Developmental Considerations and Practical Recommendations for Parents and Early Childhood Educators in the Age of AI

Victoria Delaney[a] and Jennifer J. Chen[b]
[a]San Diego State University, ORCID: 0000-0002-1907-0303
[b]Kean University, ORCID: 0000-0003-3181-0033

Executive Summary

Tools that use artificial intelligence (AI) can offer valuable learning opportunities and benefits, but they can also amplify potential risks for children whose capacity to understand and self-regulate their interactions with AI are beyond their current level of development.[1] Given the increasing abundance and diversity of AI tools in everyday life, parents and early childhood educators (ECEs) must carefully curate learning experiences that are developmentally appropriate and safe for young children. Building on Haidt's principles[2] of how children learn in the physical world, we recommend that parents and ECEs seeking to introduce AI to children (ages birth-8)[3] adhere to three research-based recommendations:

1. Choose AI tools that are tangible and embodied, as young children first learn how to perceive and think about the world with their bodies, movement, and senses.
2. Interact with AI tools in ways that are synchronous and adult-mediated, to help young children develop understanding for social cues about conversation while receiving guidance from adults about the limitations of AI.
3. Situate AI in relationship-driven communities of humans, so that children gain and hone skills in building relationships with real people.

Taken together, these recommendations can foster developmentally appropriate social interactions among children, adults, and machines, introduce children to tasks that AI tools can do, and mitigate the risk of unplanned, harmful interactions between AI tools and children.

Introduction

Oakleigh is a two-year-old visiting her cousins, who own and routinely use a smart speaker. Oakleigh frequently hears them ask, "Hey Google, play 'The Wheels on the Bus,'" to which the speaker responds, "Sure. Playing, 'The Wheels on the Bus.'" Occasionally, they repeat the song using the command, "Hey Google, play the last song." Oakleigh observes these interactions with delight and interest. Before long, she has begun to mimic her cousins by triumphantly declaring, "Hey Google, play the last song!" She does not understand how or why the song is played, other than witnessing repeated instances of "play the last song" resulting in the smart speaker playing "The Wheels on the Bus." A few days later, she says, "Hey Google, play the last song!" and her uncle's punk-rock music from the '90s abruptly fills the room at full volume. Oakleigh bursts into tears and runs out of the room, baffled at why "The Wheels on the Bus" is not playing from the smart speaker. Oakleigh's parents react with surprise and concern that their daughter was able to communicate with a smart speaker unsupervised. Nonetheless, they have an in-depth conversation during the car ride home about strategies they can use to facilitate and mediate their daughter's interactions with AI, given its potential to put young children in confusing or even harmful situations.

AI-powered consumer-facing devices (AI tools) are becoming increasingly commonplace in households across all levels of socioeconomic status.[4] A vast majority of these devices were

not designed for children, and yet, children interact with them on a daily basis. Many of their interactions are benign, even educative, as AI tools can create new opportunities to acquire information and opportunities to learn how to interact with human-like machines.[5, 6, 7] However, children (aged birth-8)[3] cannot be expected to understand how AI tools work, nor are they fully able to until they reach early adolescence.[8] Their brains have evolved for millennia to learn through play-based, tangible experiences that give them in situ practice toward being a contributing member in a community (of humans).[2]

Our stance is that AI tools can contribute positively to young children's learning in developmentally appropriate, tangible, and playful ways. However, as in the case of Oakleigh, we cannot leave children to navigate AI tools on their own. Parents and early childhood educators (ECEs), who are the most immediate adult decision makers about when, how, and how often children interact with AI,[9] need guidance on how to help children make sense of AI tools, if they choose to introduce them in the first place. Parents and ECEs must also be equipped with knowledge, strategies, and skills for protecting young children from harmful interactions involving AI tools if and when they surface.

If parents and ECEs support children in using AI tools in ways that also support a play-based, developmentally appropriate childhood, children can thrive while using AI technologies that are shaping today's world. Throughout the rest of this brief, we describe in more detail why children need adult guidance when they use AI tools, and why parents and ECEs need practical guidance to support children's use of AI. We recommend three research-based strategies that parents and ECEs can apply to help children practice and eventually understand how to interact with AI tools safely and appropriately.

An Urgent Call to Action

AI development is driven in part by industrial leaders who make assumptions about what lay consumers will want, need, and buy. While some AI tools incorporate educators' knowledge of how children learn, many do not. If left unattended, children's use of AI tools can blur their perceptions of humanity and machinery, expose them to misinformation, and foster false ideas about how to communicate in ways that build toward healthy relationships. Children's use of AI tools can harm their cognitive and social development if adult guidance is not present.

It is therefore imperative that parents and ECEs become informed consumers of AI tools in service of young children. This implies that parents and ECEs must educate themselves about what AI tools can do and become critical and strategic consumers of AI. We acknowledge that this recommendation is challenging because of the ever-changing nature of AI development and the opaqueness of AI systems from a consumer's perspective. However, schools, parent groups, and community organizations can assist by providing resources and hosting small-group discussions in non-technical language about AI tools for parents and ECEs. Pediatricians can provide parents with written materials during well-child visits on children's AI use that align with recommendations from research on child development. Most importantly, parents and ECEs should not view their use of AI tools as a false choice between "feeding the machine" and abstaining from AI completely. Because AI can be applied across a broad range of consumer-based applications, parents and ECEs should model strategic AI use by choosing technologies that they perceive as beneficial in their own lives, cultures, and contexts. By doing so, they can demonstrate to children that AI, like so many other

technologies that have come before it, is fundamentally a set of tools with its own class of affordances and limitations.

AI, Technological Change, and Child Development

In early childhood, young children (aged 0-5) grow rapidly and need developmentally appropriate practice to build new skills.[3, 10] For example, in their physical and perceptual development, they are walking, climbing and gripping objects in the world. They are also developing cognitive and social skills, such as holding a conversation and mimicking actions that older children take. To grow and sharpen these skills, they need unstructured play time with others to learn about communication patterns, risk-taking, and leadership.[2, 11]

In 2024, at the time of this writing, playtime can include experimenting with AI tools. Young children can and do interact with AI, sometimes routinely enough to execute simple instructions on their own.[12] Yet, few studies measure what children actually understand about AI tools with fidelity or rigorously assess if and how their interactions with AI tools strengthen or impede learning. The question of whether AI tools can be helpful for early learning seems to depend on several cultural and contextual factors in addition to the modality used in the design of the tools. For instance, tangible robots with human-like features may be understandable to young children.[13, 14, 15] On the other hand, AI tools with screens, copious amounts of text, and/or smart speakers without human-like embodiment can transmit sensory cues that are beyond what young children can perceive.[16] Findings from prior work also suggest that young children who consume too much information through smartphones, tablets, or computers have a stronger tendency to show passive behaviors and delayed learning.[17] Therefore, if we expect young children to learn from AI tools at all, the tool's features should align with children's perceptual, physical, and social developmental trajectories.

Older children (aged 6-8) tackle more advanced cognitive and social challenges. Their attention span lengthens, their short and long-term memory improves, and they become more adept at solving complex problems.[18] They begin to express preferences to learn with and from their peers. For instance, they tend to notice and copy social behaviors from peers that they want to emulate.[19] These behaviors imply that parents and ECEs need to think carefully about constructing social environments that are safe and appropriate for children, such as giving them enough time and appropriate tasks to practice learning from one another, especially in environments where AI tools are present.

AI tools can amplify older children's learning, provided that their features align with and promote developmentally appropriate social interactions. Research has shown that older children can begin to perceive AI agents as flawed and breakable, and older children can devise questions that test the limits of intelligent devices.[20, 21] They can also begin to recognize patterns in the design of AI technologies, such as developing rudimentary ideas about how image classifiers work.[22] However, older children still need help with discerning errors from AI systems,[23] because they tend to struggle with abstract concepts and scientific reasoning (e.g., "AI hallucinations").[24]

What Parents and ECEs Can Do

Given that many features and modalities of AI tools do not align with the developmental trajectories of early childhood by default, there is some mediation work that should be done by parents and ECEs to support children's explorations with AI. Building on research discussed earlier, we recommend three strategies that build directly upon Haidt's research[2] on smart technologies and child development: focus on AI tools/experiences that (1) are tangible and embodied, (2) provide synchronous and adult-mediated interactions, and (3) take place within social communities where children can practice cultivating and sustaining relationships. In practice, these strategies are not mutually exclusive and can complement each other. Taken together, they can collectively encourage parents and ECEs to act intentionally when choosing AI tools and orchestrating AI-based learning experiences for children.

Recommendation 1: Choose AI Tools that are Tangible and Embodied

Children learn through play that is tangible (driven by physical objects) and embodied (children use their bodies to communicate). Tangible play helps children develop their five senses, improve their fine motor skills, and increase their spatial awareness.[3] Embodied play can promote children's development of the ability to express ideas with bodily movement, including creativity, learning self-awareness and self-control, and refining their use of multiple senses at the same time.

AI, in the form of robotic toys, may help children learn because they are tangible and embodied. This idea has been studied in literacy and numeracy interventions, where researchers have examined children's behaviors and learning outcomes during interventions with robots. For instance, findings from Hsaio and colleagues[25] and Kewalramani and colleagues[26] showed that kindergarten-aged children played creatively, collaboratively, and inquisitively with robots. Because the activities from these studies were collaborative in nature, it is unclear what aspects of children's learning can be attributed to the robotic intervention versus their interactions with their teacher, task, and/or one another. Yet, these studies suggest that children's prosocial, tangible, robotic play did not hinder their learning.

Studies involving young children and robots suggest that humanoids (robots designed with human-like physical features) are better-suited for children's learning. Preschool teachers who gave feedback on "Maya," a humanoid robot developed by Akdeniz and Özdinç,[14] noticed that, "the toy has a head and body, but it is good for body integrity to have feet as well'' (p. 7). Furthermore, findings from Chiou et al.[27] suggest that children are more likely to trust AI (and therefore, become open to learning from it) if it contains features that children perceive to be human-like. This discovery makes sense, because young children's perceptive and judgment capabilities are still developing. Young children may not be able to imagine Maya with legs as older children and adults can. Parents and teachers should therefore prioritize AI toys that resemble living species (robots shaped like familiar animals are good substitutes, provided that their embodiment is accurate).

Table 1

Choose AI Tools that are Tangible and Embodied

AI-curious parents should:	AI-curious ECEs should:
1. Provide children with AI-powered toys that are designed to resemble living species. Examples are the Ruko 1088 and FollowMe robot dog. A counterexample is the Moxie robot (no legs, feet, or hands). 2. Encourage children to play with tangible robots in ways that develop their prosocial skills with tangible robots, such as asking questions, mimicking human conversations, and giving logical directions.	1. Design collaborative tasks between small groups of children and humanoid robots that build communication skills. For instance, children can work together to create movement and/or dance routines for robots, and then enact them together. 2. Invite children to brainstorm and share limitations of robots, calling attention to tasks where humans excel. A teacher may ask children, "What can you do better or more easily than your robot?"

Recommendation 2: Interact with AI Tools in Ways that are Synchronous and Adult-Mediated

When children learn through traditional, physical play, they develop synchronous communication patterns and enhance their understanding of how language and expression are used in one-to-one or small-group interactions within communities.[11] For instance, through repeated practice, children learn that humans communicate by taking turns: by waiting for the speaker to finish before they speak, and by focusing their attention on the speaker. They can also become attuned to speech cadence, tone, and expression as ways that humans can improve their communication.

Very young children (aged 0-3) are unlikely to benefit from communicating with an AI tool because they are still developing their capacity for receptive (what is spoken to them) and expressive (what they can convey) language.[28] Children at this age rely on adults, especially their primary caregivers, to slow their speech deliberately, emphasize syllables, and repeat words ("parentese") as they are learning receptive and expressive language.[29, 30] Very young children struggle to comprehend dialogue spoken between adults; for instance, conversations between characters on television are difficult to understand because they occur too quickly for young children with limited language processing abilities.[31] Non-embodied, conversational AI tools are likely to exhibit the same speech patterns as television for very young children. Thus, we recommend that parents and ECEs avoid these tools for very young children.

Many non-embodied AI tools are designed for synchronous, turn-taking conversational patterns. However, they do not respond as humans would when conversational norms are broken. For example, when a smart speaker is interrupted, its algorithm makes an inference about the interruption's source through spoken cues alone, whereas a human relies on spoken and visual cues. For this reason, we recommend that parents and ECEs practice *joint media engagement,* or interactions with technology that are mediated by adults, when using non-embodied forms of AI with children.[32, 33] Without adults, children's interactions with digital media, including media that incorporates AI, offer limited benefits to them.[34]

Adult facilitation enables opportunities to mediate small-group interactions between children, themselves, and AI tools by explaining features of and output from AI tools in child-friendly language. For instance, adults can help children understand that a conversational agent is a machine, as many children struggle to classify AI as living or non-living.[35] They can also promote dialogue about AI, including correcting children's misconceptions about the ability of AI tools to "think" and "reason".[20, 33] For example, if a child says, "My Google Home is thinking," the parent or teacher can explain that computers do not think, but rather are programmed to use a set of instructions to search for an answer. Joint media engagement further affords adults opportunities to give children immediate feedback about their patterns of speech or about AI itself. For example, parents can point out conversational behaviors that are socially unacceptable (e.g., interrupting) that AI tools are trained to ignore.[36, 37]

Table 2

Interact with AI Tools in Ways that are Synchronous and Adult-Mediated

AI-curious parents should:	AI-curious ECEs should:
1. Co-construct interactions with non-embodied AI devices and children.	1. Create shared opportunities for dialogue between the teacher, children, and AI devices that follow conversational norms.
2. Encourage children to follow humanistic social norms when conversing with AI tools, such as turn-taking and waiting until the speaker is finished.	2. Help children construct high-level explanations of how AI works (e.g., "The computer is searching for an answer based on the question we just asked to it!").
3. Scaffold and correct children's misconceptions about AI (e.g., "there is not a person inside the smart speaker, it's just a computer voice designed to sound like a person").	3. Help children identify their misconceptions about AI (e.g., "What makes you say that the computer is thinking?" "The computer is not thinking, it is searching through lots of information for an answer").
4. Avoid non-embodied AI devices for children under age three.	

Recommendation 3: Situate AI Tools in Relationship-Driven Communities of Humans

As social learners, it is important for children to learn within communities. In fact, one of the defining characteristics of humanity is that we can learn from one another by tapping into knowledge stored from our ancestors, so that we do not have to build knowledge of survival from scratch with each forthcoming generation.[2] Haidt explains that childhood is prolonged for humans because it gives us more time to learn through shared experiences and practice new skills, such as relationship-building.

The nature of our developmental history implies that adults should curate experiences for children that encourage them to interact with AI in a social manner. In the context of the home, parents and children can play AI-based games together and hold conversations about data-modeling relationships.[38] They can challenge their smart speaker to tasks that are atypical, such as asking a smart speaker to tell them a joke, [39, 40] to develop ideas about what kinds of inquiries will "break" AI systems. In elementary schools, teachers can create small-group activities for children to explore AI tools and age-appropriate curricula together.[41, 42] Giving children small-group opportunities to interact with AI can help them make sense of AI's affordances (e.g., retrieving factual information) and limitations (e.g., relational storytelling).[43]

One area that parents and ECEs should attend to is the rise of *personalized learning* with AI tools, or adaptive tools whose output is based on the user's responses. Personalized learning tools, such as Khanmigo or Caktus.ai, have garnered attention from the media and venture capitalists but rarely consider young children's needs to learn from embodied human interactions. If adults wish for their children to explore personalized learning tools, we recommend that they create small-group arrangements for children to collaborate with one another and treat AI as an additional resource. For example, a teacher could require that when children work together, they first ask questions of one another, then ask their AI tool, and finally ask the teacher. Practices like this can encourage children to learn to make strategic use of AI without over-relying on it. Furthermore, they can promote prosocial, in-person interactions that AI tutors cannot replicate.

Table 3

Situate AI Tools in Relationship-Driven Communities of Humans

AI-curious parents should:	AI-curious ECEs should:
1. Encourage children to do activities that involve AI together, such as playing games against AI agents or using generative AI to develop and test new recipes. 2. Intentionally design playful experiences where AI tools are likely to fail, such as asking, "What can I get my best friend for their birthday?" and brainstorm why AI tools are generally worse than humans at these tasks. 3. Encourage more human interaction during personalized learning when possible. For example, parents can ask their children to	1. Use AI curricula in small-group activities where children interact with agency over AI, such as the "Popbots[42]" curriculum. 2. Reinforce that children's mastery of a topic means that they do not rely on AI tools, but rather have gained the knowledge and/or skills themselves. 3. Concerning personalized learning and generative AI tools in classrooms, build norms with children that prioritize their collaboration and leverage AI as a strategic tool.

"teach them" or their sibling as a way to build confidence and mastery.

Conclusion

In this brief, we discussed AI tools and practices that parents and ECEs can consider to help children learn about AI in ways that are both evidence-based and developmentally appropriate. We encourage parents and ECEs to make use of AI tools and experiences that are tangible, embodied, synchronous, adult-mediated, and embedded within social communities. We caution parents and ECEs against using AI tools in ways that do not align with children's perceptual, physical, and social developmental trajectories. When parents and ECEs intentionally select AI tools and experiences that are developmentally appropriate and prioritize children's need for play, they can create opportunities to learn and safeguard children from harmful AI use.

Most importantly, parents and ECEs should develop strong self-awareness of their own AI use and its implications for what children learn. Young children rely heavily on adults for cues about appropriate behaviors and practices. Haidt pointed out that when parents' uses of AI on smartphones increased in the early 2010s, they unknowingly modeled overuse to children, and in turn, decreased children's autonomy, sense of trust, and perception of their own competence. It is urgent that parents and ECEs pause and consider whether this is a future they want to build for forthcoming generations. Indeed, both authors on this brief are parents and educators, and we empathize with our peers who struggle to navigate the ever-evolving world of AI tools. However, we believe that when adults monitor their own AI use, by exploring new technologies and setting reasonable boundaries, they can encourage positive, strategic uses of AI while centering human-to-human interactions that children, like Oakleigh and her cousins, need.

Acknowledgments

We offer our sincere thanks to Aryanna Chartrand for her thoughtful contributions to the early ideation stages of this brief.

References

1. Chen, J. J., & Lin, J. C. (2024). The double-edged sword of artificial intelligence: Wielding the POWER principles to maximize its positive effects and minimize its negative effects. *Contemporary Issues in Early Childhood*, *25*(1) 146–153. https://doi.org/10.1177/14639491231169813

2. Haidt, J. (2024). *The anxious generation: How the great rewiring of childhood is causing an epidemic of mental illness*. Random House.

3. NAEYC. (2022). *Developmentally appropriate practice in early childhood programs serving children from birth through age 8* (4th ed.). NAEYC.

4. Laricchia, F. (2023). *Smart speaker household penetration rate in the United States from 2014 to 2025.* Statista Consumer Electronics. https://www.statista.com/statistics/1022847/united-states-smart-speaker-household-penetration/

5. Chen, J. J. (2024). A scoping study on AI affordances in early childhood education: Mapping the global landscape, identifying research gaps, and charting future research directions. *Journal of Artificial Intelligence Research.*

6. Kurian, N. (2024). 'No, Alexa, no!': designing child-safe AI and protecting children from the risks of the 'empathy gap' in large language models. *Learning, Media and Technology*, 1-14. https://doi.org/10.1080/17439884.2024.2367052

7. Yang, W. (2022). Artificial Intelligence education for young children: Why, what, and how in curriculum design and implementation. *Computers and Education: Artificial Intelligence*, *3*, 100061. https://doi.org/10.1016/j.caeai.2022.100061

8. Hitron, T., Orlev, Y., Wald, I., Shamir, A., Erel, H., & Zuckerman, O. (2019, May). Can children understand machine learning concepts? The effect of uncovering black boxes. In *Proceedings of the 2019 CHI conference on human factors in computing systems* (pp. 1-11). https://doi.org/10.1145/3290605.3300645

9. Kizilcec, R. F. (2024). To advance AI use in education, focus on understanding educators. *International Journal of Artificial Intelligence in Education*, *34*(1), 12-19. https://doi.org/10.1007/s40593-023-00351-4

10. National Scientific Council on the Developing Child (2007). *The science of early childhood development: Closing the gap between what we know and what we do*.

11. Chen, J. J., & Kacerek, C. (2022). Leaders and followers during sociodramatic play: A study of racial/ethnic minority preschool children from socioeconomically disadvantaged backgrounds. *Journal of Research in Childhood Education*, *36*(3), 517-540. https://doi.org/10.1080/02568543.2021.1960939

12. Williams, R., Park, H. W., & Breazeal, C. (2019, May). A is for artificial intelligence: the impact of artificial intelligence activities on young children's perceptions of robots. In *Proceedings of the 2019 CHI conference on human factors in computing systems* (pp. 1-11). https://doi.org/10.1145/3290605.3300677

13. Wang, X., Yin, N., & Zhang, Z. (2021). Smart design of intelligent companion toys for preschool children. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing 35*, 151-164. https://doi.org/10.1017/S0890060420000499

14. Akdeniz, M., & Özdinç, F. (2021). Maya: An artificial intelligence based smart toy for pre-school children. *International Journal of Child-Computer Interaction*, *29*, 100347. https://doi.org/10.1016/j.ijcci.2021.100347

15. Su, J., Ng, D. T. K., & Chu, S. K. W. (2023). Artificial intelligence (AI) literacy in early childhood education: The challenges and opportunities. *Computers and Education: Artificial Intelligence*, *4*, 100124. https://doi.org/10.1016/j.caeai.2023.100124
16. Garg, R., & Sengupta, S. (2020). He is just like me: a study of the long-term use of smart speakers by parents and children. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, *4*(1), 1-24. https://doi.org/10.1145/3381002
17. Lillard, A.S. & Peterson, J. (2011) The immediate impact of different types of television on young children's executive function. *J Pediatrics*. 128, pages 644-649.
18. Case, R., & Griffin, S. (1990). Child cognitive development: The role of central conceptual structures in the development of scientific and social thought. In *Advances in psychology* (Vol. 64, pp. 193-230). North-Holland.
19. Boyd, R., & Richerson, P. J. (2009). Culture and the evolution of human cooperation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1533), 3281-3288. doi:10.1098/rstb.2009.0134
20. Druga, S., Williams, R., Breazeal, C., & Resnick, M. (2017, June). " Hey Google is it ok if I eat you?" Initial explorations in child-agent interaction. In *Proceedings of the 2017 conference on interaction design and children* (pp. 595-600). http://dx.doi.org/10.1145/3078072.3084330
21. Lovato, S. B., Piper, A. M., & Wartella, E. A. (2019, June). Hey Google, do unicorns exist? Conversational agents as a path to answers to children's questions. In *Proceedings of the 18th ACM international conference on interaction design and children* (pp. 301-313). https://doi.org/10.1145/3311927.3323150
22. Vartiainen, H., Tedre, M., & Valtonen, T. (2020). Learning machine learning with very young children: Who is teaching whom?. *International journal of child-computer interaction*, *25*, 100182. https://doi.org/10.1016/j.ijcci.2020.100182
23. Touretzky, D., Gardner-McCune, C., & Seehorn, D. (2023). Machine learning and the five big ideas in AI. *International Journal of Artificial Intelligence in Education*, *33*(2), 233-266. https://doi.org/10.1007/s40593-022-00314-1
24. Piaget, J. (1972). *The psychology of the child*. Basic books.
25. Hsiao, H.-S., Chang, C.-S., Lin, C.-Y., & Hsu, H.-L. (2015). "iRobiQ": The influence of bidirectional interaction on kindergarteners' reading motivation, literacy, and behavior. *Interactive Learning Environments*, *23*(3), 269-292. https://doi.org/10.3389%2Ffrobt.2022.971749
26. Kewalramani, S., Kidman, G., & Palaiologou, I. (2021). Using Artificial Intelligence (AI)-interfaced robotic toys in early childhood settings: A case for children's inquiry literacy. *European Early Childhood Education Research Journal, 29*(5), 652-668. https://doi.org/10.1080/1350293X.2021.1968458
27. Chiou, E. K., Schroeder, N. L., & Craig, S. D. (2020). How we trust, perceive, and learn from virtual humans: The influence of voice quality. *Computers & Education*, *146*, 103756. https://doi.org/10.1016/j.compedu.2019.103756
28. Chen, J. J. (2024). *Responsive practice for dual language learners in early childhood education: Theory and case studies*. Redleaf Press.
29. Ramírez-Esparza, N., García-Sierra, A., & Kuhl, P. K. (2014). Look who's talking: Speech style and social context in language input to infants are linked to concurrent and future speech development. *Developmental science*, *17*(6), 880-891. https://doi.org/10.1111/desc.12172

30. Ramírez, N. F., Weiss, Y., & Sheth, K. K. (2024). Parentese in infancy predicts 5-year language complexity and conversational turns. *Journal of Child Language*, *51*(2), 359-384. https://doi.org/10.1017/S0305000923000077
31. Office of Educational Technology (2018). Guiding Principles for Use of Technology with Early Learners. U.S. Department of Education. Available online at: https://tech.ed.gov/earlylearning/principles/ (Accessed July 16, 2024).
32. Stevens, R., & Penuel, W. R. (2010, October). Studying and fostering learning through joint media engagement. Principal Investigators Meeting of the National Science Foundation's Science of Learning Centers, Arlington, VA.
33. Druga, S., Christoph, F. L., & Ko, A. J. (2022, April). Family as a Third Space for AI Literacies: How do children and parents learn about AI together?. In *Proceedings of the 2022 CHI conference on human factors in computing systems* (pp. 1-17). https://doi.org/10.1145/3491102.3502031
34. Kucker, S. C. (2021). Processes and pathways in development via digital media: Examples from word learning. *Infant Behavior and Development*, *63*, 101559. https://doi.org/10.1016/j.infbeh.2021.101559
35. Xu, Y., & Warschauer, M. (2020, April). What are you talking to?: Understanding children's perceptions of conversational agents. In *Proceedings of the 2020 CHI conference on human factors in computing systems* (pp. 1-13). http://dx.doi.org/10.1145/3313831.3376416
36. Beneteau, E., Boone, A., Wu, Y., Kientz, J. A., Yip, J., & Hiniker, A. (2020, April). Parenting with Alexa: exploring the introduction of smart speakers on family dynamics. In *Proceedings of the 2020 CHI conference on human factors in computing systems* (pp. 1-13). https://doi.org/10.1145/3313831.3376344
37. Garg, R., Cui, H., Seligson, S., Zhang, B., Porcheron, M., Clark, L., Cowan, B. R., & Beneteau, E. (2022, April). The last decade of HCI research on children and voice-based conversational agents. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (pp. 1-19). https://doi.org/10.1145/3491102.3502016
38. Tseng, T., King Chen, J., Abdelrahman, M., Kery, M. B., Hohman, F., Hilliard, A., & Shapiro, R. B. (2023, June). Collaborative Machine Learning Model Building with Families Using Co-ML. In *Proceedings of the 22nd Annual ACM Interaction Design and Children Conference* (pp. 40-51). https://doi.org/10.1145/3585088.3589356
39. Druga, S., Vu, S. T., Likhith, E., & Qiu, T. (2019). Inclusive AI literacy for kids around the world. In *Proceedings of FabLearn 2019* (pp. 104-111). https://doi.org/10.1145/3311890.3311904
40. Andries, V., & Robertson, J. (2023). Alexa doesn't have that many feelings: Children's understanding of AI through interactions with smart speakers in their homes. *Computers and Education: Artificial Intelligence*, *5*, 100176. https://doi.org/10.1016/j.caeai.2023.100176
41. Papert, S. A. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic books.
42. Williams, R., Park, H. W., Oh, L., & Breazeal, C. (2019, July). Popbots: Designing an artificial intelligence curriculum for early childhood education. In *Proceedings of the AAAI conference on artificial intelligence* (Vol. 33, No. 01, pp. 9729-9736).
43. Girouard-Hallam, L. N., & Danovitch, J. H. (2022). Children's trust in and learning from voice assistants. *Developmental Psychology*, *58*(4), 646–661. https://doi.org/10.1037/dev0001318