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Exploring the Impact of Narrator Type on Response Latency and Utterance Length During Interactive Storytelling

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Abstract— **The inexorable progress of technology brought forth an era where robots increasingly integrate into human life which necessitates the understanding of human-robot interactions (HRI). This study unravels the details of HRI within interactive storytelling contexts. Through a between-subject experiment with 28 participants, we assessed response latency and utterance lengths to interactive story narrations delivered by either a human or a robot. Findings indicated that participants displayed longer response latency interacting with the robot narrator while articulating shorter utterances compared to the human condition where participants displayed longer utterances and shorter response latency. These observations suggest significant differences in cognitive and communicative strategies in human-human versus human-robot interactions. The results underscore the challenges and potential of designing social robots that are time-sensitive in interacting with humans. Future explorations should focus on the cognitive and emotional drivers behind these interactions.**

I. Introduction

As robots become commonplace in sectors where they interact with the general population, such as customer service and education, the complexities of social human-robot interaction (HRI) intensify due to the deeply personal and dynamic nature of the interaction. Hence, deeper exploration is necessary to better understand the nuances between human-robot interactions and how they may differ or be similar to human-human interactions so we may better design robots for their intended roles and activities in society [1], [2]. Storytelling stands out as one such intrinsically human activity that is being performed by robots, which prompts significant inquiries regarding human engagement, cognitive processing, and emotional connectivity [3], [4].

Understanding the details of HRIs necessitates empirical measurement that can evaluate detailed aspects of the interaction. A primary measurement tool that has consistently emerged in this context is ”response latency”. As evidenced by studies like [5] and [6], response latency has served as a tool to measure human cognitive burden and engagement levels in HRI. Findings in [5] shed light on how variations in robotic actions, like retraction response time, can significantly influence interaction forces with human participation, which shows that the underlying human reaction times play a pivotal role in HRI. Similarly, [6] further extended the utility of response latency to measure cognitive burden in spatial communication with robots, thereby offering deeper insights into cognitive processing in HRI in different interactive contexts.

Although the field of HRI has flourished with the design of robots emulating human-like interactions [7], [8], there exists a research gap. While contemporary studies have explored the multifaceted applications of robots across fields such as education or healthcare [9], [10], they often overlook the nuanced dynamics of human-robot interactions that require collaborative content generation such as within an interactive storytelling context. Storytelling contexts, in particular, are distinctive as they encapsulate deeply human experiences, emotions, and cognitive processes. Exploring interactions in interactive storytelling contexts is crucial since it can uncover how robots might be integrated into roles that require not just functional efficacy but also profound interactive and creative understanding. However, these crucial aspects of HRI, especially within storytelling scenarios, remained largely unexplored [11], [12].

Examining interactant responses generated through interactive storytelling gives us the chance to delve into the participants' cognitive realm and how robots and humans could build successful HRI. Such an investigation can not only advance our understanding of the limits and potential of human-robot communication but also guide the design of robots for social interactions [13], [14]. Drawing together these multifaceted considerations, a clear yet uncharted intersection emerges at the confluence of human-robot interaction, interactive storytelling, and cognitive processing. The pressing inquiry that surfaces is: In what ways do robot narrators, mirroring human nuances, impact our engagement in interactive stories and our cognitive processing? With these pivotal questions at the forefront, this research aims to bridge this knowledge gap through the following research questions.

The specific research questions (RQs) addressed in this paper include:

RQ1: Does the presence of a robot narrator increase response latency in participants compared to a human narrator?

RQ2: Do participants provide longer verbal utterances when interacting with a human narrator compared to a robot narrator?

II. Related Works

A central concern in HRI studies has been understanding human response latency in interactive social contexts and its adaptability to robot behaviors. Studies that centralized response latency have been conducted in social and physical

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HRI settings. For instance, [5] explored human-to-robot handovers, finding that variations in robot behavior, such as grasp method and retraction speed, considerably affected interaction forces. Crucially, this study revealed that human reaction time, approximately 150 ms for haptic stimuli, played a pivotal role in influencing these forces. The faster retraction speed led to almost double the retraction force, emphasizing the need to modulate and limit retraction speeds and underscoring the importance of considering human response time in designing efficient HRI [5].

Similarly, [6] delved into spatial communication, probing if robots are perceived as human-like social partners. The study utilized response latency as a tool to assess cognitive processing, discerning that speakers exhibited increased response latency when required to describe from the addressee's perspective. This pivotal finding implies that response latency is a vital metric in understanding cognitive burden in HRI and could significantly influence robot design to minimize the cognitive load on humans and set the ground for well-balanced HRI interactions.

Moreover, researchers in [15] demonstrated that robots could even facilitate human language production during a joint picture naming task. The study utilized naming response latency as a reflection of response time, revealing that co-naming with a robot led to faster naming latency. Such findings indicated the robots' potential to improve spoken language, especially in educational and clinical settings. However, not just adults, but even children's interaction with robots displayed the significance of response latency. In [16], the potential of robots in collaborative storytelling with children was explored. The study showed that longer experimenter latency correlated with a slower yield of meaningful content in storytelling. Such findings support the necessity of timely responses to ensure efficient and meaningful HRI interaction, especially in an educational context where children's cognitive processing is engaged for learning purposes.

Furthermore, the research in [17] uncovered the nuances of human perception and interaction with robots that mimic human features. Through the lens of social attention, the study illuminated the dynamics of how the appearance and motion of an agent, robotic or human, can influence implicit social attention. Interestingly, agents with human-like attributes proved more effective in capturing attention, highlighting their inherent social relevance. Such measurement of response times in this research further emphasized the importance of an in-depth understanding of human-robot interactions. Such insights are pivotal, suggesting that when designing robots with a lifelike attribute, there's a heightened possibility of evoking human-like responses which set the ground for deeper HRI studies.

Researchers in [18] delved into the details of social information processing in HRI, discovering that both robots and humans provoked similar degrees of recognition memory. In this context, response latency was not just a peripheral metric but a central one. By ensuring that every participant had an equal chance to view the stimuli, the role of response latency became pivotal in affirming the robustness of the study's outcomes. This highlights the importance of understanding response latency when evaluating humans' cognitive processes during interactions with robots compared to humans. The research in [19], followed the same line and emphasized the importance of reaction and response latency in determining the naturalness and efficiency of interactions in human-robot teams. Their findings suggest that human-robot collaborations might inherently possess longer response times. This not only supports the indispensable nature of these latency metrics but also alludes to the potential challenges that might be revealed when optimizing human-robot team dynamics. Such insights amplify the need for research which delves into the details of response latency, to enhance the understanding and performance of human-robot interactions.

In their exploration of robot adaptability in short-term engagements, [20] utilized response latency as a measure of game move performance. This demonstrated the robot's adaptability while highlighting how response latency offers insights into the efficiency of human-robot interactions. The study's ramifications were profound, indicating that with the right adjustments, robots can be smoothly integrated into real-world scenarios, to serve a myriad of user demographics. The importance of latency metrics, as highlighted in this research, further motivates the need for our investigation into the impact of narrator types on response latency in interactive storytelling.

The literature robustly supports the significance of response latency in HRI across diverse contexts, from handovers to storytelling to game moves. This cumulative knowledge supports the crucial importance of exploring the impact of narrator type (robot vs. human) on response latency in interactive storytelling. As highlighted in [5], [6], understanding human response times and cognitive processing is pivotal in optimizing HRI in a social context. By examining the role of robot narrators in interactive storytelling, this research bridges the gap between the technical and cognitive aspects of HRI, which facilitates the design of robots that can both function effectively and engage with users smoothly. Storytelling, as a deeply human activity, offers a unique platform to assess the details of human engagement, cognitive processing, and emotional connectivity with non-human entities [11], [12]. In the evolving landscape of HRI, where robots are steadily making inroads into sectors like education and therapeutic interventions [9], [10], [21]–[23], there's a pressing need to understand their potential and efficacy as narrators in interactive storytelling. Current literature and research in response latency, while invaluable, do not necessarily cater to the unique challenges and nuances presented by the domain of interactive storytelling. Understanding robots' challenges and efficacy as narrators can revolutionize their integration in the field. Robots that can engage audiences interactively, while accounting for cognitive processing times, can lead to enhanced learning outcomes and therapeutic benefits. Moreover, this research can inform the development of robots for contexts requiring effective interactions or time-sensitive responses, such as elderly care or mental health interventions. Therefore, by merging the realms of cognitive processing and robotic narration, this research has the potential to provide a vivid picture of response latency in HRI interaction in an interactive storytelling context.

III. HRI and Interactive Storytelling

To investigate the HRI in interactive storytelling environments, we focus on two theoretical perspectives: Social Presence Theory and Cognitive Processing Theory. These frameworks offer individual insights pertinent to our research questions and, when combined, provide a comprehensive lens to uncover the relationship between cognitive processing and social interaction in our study's context.

A. Social Presence Theory

The Social Presence Theory, stemming from the research of [24], suggests that the perception of another party's presence in a mediated communication environment impacts communication. This perceived "presence" isn't just about physical existence; it delves into the realms of emotional and psychological availability and acknowledgment, determining how authentic or genuine an entity appears to the participant and attends the conversation. Given our first research question, which probes the difference in response latency between robot and human narrators, the Social Presence Theory becomes pivotal. If individuals perceive a robot narrator as having a genuine presence, their engagement levels, emotional responses, and ultimately their response latency could mirror interactions with a human narrator. Conversely, different perceptions of robot presence compared to humans might result in discernible differences in interaction dynamics.

B. Cognitive Processing Theory

Cognitive Processing Theory, as delineated by [25], revolves around the mechanisms by which information is received, internalized, and responded to. It delves into the depth and type of processing, asserting that the manner of cognitive engagement influences memory and response behaviors including response latency. Two facets of our research are directly illuminated by this theory. Firstly, when participants are exposed to interactive stories, which are narrated by two different agents (human vs. robot), could lead to participants' different cognitive processing in terms of processing time to articulate responses and the length of their responses. Secondly, the use of prosody, a rhythmic and melodic element, in storytelling could influence cognitive processing. As participants process these auditory cues, it might affect the immediacy and nature of their responses, thereby influencing response latency.

C. Integrated Perspective

By integrating the insights from both Social Presence and Cognitive Processing theories, we achieve a holistic framework. This combined perspective allows us to explore how social perceptions of the narrator (robot vs. human) shape participants' response latency and their utterances' length. This integrative approach ensures our exploration delves deeply into individual cognitive processing nuances while also broadly covering the social dynamics of human-robot interactions.

Grounded on these theories for this exploratory study our working hypotheses (WHs) are:

- **WH1:** Participants' response latency when the story is narrated by a robot would be significantly higher compared to when it is narrated by a human.
- **WH2:** The length of participants' utterances (responses) when the story is narrated by a human would be significantly higher compared to when it is narrated by a robot.

IV. Experimental Design

To address the research questions and evaluate the hypotheses, we conducted an exploratory analysis of data we collected from a study presented in [13] that focused on investigating human backchanneling behaviors in response to human-robot interactions and human-human interactions. Informed by Social Presence and Cognitive Processing Theories, in this exploratory analysis we focused on investigating the effects of human vs. robot narrator type on listener response latency and utterance length during an human-robot interactive storytelling scenario.

A. Interactive Storytelling

An interactive storytelling scenario was crafted to create a platform where participants could actively engage in the interaction, taking on roles as both listeners and contributors to the narrative. This was achieved by enabling participants to influence the story's direction through making choices, from a set of provided options, on how they would like the character to respond to an event.

Two interactive narratives were created, one evoking happiness and the other sadness, with participants making choices that influenced the story's incidents. The happy narrative featured a linguistic professor's comical attempts to teach a foreign language, leading to a positive outcome despite his lack of fluency. In the sad narrative, participants guided a veterinary science professor in rehabilitating an injured dog named Lacy, forming a close bond that ended in heartbreak when the professor couldn't keep Lacy. Narrative lengths varied from 8 to 15 minutes based on participant engagement. For more details on the interactive stories see [13].

B. Experimental Setup

The narrator for the human condition was a 20-year-old American female researcher who was a native English speaker. Figure 1 illustrates the presence of the human narrator on the right side of the figure, with the participant situated on the left.

In the robot narrator condition, a Furhat social robot (Figure 2) was employed, and it was operated remotely by a researcher using a customized Wizard of Oz (WoZ) interface

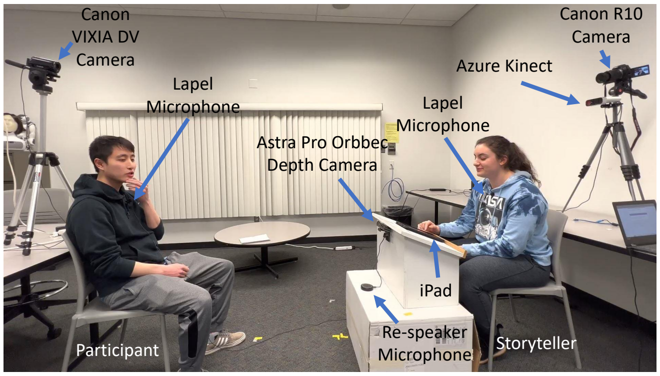

Fig. 1. Experimental setup for the human narrator condition

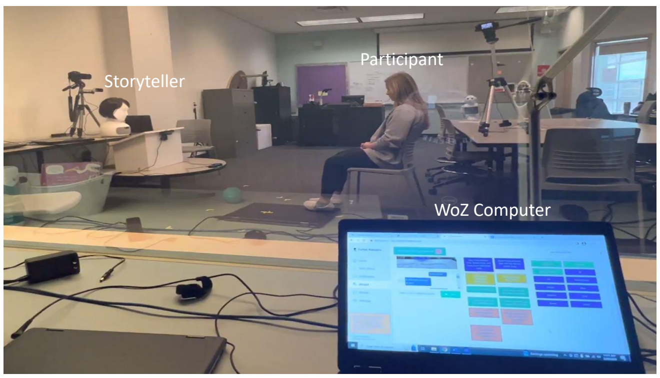

Fig. 2. WoZ and the experimental setup for the robot narrator condition

to narrate the story. The teleoperator had the ability to observe the interaction through a one-way mirror located in an adjacent room, as depicted in Figure 2.

1) Furhat Social Robot: The Furhat robot incorporates "blended embodiment," which involves projecting a human-like face onto a physical mask at the back of its head for lifelike facial expressions and natural eye gaze. It mimics human head movements with an anatomically inspired neck design. Furhat's hardware includes a wide-angle camera, two microphones, and a built-in speaker. It can seamlessly switch between different faces and masks, offering voice options like Amazon Polly (what we used in this experiment), and the Acapela Group. In terms of human-like appearance, it scores 63.43 on the ABOT database, surpassing robots like NAO (45.92) and Pepper (42.17) despite lacking arms and legs (as per [26]).

C. Procedure

This study was approved by the Oakland University Institutional Review Board (IRB) under #IRB-FY2022-103. For this experiment, 28 participants (14 individuals per condition) were recruited. There were 15 male and 13 female participants, with an average age of approximately 30 years.

Participants received a briefing before starting the experiment in another room, where they provided written informed consent and filled out a demographic and technology experience questionnaire. They were then guided to the room with the narrator and presented with the first narrative. Participants had a short break between the narrators' conditions and the second story was then started. Notably, a printed copy of the story was placed on a desk in front of the narrators during the storytelling sessions. To ensure consistency in both narrator conditions, the human narrator was permitted to refer to an iPad with the story manuscript, as memorization of the entire interactive story was not feasible. It is worth mentioning that, to maintain consistency between conditions, the robot narrator was programmed to mimic the action of reading from a printed manuscript at the same points as the human narrator.

D. Data Collection, Coding, and Analysis

All interactive story interactions were video recorded using two cameras. One video camera provided a close-up view of the participant's upper body and the second camera faced the narrator's body.[1]

To code the participants' response latency, their recorded videos were converted into audio files and Transkreptor[2] was employed as a tool to transcribe the interactions with the the exact time (seconds) that each interactant initiated speaking. The time that each speaker spent interactively answering the robot and the human narrators' questions was exported as an Excel file for further analysis. Following Tausczik and Pennebaker's approach [27] for calculating the number of words in each utterance, we counted each participant's number of words that were articulated to answer the questions during the interactive storytelling conditions. Overall, we analyzed 28 participants' response latency and the number of words in each utterance.

We evaluated our hypotheses using an independent samples t-test where the independent variable was the narrator type (i.e., human or robot) while the dependent variables were response latency measured in seconds, and the utterance length measured by the number of words used by participants during their turns to speak. The normality of the data was assessed using Shapiro-Wilk's test before conducting the t-tests. Both dependent variables were normally distributed.

V. Results and Discussion

The result of our study is depicted in Figures 3 and 4. Regarding the first hypothesis, the average time of the response latency for the robot narrator condition (μ = 4.11, σ = 0.48) was higher than the human narrator condition (μ = 3.68, σ = 0.58), and this difference was significant ($t(26) = 2.14$, $p = 0.021$). The calculated effect size (Cohen's d) for the comparison of the response latency is approximately 0.80. This effect size suggests a large effect size in response latency between the robot and human narrator conditions. A power of 0.66 suggests that with this effect size, this study has a reasonable chance of detecting a significant difference in response latency between the robot and human narrators. Considering this result, the first hypothesis would be accepted.

[1]Datasets can be made available upon request from the corresponding author.

[2]https://transkriptor.com

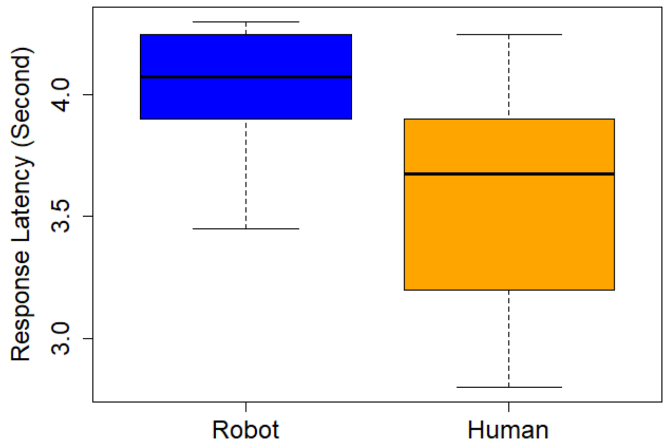

Fig. 3. Response latencies for robot vs. human narrators

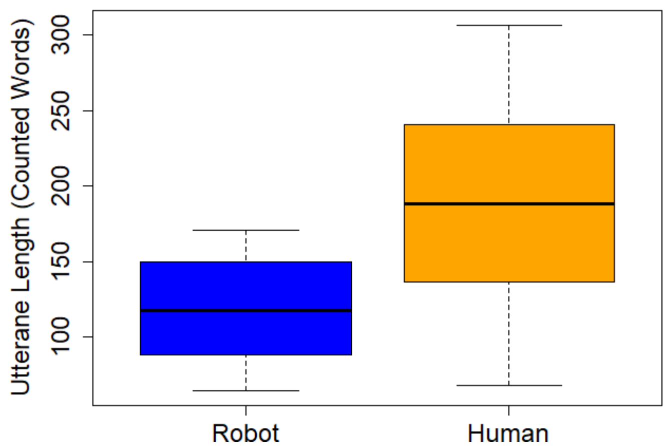

Fig. 4. Utterance length for robot vs. human narrators

These findings provide crucial insights into the HRI interaction dynamism, particularly in the context of interactive storytelling. The independent sample t-test results revealed significant differences in response latency between participants engaging with robot narrators compared to those interacting with human narrators. Specifically, participants in the robot condition exhibited longer response latencies. This aligns with the previous findings that emphasize the importance of understanding human response time in HRI [5]. They also stressed how variations in robot behavior could considerably affect human interaction dynamics, suggesting that the nature of robotic narrators in our study might have influenced the extended response latency observed.

Moreover, studies like [6] highlighted the role of response latency in measuring cognitive load in spatial communication, suggesting that longer response latencies could indicate increased cognitive burden. The extended response latency observed in our robot condition might imply a higher cognitive burden on participants when engaging with robot narrators. This parallels the cognitive response behaviors [25]. Considering the details dynamics of human engagement, cognitive processing, and emotional connectivity, our findings emphasize the profound potential and challenges of HRI in interactive storytelling [11], [12].

For the second hypothesis, the average word count of the participants' utterances (responses) during the robot narrator condition (μ = 119.71, σ = 33.93) was lower than the human narrator condition (μ = 188.71, σ = 78.50), and this difference was significant ($t(26)$ = -3.01, p = 0.003). The calculated effect size (Cohen's d) for the comparison of the utterance (response) length is approximately 1.141. This effect size suggests a moderately large difference in the length of utterances between the robot and human narrator conditions. Considering this effect size, a power of 0.9 suggests that this study has a high probability of detecting a significant difference in the utterance length between the robot and human narrators which accepts our second hypothesis.

Our results highlight that humans produce longer utterances with a human narrator compared to a robot narrator. This variance in speech length could be indicative of the cognitive processing differences between human-human and human-robot interactions. In [6] a possible framework was provided for understanding this difference. In their investigation into spatial communication, they assessed participants' cognitive burden during interaction with the robot. Such cognitive loading could potentially lead to shorter, more concise utterances when dealing with robots, as seen in our study.

Taken together, our findings present a detailed picture of human cognitive processing in the context of interactive storytelling sessions presented by robot vs human narrators. The longer response latency, but shorter utterance length observed in the robot condition, stands in sharp contrast to the shorter response latency but longer utterances in the human condition. This discrepancy reveals the differential cognitive load of individuals when faced with human versus robot interlocutors. The current literature, such as the work of [5] reinforces the importance of such observations, emphasizing the critical role of response latency in understanding and optimizing human-robot interactions. The balance between the social perceptions of the narrator, as discussed in the Social Presence Theory, and cognitive processing details, as posited by the Cognitive Processing Theory, shape the interactions in the storytelling settings. As robots continue to integrate into domains like education and therapeutic interventions, understanding their efficacy and challenges as narrators are paramount [9], [10].

On the implication side, the findings of this study underscore the intricate relationship between Social Presence and Cognitive Processing theories in the context of human-robot interactions during interactive storytelling. The observed longer response latencies and shorter utterances in interactions with a robot narrator suggest that enhancing the human likeness of robots could potentially decrease the interactant's cognitive load, which could lead to shorter response latency and lead to lengthier responses. This would have the potential to improve the communication quality between humans and robots. Hence, these insights potentially call for a robot that is equipped with more sophisticated, human-like features to convey the same presence impression on interactants as a human narrator does. Future research should further investigate the nuances of this relationship, exploring how varying degrees of the robot's human likeness impact cognitive processing and social presence in different interactive scenarios. This could pave the way for more personalized and effective human-robot interaction strategies in educational, therapeutic, and entertainment domains.

REFERENCES

[1] J.-C. Liang and G.-J. Hwang, "A robot-based digital storytelling approach to enhancing efl learners' multimodal storytelling ability and narrative engagement," *Computers & Education*, vol. 201, p. 104827, 2023.

[2] M. E. Ligthart, M. A. Neerincx, and K. V. Hindriks, "Design patterns for an interactive storytelling robot to support children's engagement and agency," in *Proceedings of the 2020 ACM/IEEE international conference on human-robot interaction*, 2020, pp. 409–418.

[3] J. M. K. Westlund, L. Dickens, S. Jeong, P. L. Harris, D. DeSteno, and C. L. Breazeal, "Children use non-verbal cues to learn new words from robots as well as people," *International Journal of Child-Computer Interaction*, vol. 13, pp. 1–9, 2017.

[4] J. K. Westlund and C. Breazeal, "The interplay of robot language level with children's language learning during storytelling," in *Proceedings of the tenth annual ACM/IEEE international conference on human-robot interaction extended abstracts*, 2015, pp. 65–66.

[5] M. K. Pan, E. A. Croft, and G. Niemeyer, "Exploration of geometry and forces occurring within human-to-robot handovers," in *2018 IEEE Haptics Symposium (HAPTICS)*. IEEE, 2018, pp. 327–333.

[6] C. Xiao, L. Xu, Y. Sui, and R. Zhou, "Do people regard robots as human-like social partners? evidence from perspective-taking in spatial descriptions," *Frontiers in Psychology*, vol. 11, p. 578244, 2021.

[7] B. Fang, X. Wei, F. Sun, H. Huang, Y. Yu, and H. Liu, "Skill learning for human-robot interaction using wearable device," *Tsinghua Science and Technology*, vol. 24, no. 6, pp. 654–662, 2019.

[8] H. Su, W. Qi, J. Chen, C. Yang, J. Sandoval, and M. A. Laribi, "Recent advancements in multimodal human–robot interaction," *Frontiers in Neurorobotics*, vol. 17, p. 1084000, 2023.

[9] A. Bohr and K. Memarzadeh, "The rise of artificial intelligence in healthcare applications," in *Artificial Intelligence in healthcare*. Elsevier, 2020, pp. 25–60.

[10] A. M. Cox, "Exploring the impact of artificial intelligence and robots on higher education through literature-based design fictions," *International Journal of Educational Technology in Higher Education*, vol. 18, no. 1, p. 3, 2021.

[11] I. Leite, M. McCoy, M. Lohani, D. Ullman, N. Salomons, C. Stokes, S. Rivers, and B. Scassellati, "Narratives with robots: The impact of interaction context and individual differences on story recall and emotional understanding," *Frontiers in Robotics and AI*, vol. 4, p. 29, 2017.

[12] R. Andreasson, B. Alenljung, E. Billing, and R. Lowe, "Affective touch in human–robot interaction: conveying emotion to the nao robot," *International Journal of Social Robotics*, vol. 10, pp. 473–491, 2018.

[13] P. Shahverdi, K. Rousso, J. Klotz, I. Bakhoda, M. Zribi, and W.-Y. G. Louie, "Emotionally specific backchanneling in social human-robot interaction and human-human interaction," in *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE, 2023, pp. 4059–4064.

[14] W.-W. Shen and J.-M. Lin, "Robot assisted reading: a preliminary study on the robotic storytelling service to children in the library," in *Innovative Technologies and Learning: First International Conference, ICITL 2018, Portoroz, Slovenia, August 27–30, 2018, Proceedings 1*. Springer, 2018, pp. 528–535.

[15] O. A. Wudarczyk, M. Kirtay, D. Pischedda, V. V. Hafner, J.-D. Haynes, A. K. Kuhlen, and R. Abdel Rahman, "Robots facilitate human language production," *Scientific Reports*, vol. 11, no. 1, p. 16737, 2021.

[16] M. Sun, I. Leite, J. F. Lehman, and B. Li, "Collaborative storytelling between robot and child: A feasibility study," in *Proceedings of the 2017 Conference on Interaction Design and Children*, 2017, pp. 205–214.

[17] A. X. Li, M. Florendo, L. E. Miller, H. Ishiguro, and A. P. Saygin, "Robot form and motion influences social attention," in *Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction*, 2015, pp. 43–50.

[18] M. Kim, T. Kwon, and K. Kim, "Can human–robot interaction promote the same depth of social information processing as human–human interaction?" *International Journal of Social Robotics*, vol. 10, pp. 33–42, 2018.

[19] C. E. Harriott and J. A. Adams, "Towards reaction and response time metrics for real-world human-robot interaction," in *2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*. IEEE, 2017, pp. 799–804.

[20] A. Andriella, C. Torras, and G. Alenya, "Short-term human–robot interaction adaptability in real-world environments," *International Journal of Social Robotics*, vol. 12, pp. 639–657, 2020.

[21] P. Shahverdi, K. Rousso, I. Bakhoda, N. Huang, K. Rohrbeck, and W.-Y. G. Louie, "Robot-mediated job interview training for individuals with asd: A pilot study," in *2023 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*. IEEE, 2023, pp. 564–570.

[22] C. M. Wilson, L. Boright, W.-Y. G. Louie, P. Shahverdi, S. K. Arena, R. Benbow, J. R. Wilson, Q. Chen, K. Rousso, and N. Huang, "Effect of robotic delivery of physical activity and fall prevention exercise in older adults: a pilot cohort study," *Cureus*, vol. 15, no. 8, 2023.

[23] M. Trombly, P. Shahverdi, N. Huang, Q. Chen, J. Korneder, and W.-Y. G. Louie, "Robot-mediated group instruction for children with asd: a pilot study," in *2022 31st IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*. IEEE, 2022, pp. 1506–1513.

[24] J. Short, E. Williams, and B. Christie, "The social psychology of telecommunications," *(No Title)*, 1976.

[25] F. I. Craik and R. S. Lockhart, "Levels of processing: A framework for memory research," *Journal of verbal learning and verbal behavior*, vol. 11, no. 6, pp. 671–684, 1972.

[26] E. Phillips, X. Zhao, D. Ullman, and B. F. Malle, "What is human-like? decomposing robots' human-like appearance using the anthropomorphic robot (abot) database," in *Proceedings of the 2018 ACM/IEEE international conference on human-robot interaction*, 2018, pp. 105–113.

[27] Y. R. Tausczik and J. W. Pennebaker, "The psychological meaning of words: Liwc and computerized text analysis methods," *Journal of language and social psychology*, vol. 29, no. 1, pp. 24–54, 2010.