

## **Boon or bane: Meta-analyzing the impacts of social robots on child development**

**Abstract:** Social robots are increasingly prevalent in everyday life, potentially shaping the environment of children. However, the impact of these robots on child development remains unclear. To address this, we conducted a meta-analysis of 78 studies involving 4544 children with different developmental statuses. To facilitate the analysis, we devised the Affective, Behavioral, Cognitive, and Social (ABC-S) framework, delineating the diverse aspects of child development. The results showed an overall small-to-moderate-sized positive effect of social robots on children, especially in their emotion and cognition development, while no significant adverse impact was found. The positive effect varied based on moderators including robot characteristics (i.e., morphologies, robots' roles), context factors (i.e., academic disciplines and intervention duration), and children demographics (i.e., age, developmental statuses, and regions of residency). For instance, anthropomorphic robots exhibited a more pronounced impact than mechanomorphic ones, and social robots functioning as teaching assistants or task facilitators showed superior performance over other roles. In terms of context factors, marginal effectiveness improvement was identified for extended exposure to social robots. Furthermore, social robots exhibited greater benefits for children in developing regions compared to those in developed regions, and they are proved more effective for older children than younger ones. In summary, this study contributed to theories in Human-Robot Interactions and children's development by developing a comprehensive framework to understand and evaluate social robots' impact on children, while also revealing ways to design and implement social robots for better developmental outcomes.

**One-Sentence Summary:** Social robots moderately facilitate child development, influenced by robot morphologies, context factors, and children demographics.