, our results indicate that participants do not have adverse feelings and instead respond positively when interacting with social robots that provide them with opportunities to contribute to an experience's narrative and gameplay. Similar to how traditional passive media like film and theater are incorporating interactive and walkaround mechanics to generate engagement and enjoyment, entertainment robots can move from storytelling or monologuing with minimal user involvement to dynamic, narrative-driven interactions incorporating gameplay. Robots can therefore be an integral part in shaping the future of live interactive entertainment, where autonomous robot characters scale well to provide personalized role-playing experiences to people compared to human actors.

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