The Playful Path to Progress: Uncovering the Bright Future of Social Robots

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Abstract

This paper investigates the potential of social robots as play partners and their potential impact on human development. In this exploration, we aim to shed light on the potential role of social robots in teaching humans and emphasise their possible significance in promoting learning and development. Our introduction begins by emphasising the intrinsic value of play and provides a historical and evolutionary perspective to contextualise our research. We then delve into the concept of social play, highlighting its importance in human development. Throughout this paper, we explore the crucial role of interactional play in human development, offering examples at various stages of life. We emphasise the significance of social robots as play partners and examine the benefits they could bring to the learning and development process. In conclusion, we summarise the potential role of social robots as play partners and underscore the considerable impact they could have on human development.

Keywords: Social Robots, Human Development, Interactional Play, Educational Play

1. Introduction

Play and games play a vital role in human development across different stages of life. They provide enjoyment and serve as essential tools for education, enabling the acquisition of crucial qualities, knowledge, and social interaction (Liaudanske, 2023). Social play, in particular, is crucial for developing behavioural flexibility, social and cognitive competence, and group cohesion. The absence of social play during critical developmental periods can adversely affect social, cognitive, emotional, and sensorimotor development (Trezza et al., 2010; Vanderschuren & Trezza, 2014).

It is imperative to ensure that individuals of all ages, from children to adults, have access to play throughout their lives, regardless of their circumstances (Milteer et al., 2012; Nijhof et al., 2018). In this regard, social robots have the potential to serve as a solution, facilitating the widespread implementation of social play, even in challenging settings. This article explores the possibilities of social robots as play partners for humans, fostering positive human development.

Indeed, social robots have been increasingly recognised for their potential to enhance human development through interactional play. However, it is essential to acknowledge that the benefits of social robots may vary depending on the context and the specific population they serve. This paper particularly emphasises the potential positive impact of social robots on target audiences such as autistic children and the elderly, where traditional human-human interactions may be limited or challenging. By identifying these specific groups, we aim to highlight situations where social robots can be more beneficial than human counterparts. Additionally, we recognise the inherent limitations of social robots, particularly when compared to the richness and complexity of human-human interactions. These limitations include the potential for fear or discomfort on the part of the human user and practical constraints such as financial costs and accessibility.

Nevertheless, this paper offers a novel contribution to the field of human-robot interaction (HRI) by exploring the role of social robots as play partners in promoting human development, a topic that has received limited attention in current literature. While previous studies have extensively examined the use of social robots in therapeutic settings and their potential for companionship, this research uniquely focuses on the intersection of social play, cognitive development, and the emotional well-being of users across

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different life stages. Doing so not only expands the understanding of how social robots can be integrated into various developmental contexts but also challenges traditional perspectives that view robots primarily as tools for learning or assistance.

2. Social Play in Human Development

Social play plays a critical role in the development of human beings, impacting various aspects of cognitive, emotional, and social growth. Extensive research has been conducted to explore how play contributes to acquiring skills and behaviours essential for a healthy childhood and beyond.

2.1 Cognitive and Social Development

One significant area influenced by social play is cognitive development. Research has shown that engaging in social play enhances cognitive skills such as problem-solving, creativity, and language development (Christie & Johnsen, 1983; Yogman et al., 2018; Milteer, 2012). Through play, children are provided with opportunities to exercise their social knowledge and logical thinking abilities, enabling them to learn important skills such as cooperation, negotiation, and overcoming challenges (Christie & Johnsen, 1983; Milteer et al., 2012; Nijhof et al., 2018).

Moreover, games can potentially foster the development of critical skills such as creativity, empathy, and problem-solving (Filho et al., 2022). Social play exposes individuals to different perspectives and teaches them to think flexibly, contributing to their cognitive and social competence.

2.2 Emotional and Behavioral Regulation

Social play also has a significant impact on emotional and behavioural regulation. It has been found that games stimulate emotional intelligence and the processing of negative emotions and aggressive tensions, particularly during adolescence (Galanti, 2019). Play supports the development of emotional regulation and resilience, enabling children to effectively manage stress and develop coping mechanisms (Yogman et al., 2018; Milteer et al., 2012; Nijhof et al., 2018).

In addition to emotional regulation, social play is crucial for developing executive functions, encompassing self-regulation, goal pursuit, and ignoring distractions (Yogman et al., 2018; Milteer et al., 2012). By engaging in play, individuals can practice these executive functions, ultimately enhancing their ability to regulate their behaviour and achieve their goals.

Considering social well-being, play emerges as a protective factor against psychopathologies by promoting the experience of positive emotions and enhancing emotion regulation, ultimately supporting adaptive emotional functioning (Zaharia et al., 2022). Therefore, play and games have the potential to significantly contribute to emotional and social development, fostering positive relationships among diverse populations (Anachury et al., 2023).

2.3 Moral Development

Finally, according to Lawrence Kohlberg's theory, social play has a significant role in moral development. Kohlberg's theory of moral development, extensively studied for over three decades, highlights the impact of socialisation on shaping an individual's moral reasoning (Gump et al., 2000). Kohlberg suggests that moral development is driven by an individual's intrinsic motivation for self-realisation and social acceptance, underscoring the importance of social interactions in the moral growth process ("Ideological Education of College Students in China: Based on the Distribution Characteristics of Moral Development", 2018). Research indicates that the social context influences the pace of moral reasoning development, demonstrating the crucial role of social play and interactions in moulding moral judgments (Tudin et al., 1994).

Kohlberg's theory also emphasises the necessity of cognitive and social disequilibrium for moral development. While cognitive disequilibrium, such as discussing hypothetical dilemmas, aids cognitive growth, social disequilibrium, like engaging in moral games, promotes social development (Haan, 1985). This underscores the importance of social experiences, including play, in enhancing moral reasoning abilities.

Furthermore, Kohlberg recognises the intricate interplay between social environments and moral development. Studies have shown that school environments fostering participation in decision-making processes and exposing individuals to varying levels of moral reasoning can spur moral development by creating cognitive conflicts (Powers, 1988). This highlights the role of social structures, such as families and schools, in nurturing moral growth through social engagement and the potential of the child and adult's environment to grow morally.

In conclusion, social play is a critical component of human development, influencing cognitive, emotional, moral and social aspects. It contributes to developing cognitive skills, social knowledge, emotional regulation, and behavioural flexibility. Engaging in social play fosters positive relationships and supports the acquisition of important life skills necessary for healthy and well-rounded development.

3. Mechanisms of Social Play

Social play involves activating various neurotransmitter systems, contributing to its rewarding and motivational aspects. The neurotransmitter systems implicated include opioids, endocannabinoids, dopamine, and noradrenaline (Vanderschuren et al., 2016; Trezza et al., 2010; Pellis & Pellis, 2007). These systems modulate pleasurable experiences and play a crucial role in shaping social play's motivational properties.

The nucleus accumbens (NAcc) is one key brain region in modulating social play. The NAcc is known to be a central

site for the integration of reward-related signals, and it plays a significant role in the processing of both opioids and dopamine, both involved in the rewarding aspects of social play (Kerkhof et al., 2013; Vanderschuren et al., 2016). The activation of the NAcc during social play highlights its importance in the neural mechanisms underlying the rewarding nature of this behaviour.

Beyond the neurotransmitter systems and reward mechanisms, social play engages various cognitive processes that facilitate social interactions and learning. The social cognitive theory provides a framework for understanding how social play influences behaviour through direct and socially mediated pathways, promoting changes by informing, enabling, motivating, and guiding participants (Bandura, 2001; Beauchamp et al., 2019). This theory emphasises the role of cognitive processes in the social play experience.

Learning through observation, imitation, and mirroring emotions are fundamental social play mechanisms (Frith & Frith, 2012). By observing and imitating others, individuals acquire social knowledge and develop trust, which is crucial for accurate social interactions. These cognitive processes allow individuals to learn from their peers, expanding their behavioural repertoire and enhancing their social competence.

Mentalising and meta-cognitive processes also play a significant role in social play. Implicit and explicit mentalising processes enable individuals to track others' intentions, desires, and beliefs, fostering a deeper understanding of social interactions (Frith & Frith, 2012). These processes enhance learning and the ability to share experiences, contributing to the development of accurate social interactions and emotional regulation.

In summary, social play is a multifaceted behaviour involving various neurotransmitter systems interplay and engages critical brain regions such as the prefrontal cortex (PFC), striatum, and nucleus accumbens (NAcc). It is a rewarding experience essential for developmental processes, influencing behavioural flexibility, social competence, and emotional regulation. The cognitive mechanisms underlying social play, including observation, imitation, and mentalising, contribute to facilitating social interactions and acquiring social knowledge through play. These mechanisms are vital for individuals to navigate the complexities of social interactions and develop a deeper understanding of others.

4. Social Robots as Play Partners

Social robots have emerged as autonomous machines capable of intelligently interacting and communicating with humans, often designed to mimic human or animal behaviours to facilitate social interaction (Fox & Gambino, 2021). Recently, these robots have been increasingly developed to serve as social play partners, enhancing social interactions and providing companionship. Leveraging advanced learning algorithms and emotional intelligence, social robots engage in various activities, from playing games to assisting in therapeutic settings, intending to create meaningful interactions.

4.1 Perception as Intentional Agents

One significant aspect of designing social robots as play partners involves creating the perception of intentional agents. Research has shown that social robots perceived as intentional agents can activate areas in the human brain associated with social-cognitive processing, fostering feelings of social connection, empathy, and prosocial behaviour (Wiese et al., 2017). By leveraging this perception, social robots can establish a sense of shared understanding and engagement with humans, enhancing the quality of social interactions.

4.2 Enhanced Learning and Interaction through Social Mechanisms

Social robots employ a range of social mechanisms to enhance learning and interaction. Social robots can direct attention and actions through stimulus enhancement, emulation, mimicking, and imitation techniques, significantly impacting the learning process and interaction quality (Cakmak et al., 2010). By utilising these social mechanisms, social robots facilitate engagement and learning in play scenarios, promoting a more effective and enjoyable experience for humans.

4.3 Therapeutic and Developmental Benefits

Social robots have proven beneficial in therapeutic and developmental settings, particularly when interacting with children. Children often develop social and moral relationships with social robots, which can be viewed as a distinct ontological category separate from humans, animals, or artefacts (Kahn et al., 2013). These relationships can provide children with valuable social interaction and support, fostering their social and emotional development.

Implementing empathic models in social robots has been shown to sustain long-term interactions with children, enhancing their perception of social presence, engagement, and social support (Leite et al., 2014). In scenarios where robots interact with children over extended periods, such as playing chess, social robots have demonstrated their ability to engage children and provide meaningful social interactions.

Furthermore, social robots effectively engage autistic children, promoting social behaviours and communication skills by embedding social interaction into intrinsic reinforcers (Kim et al., 2013). These robots serve as interaction partners that encourage more speech and social interaction than human or computer game partners, making them valuable tools for social skills and communication therapies for children with autism spectrum disorders (ASD).

4.4 Role and Behavior Adaptation in Social Contexts

Social robots can adapt their roles and behaviours in social play scenarios, influencing human socioemotional and

task-oriented behaviours (Oliveira et al., 2019; Correia et al., 2021). Robots can shape social play interactions by adjusting their roles as partners or opponents and exhibiting competitive or cooperative behaviours. This adaptability can encourage humans to engage in different types of social behaviour, promoting social coordination and the development of relevant skills that can be transferred to other contexts (Yuan et al., 2022).

4.5 Natural and Efficient Interaction

To establish natural and efficient interactions, social robots often mimic human motion features (Sciutti & Sandini, 2017). By imitating human movements, social robots facilitate phenomena such as mutual adaptation, synchronisation, and anticipation, which are fundamental to social play. These natural and efficient interactions contribute to a more immersive and engaging play experience, allowing for a greater connection and enjoyment between humans and robots.

In conclusion, social robots could be valuable play partners, capable of enhancing social interactions and providing companionship. These robots foster social connections, facilitate learning, and promote social and emotional development by leveraging intentional agent perception, employing social mechanisms for enhanced learning and interaction, and adapting roles and behaviours in social contexts. Through their ability to establish natural and efficient interactions, social robots create meaningful play experiences that benefit individuals of various ages and abilities. Indeed, social robots have emerged as promising tools for facilitating play and promoting development, especially in contexts where traditional human interaction may be less effective. For instance, autistic children often face challenges in social communication and may benefit from the predictable and non-judgmental nature of social robots, which can provide a safe environment for practising social skills (Scassellati et al., 2012). Similarly, elderly individuals, particularly those experiencing loneliness or cognitive decline, may find companionship and cognitive stimulation in interactions with social robots, potentially alleviating feelings of isolation and improving mental well-being (Tapus et al., 2009).

However, it is important to recognise that social robots are not universally beneficial in all contexts. Their effectiveness is largely dependent on the specific needs and circumstances of the target audience. For example, while social robots can offer valuable support to individuals with autism or the elderly, they may not be as effective in situations where deep emotional connection, empathy, or nuanced social interaction is required. Human-human interactions, rich in emotional depth and complexity, cannot be fully replicated by robots, which lack genuine empathy and the ability to understand and respond to the full range of human emotions (Darling, 2016).

5. Discussion

The preceding chapters have highlighted the critical role of social play in human development, emphasising its impact on cognitive, emotional, and social aspects. The mechanisms underlying social play have also been explored, shedding light on the neurotransmitter systems and cognitive processes involved. Building upon this foundation, this chapter discusses the implications and potential considerations of incorporating social robots as play partners.

5.1 Design Recommendations

Social robots offer unique opportunities to enhance social interactions and provide companionship, particularly by creating meaningful and engaging play experiences. Leveraging advanced learning algorithms and emotional intelligence, social robots can activate social-cognitive processes in the human brain, fostering feelings of social connection, empathy, and prosocial behaviour. However, to maximise the effectiveness of social robots in various contexts, developers should consider several practical guidelines that address robot behaviour, adaptability, personalisation, cultural sensitivity, and the use of machine learning for continuous improvement.

5.1.1 Playing the Right Game: Behaviour and Interaction Design

Social robots should possess rich, emotive capabilities to create a more enjoyable and engaging storytelling experience. These capabilities can enhance interactions, making them more immersive for human participants (Nichols et al., 2021). By incorporating emotional elements into their design, social robots can establish deeper connections with users, fostering emotional engagement and increasing the overall impact of the storytelling experience.

It is important to balance game-playing competence and natural social behaviours when designing social robots for game-playing. By utilising emotional frameworks, robots can respond to game situations in a human-like manner, increasing trust and cooperation with human partners (Correia et al., 2021; Correia et al., 2016). This integration of emotional responses can create a more immersive gaming experience, enhancing the overall enjoyment and engagement of the participants.

Designing social robots to recognise and respond to full-body gestures during play can greatly enhance the enjoyment of the interaction. Robots can actively engage participants by providing feedback and suggesting ways to play, creating a more interactive and enjoyable experience (Cooney et al., 2014). Incorporating motion-based interactions into the design of social robots can encourage physical engagement, making the overall experience more immersive and rewarding for users.

5.1.2 Facilitating Learning and Positive Interaction

It is beneficial to implement various social learning mechanisms to improve the learning process and interaction quality of social robots. These mechanisms include stimulus enhancement, emulation, mimicking, and imitation (Cakmak et al., 2010). By incorporating these mechanisms, social robots can better understand and respond to human behaviour, facilitating more effective learning and interaction between the robot and its human counterparts. By utilising these social mechanisms, social robots can promote more effective and enjoyable play experiences for humans. This aspect is particularly relevant in educational settings, where social robots can serve as interactive and adaptive learning companions, supporting cognitive and social skill development.

Robots should align their actions with words to foster positive interactions, especially in cooperative settings. Consistency between verbal and non-verbal behaviour helps to establish trust and maintain a positive perception of the robot's actions (Correia et al., 2019). However, even when providing criticism, maintaining this alignment is crucial. By consistently offering constructive criticism, social robots can effectively guide human actions while preserving trust and rapport.

5.1.3 Adaptability and Personalisation

For social robots to be effective across diverse contexts, adaptability is key. Robots should be capable of adjusting their behaviours based on user feedback and interaction history. Machine learning algorithms can be employed to refine these behaviours over time, ensuring that the robot's responses remain relevant and engaging based on users' spoken, written or behavioural feedback. For example, in educational settings, a robot could adapt its teaching style based on the learning progress of a student, providing personalised feedback and support (Belpaeme et al., 2018). In therapeutic settings, such as with children with autism, robots could learn to recognise and respond to subtle cues of discomfort or interest, tailoring their interactions to better suit the needs of the child (Scassellati et al., 2012).

5.1.4 Cultural Sensitivity

The design of social robots should also account for cultural differences, which can influence how users perceive and interact with robots. For example, in some cultures, direct eye contact may be considered disrespectful, while in others, it is seen as a sign of engagement. Robots should be designed with the flexibility to modify their behaviours based on cultural contexts, ensuring that they are perceived positively by users from different backgrounds (Shin & Choo, 2011; Lim et al., 2021). Developers can achieve this by incorporating known explicit cultural norms, such as physical gestures, into the robot's behavioural algorithms and allowing for customisation based on the user's cultural preferences.

5.1.5 Machine Learning and Continuous Improvement

Implementing machine learning algorithms allows social robots to continuously improve their interaction quality over time. By analysing data from previous interactions, robots can identify patterns in user behaviour and preferences, enabling them to refine their responses and better meet user needs. This continuous improvement process is particularly important in long-term interactions, where maintaining user engagement and satisfaction is crucial (Graaf et al., 2014; Leite et al., 2014). For instance, a robot in a caregiving role might learn to recognise signs of anxiety, adapting its behaviour to provide comfort more effectively.

5.2 Social Robots Potential & Practical Implications

Social robots have shown significant therapeutic and developmental benefits, particularly in their interactions with children. These robots can foster cognitive, social, and emotional development by providing consistent, supportive interactions. Research has demonstrated that social robots are effective in sustaining long-term engagement with children, enhancing their sense of social presence, engagement, and support. This makes them valuable tools in therapeutic settings, especially for children with autism spectrum disorder (ASD), where they promote social behaviours and communication skills through predictable and interactive play scenarios (Leite et al., 2014). These capabilities allow social robots to complement existing interventions, providing consistent, non-judgmental interactions that support individuals with specific developmental needs (Scassellati et al., 2012).

Beyond therapeutic contexts, social robots have the potential to impact various real-world settings, including education and recreation. In educational environments, social robots can serve as interactive learning companions, enhancing traditional teaching methods by offering personalised, play-based learning experiences. Studies have shown that such robots can significantly improve student engagement and motivation by tailoring learning experiences to individual needs. This approach fosters a collaborative learning environment that supports the development of critical thinking and problem-solving skills (Belpaeme et al., 2018). However, successful implementation requires that educators are trained to integrate these technologies effectively, ensuring that robot interactions enhance rather than replace human instruction.

In recreational contexts, social robots can serve as engaging play partners for both children and adults, promoting social interaction and emotional well-being through shared play experiences. The adaptability of social robots to user preferences and play styles enables them to create personalised and immersive experiences that foster emotional connections and social bonding (Leite et al., 2014). Nevertheless, it is crucial to ensure that these interactions remain healthy and balanced, avoiding over-reliance on

robots for social interaction and mitigating the risk of reduced human-to-human engagement.

While the potential benefits of social robots are substantial, several challenges must be addressed to ensure their successful integration into real-world settings. Cost and accessibility are primary concerns that may limit the widespread adoption of social robots in educational, therapeutic, and recreational contexts. Additionally, there is a need for comprehensive training programs for educators, therapists, and caregivers to manage and optimise robot interactions effectively. The development of ethical guidelines and standards is also critical to prevent misuse and to ensure that social robots are used in ways that enhance, rather than detract from, human relationships (Tapus et al., 2009).

Moreover, the long-term impact of social robots on human development and social behaviour remains an area requiring further research. Understanding how sustained interactions with robots affect users over time is essential for evaluating the broader implications of their use (Graaf et al., 2014). Addressing these challenges will be key to realising the full potential of social robots in various practical applications.

Furthermore, social robots offer significant potential in educational, therapeutic, and recreational contexts; their limitations must be clearly understood to avoid overestimating their capabilities. One limitation is the potential for fear or discomfort in users, particularly those unfamiliar with robots or those who may feel threatened by the presence of a machine in traditionally human-centric roles. This discomfort can hinder the effectiveness of social robots and may limit their acceptance and integration into certain environments (Bartneck et al., 2007).

Another critical limitation is the financial cost associated with the development, deployment, and maintenance of social robots. High costs can restrict access to these technologies, particularly in underfunded educational or healthcare settings, where the benefits of social robots might be most needed (Sharkey & Sharkey, 2012). Moreover, the technological sophistication required to develop robots capable of meaningful social interaction often comes with significant financial investment, which may not be justifiable in all contexts.

In conclusion, the insights gained from this study offer valuable guidance for the application of social robots in educational, therapeutic, and recreational contexts. By carefully considering the benefits and challenges of implementing social robots as play partners, strategies can be developed to maximise their positive impact on human development while mitigating potential risks. As social robots continue to evolve, ongoing research and thoughtful implementation will be essential to ensure that these technologies are integrated effectively and ethically into real-world settings.

5.3 Ethical Considerations and Human-Robot Interaction

The integration of social robots as play partners presents significant ethical challenges that must be addressed to ensure their responsible use. As these robots become increasingly sophisticated in mimicking human behaviours, the potential for ethical dilemmas grows, particularly concerning privacy, emotional dependency, and the broader societal impact of long-term robot interaction.

One of the primary concerns is privacy. Social robots often collect and process sensitive personal data, including information about users' behaviours, preferences, and emotional states. Without stringent data protection measures, this data collection poses significant risks, such as breaches of confidentiality or unauthorised use of personal information. Šabanović (2010) emphasises that the design and deployment of social robots must be guided by ethical frameworks that prioritise user privacy and data protection to prevent violations of users' rights (Šabanović, 2010). Ensuring transparency in data collection and usage, as well as securing informed consent, are critical steps in safeguarding user privacy. Policymakers must collaborate with technologists to develop regulations that protect user privacy while allowing for the beneficial use of data to improve robot functionality.

Another ethical consideration is the risk of emotional dependency on social robots. As robots become more adept at simulating human-like interactions, there is a danger that users, especially vulnerable populations like children and the elderly, may form attachments to these machines, which could blur the boundaries between genuine human relationships and artificial interactions (Boch et al., 2023). This dependency could lead to confusion about the nature of relationships and even exploitation, as users may rely too heavily on robots for emotional support (Leite et al., 2014). To mitigate this risk, it is crucial that robots are designed to complement human interactions rather than replace them. For instance, robots could encourage users to seek out human companionship, promoting a balanced interaction between human and robotic support.

In addition, it is important to acknowledge the limitations of social robots in replicating the depth of human-human interactions. While robots can simulate certain aspects of social behaviour, such as facial expressions or verbal communication, they do not possess the genuine emotional capacity or empathy that human interactions offer. This limitation is particularly relevant in contexts where emotional support and empathy are crucial, such as in caregiving or therapy. Relying too heavily on robots in these settings could inadvertently reduce opportunities for meaningful human interaction, potentially leading to feelings of isolation or neglect in vulnerable populations (Turkle, 2017).

To mitigate these risks, it is essential to consider the specific contexts in which social robots are deployed and to ensure that they are used to complement, rather than replace, human interactions. For example, in therapeutic settings for autistic children, social robots should be integrated as part of a broader treatment plan that includes human therapists and caregivers, ensuring that the emotional and social needs of the individual are fully addressed.

The societal implications of widespread social robot use also raise ethical concerns. Robots designed to mimic human

behaviour might inadvertently reinforce harmful stereotypes or perpetuate social biases. For example, if robots are predominantly used in caregiving roles, there is a risk that these roles may be devalued, or human caregivers may feel marginalised. Furthermore, the design of social robots, particularly in terms of perceived adaptivity and sociability, can influence user behaviour and acceptance, raising questions about the long-term effects of integrating these technologies into daily life (Shin & Choo, 2011). It is essential to consider how these technologies might shape societal norms and values, particularly in areas like caregiving and education.

Addressing these ethical challenges requires the establishment of clear guidelines and regulations to safeguard users' well-being. This includes setting standards for informed consent, especially when robots interact with vulnerable groups like children. Users must be fully informed about the capabilities and limitations of social robots, including how their data will be used and the potential risks associated with prolonged interaction. Boch et al. (2023) highlight the need for ongoing research to develop and refine these ethical guidelines and explore the long-term impacts of social robot interactions on human behavior, social development, and mental well-being. Policymakers must take an active role in shaping the ethical use of social robots by establishing guidelines that promote fairness, inclusivity, and respect for human dignity. These policies should be dynamic, evolving alongside technological advancements to address emerging ethical concerns.

Moreover, the potential for social robots to influence human social norms and behaviours warrants careful consideration. Long-term interactions with robots could alter users' perceptions of human relationships, empathy, and social responsibility. For example, Graaf et al. (2014) found that prolonged exposure to social robots can lead to changes in user behaviour and attitudes over time, especially when considering the topic of social play, which has a role in norms and moral education, underscoring the importance of carefully managing how these technologies are introduced into social environments (Graaf et al., 2014).

In conclusion, while social robots hold promise as tools for promoting development and providing companionship, their limitations must be carefully considered. By clearly identifying the target audiences that would benefit most from social robots, such as autistic children and the elderly, and by acknowledging the contexts in which social robots may fall short compared to human-human interactions, we can better understand the role these technologies should play in society. This balanced approach ensures that social robots are used where they are most effective while also recognising the irreplaceable value of human connection.

5.4 Limitations, Future Directions and Research

While social robots hold promise as play partners, there are several areas for future research. Long-term studies are needed to assess the sustained effects of social robot interactions on social development, mental health, and overall well-being. Understanding the optimal design features, including appearance, behaviour, and adaptability, for different populations and contexts is crucial. Additionally, investigating the potential benefits and limitations of incorporating social robots in educational and therapeutic interventions will contribute to their effective implementation.

Existing research on social robots often relies on experimental designs that, while valuable, present significant methodological limitations. For example, many studies employ controlled laboratory settings that may not accurately reflect real-world interactions, limiting the external validity of their findings. Sequeira et al. (2016) highlight the challenges of traditional experimental designs by proposing a restricted-perception Wizard-of-Oz (WoZ) methodology. This approach more closely mimics the actual perceptual and behavioural limitations of social robots, leading to more ecologically valid interaction strategies. However, even this method faces challenges in scaling and generalizability, as it depends heavily on the specific context and the skill of the human 'wizard' controlling the robot. These limitations underscore the need for more robust, scalable methodologies that can better capture the complexities of human-robot interactions in diverse and dynamic environments (Sequeira et al., 2016).

Relatedly, theoretical frameworks used in social robot studies are often grounded in social cognitive theory, which provides a strong foundation for understanding learning and interaction through imitation and observation. However, this approach may overlook other critical dimensions of human-robot interaction, such as group dynamics and the role of social identity. Abrams and Rosenthal-von der Pütten (2019) propose the I–C–E framework (Ingroup identification, Cohesion, Entitativity) as an alternative theoretical foundation, focusing on group dynamics in human-robot interaction (HRI). This framework shifts the focus from dyadic interactions to the more complex social settings where multiple humans and robots interact, thus offering a richer understanding of how social robots can influence group behaviour and social cohesion (Abrams & Rosenthal-von der Pütten, 2019). Additionally, Fox and Gambino (2021) challenge the assumption that human-robot interactions should closely mirror human-human relationships, arguing that current interpersonal theories may not fully capture the nuances of human-robot interactions. They suggest that alternative frameworks, which account for the unique characteristics of robots, could offer more accurate predictions and insights into HRI (Fox & Gambino, 2021). We thus argue for the need to continue the research in this specific field to empirically determine how the interaction with social robot specifically impact humans on the short and long run.

Research on the long-term effects of social robot interactions is still emerging, with many studies focusing on short-term outcomes. However, the importance of longitudinal studies cannot be overstated, as they provide critical insights into the sustainability and evolution of human-robot relationships over time. Graaf et al. (2014) conducted a long-term evaluation of social robots in home settings, finding that user experiences with robots evolve

significantly over extended periods. Their study observed a mere-exposure effect, where users initially showed a decline in engagement, followed by a resurgence in positive evaluations as they became more familiar with the robot. This highlights the dynamic nature of human-robot interactions and the need for long-term research to fully understand these processes (Graaf et al., 2014). Similarly, Leite et al. (2014) emphasise the importance of designing empathic robots that can sustain long-term interactions, particularly with children. Their research demonstrates that robots capable of adapting to users' emotional and social cues can maintain higher levels of engagement and social presence over time, which is crucial for their effectiveness in educational and therapeutic settings (Leite et al., 2014).

While social robots hold significant potential for enhancing social and educational outcomes, most research has been conducted in relatively homogeneous populations, limiting the generalizability of findings. Šabanović (2010) critiques the dominant linear, technologically deterministic perspective in social robotics, which often fails to consider the broader social and cultural factors that influence how these technologies are perceived and used. She advocates for a mutual shaping framework, which explores the dynamic interplay between technology and society, recognising that social robots must be designed with diverse user needs in mind (Šabanović, 2010). Additionally, Shin and Choo (2011) highlight the role of social presence in accepting social robots across different demographic groups. Their findings suggest that perceived adaptivity and sociability are key factors influencing attitudes toward social robots, with implications for designing more universally accepted robots (Shin & Choo, 2011; Li et al., 2021).

6. Conclusion

In conclusion, social robots have significant potential to enhance human development by serving as play partners, educators, and companions. However, their integration into everyday life must be cautiously approached, guided by robust ethical frameworks and informed by ongoing research. As these technologies evolve, it will be essential to balance their benefits with the need to preserve the richness of human-human interactions. Policymakers, developers, and researchers must work together to ensure that social robots are designed and deployed in ways that respect human dignity, promote social well-being, and adapt to the diverse needs of global populations.

Future research should focus on the long-term effects of human-robot interactions, the development of culturally sensitive design features, and the exploration of new theoretical and methodological approaches. By addressing these challenges, we can better understand the role of social robots in society and maximize their positive impact on human development. As we continue to explore the playful path to progress, the responsible and thoughtful integration of social robots will be crucial in shaping a future where technology enriches, rather than diminishes, the human experience.

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