Artificial Intelligence and Children's Cognitive Development

From Science to Policy

Vicky Charisi

European Commission, Joint Research Center, Digital Economy Unit

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Εθνικό Κέντρο Τεκμηρίωσης

Joint
Research
Centre

Research on Child-Robot Interaction

Theory of Affordances: Perception / Cognition / Action

**Understanding Child's development
In the context of Intelligent systems**

Robotics
AI
Dev. psychology
Cog. science
Philosophy
Pedagogy

Paradigms
- Robots as an embodied interface for children's STEAM education
- Robots as social agents that affect children's cognitive and socio-emotional development
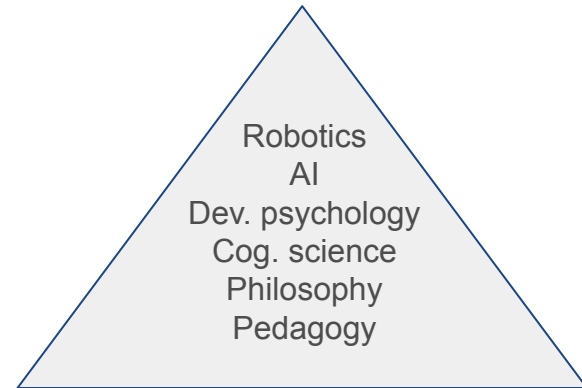
Contribute to
child-centred robot
behaviours design

Inform policy-related
discussions regarding
embodied AI and child's rights

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Complexity in researching child-robot interaction

Theories and challenges

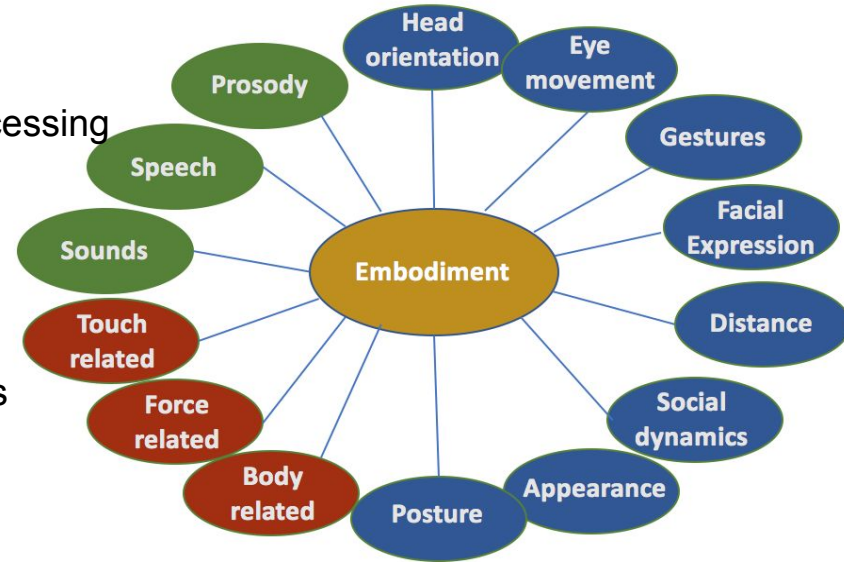Decomposing robot design and development

Computer vision
Natural Language Processing
Navigation
Planning
Perception
Action/Control
Machine learning
Developmental robotics

Multiple levels of Complexity
- Complex naturalistic settings
- Child's rapid cognitive development
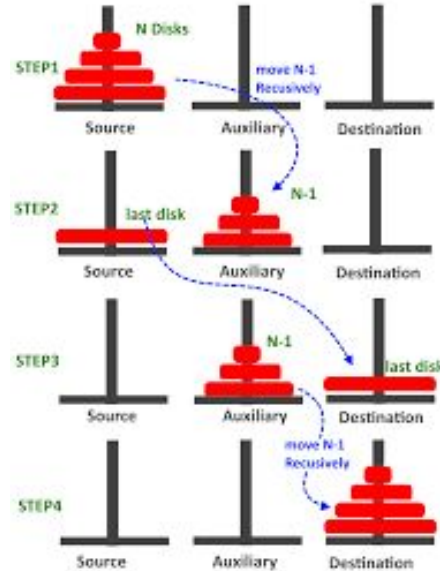- Limitations in technical developments

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Understanding the impact of robot behaviour on children's problem-solving

Tower of Hanoi

- Cognitive task

- Incremental difficulty for developmental studies

- Suitable for children

The Haru Robot
HONDA Research Institute, Japan
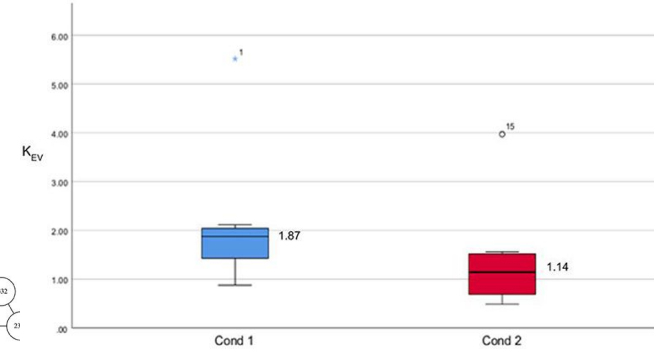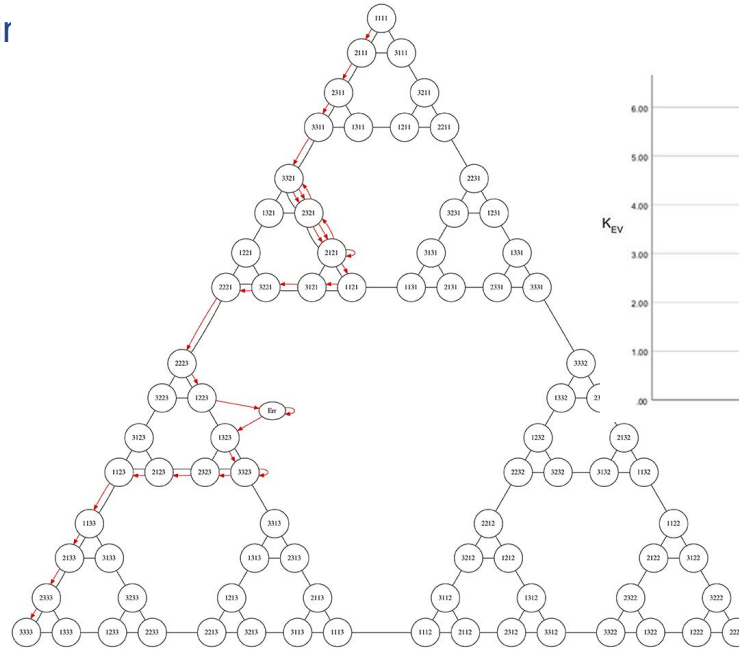
5 degrees of freedom

base rotation, neck leaning, eye stroke, eye rotation and eyes tilt.

Charisi, V., Gomez, E., Merino, L., Caballero, F., Gomez, R. (2020). Child-Robot Collaborative Problem-Solving and the Importance of Child's Voluntary Interaction: A Developmental Perspective. *Frontiers in Robotics and AI*, 7, 15.

Understanding the impact of robot behaviour on children's problem-solving

Child-initiated voluntary interaction in problem-solving tasks

Charisi, V., Gomez, E., Merino, L., Caballero, F., Gomez, R. (2020). Child-Robot Collaborative Problem-Solving and the Importance of Child's Voluntary Interaction: A Developmental Perspective. *Frontiers in Robotics and AI*, 7, 15.
https://www.frontiersin.org/articles/10.3389/frobt.2020.00015/full

Understanding the impact of robot behaviour on children's problem-solving

N = 86 children, 5-7 years old

Experimental procedure

Preliminary session → Baseline session → Intervention session → Evaluation session

Trust belief questionnaire — No Robot — Robot behaviour manipulation — Voluntary interaction
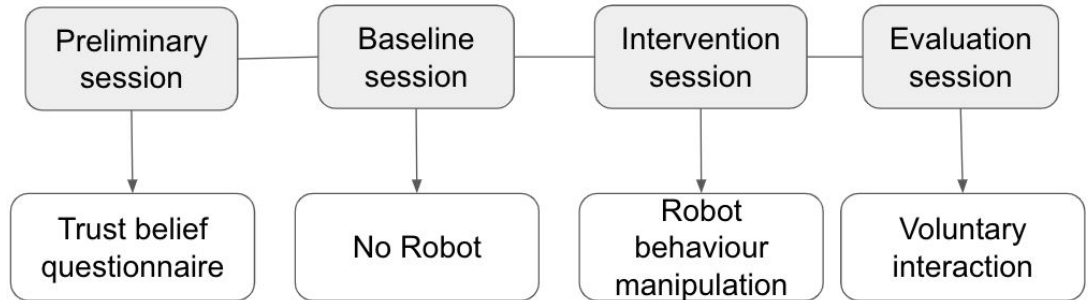
Robot cognitive reliability
Hypothesis: Robots that intentionally make mistakes elicit more child-child social interaction and negotiations

Conflict and negotiations might be correlated with the development of children's metacognitive skills
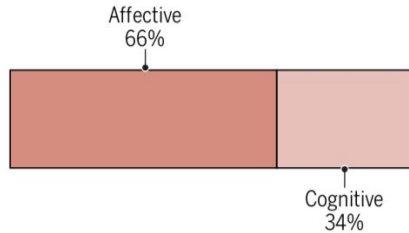
Charisi, V., Merino, L., Escobar, M., Caballero, F., Gomez, R., & Gómez, E. (2021). The Effects of Robot Cognitive Reliability and Social Positioning on Child-Robot Team Dynamics. In *2021 IEEE International Conference on Robotics and Automation (ICRA)* (pp. 9439-9445). IEEE.
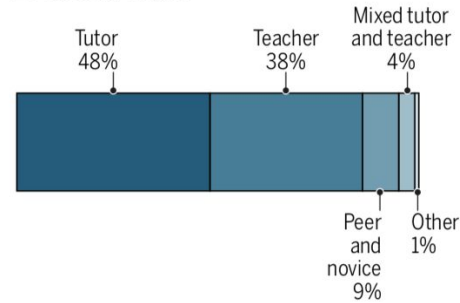https://ieeexplore.ieee.org/abstract/document/9560760

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Social Robots in Education and for autistic children

A Learning outcomes
- Affective 66%
- Cognitive 34%

B Role of robot
- Tutor 48%
- Teacher 38%
- Mixed tutor and teacher 4%
- Peer and novice 9%
- Other 1%

C Number of learners per robot
- One learner 65%
- Many learners 30%
- Other 5%

D Demographics
- Children 58%
- Adults 33%
- Mixed/unknown 9%
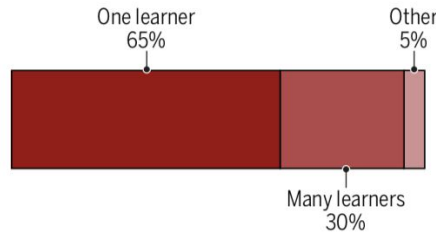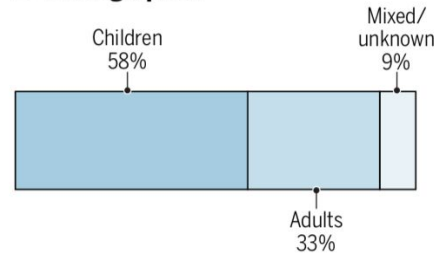
DE-ENIGMA
Playfully Empowering Autistic Children

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 688835

Liz Pellicano during a data collection session with a child with autism and Zeno. Picture by ITV News

Belpaeme, T., Kennedy, J., Ramachandran, A., Scassellati, B., & Tanaka, F. (2018). Social robots for education: A review. *Science robotics*, *3*(21), eaat5954.

Alcorn, A. M., Ainger, E., Charisi, V., Mantinioti, S., Petrović, S., Schadenberg, B. R., ... & Pellicano, E. (2019). Educators' views on using humanoid robots with autistic learners in special education settings in England. *Frontiers in Robotics and AI*, *6*, 107.

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From Science to Policy: Artificial Intelligence and Children's Rights
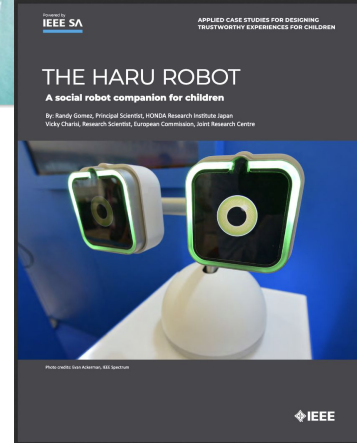
The structure of the activities and the report

A. A **review of the current policy initiatives** for AI and Children's Rights of major international organisations is included in the report.

B. Three selected AI applications for children under the lens of children's rights and identified risks such as children's privacy, possible algorithmic discrimination and lack of fairness.

C. Two **workshops** with children and young people, and **three workshops** with policymakers and researchers in the field of AI and child's rights revealed that **each group prioritised different concerns**.

D. The report recommends **requirements** for trustworthy AI, highlights **methods** for effective engagement between stakeholders, and identifies the **knowledge gaps** that need to be addressed as priority in the short- and medium-term.

https://publications.jrc.ec.europa.eu/repository/handle/JRC127564

Chapter 2
Existing policy initiatives on AI and children

UNCRC
UN General Comment 25
UNICEF
OECD
UNESCO
IEEE
Council of Europe
European Commission

Chapter 3
Analysis of the impact of selected AI applications on children's rights

Risks / Opportunity / Challenges
Recommender Systems
Conversational Agents
Robotic systems

Chapter 4
Youth's perspective: from the workshops with children and young people

Preconceptions of AI
Perceptions of the impacts of AI on children's right
Young people and their concerns
What do young people propose
Questions for further directions

Chapter 5
Experts' perspective: from the workshops with scientists and policymakers

* Considering the results from Chapters 2, 3 and 4

⚠ **Requirements**
AI minimisation and valuable purpose
Transparency, explainability, communication and accountability
Inclusion and non-discrimination
Privacy, data protection and safety
Integration and respect of children's agency

◆ **Methods**
Anticipations, evaluation, monitoring
Multi-stakeholder collaboration
Children's participation
Balancing conflicting rights

★ **Knowledge gaps**
Children's cognitions, development & play
Empowering through education
Developmentally appropriate systems and age verification
Other research questions to be addressed

Chapter 6
Researchers, policymakers and children: A triangulation of perspectives

Chapter 7
Limitations and considerations

Chapter 8
Conclusions

Chapter 9
For deeper consideration: reflections of invited experts

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A systematic literature review on Children's Rights in Human-Robot Interaction Research

	Accountability	Explainability	Fairness	Inclusion	Privacy	Safety	Transparency
User Study		21, 35, 50	20, 36	11, 12, 13, 14, 18, 19, 23, 24, 25, 27, 29, 32, 39	4, 40, 42	5, 38, 43	41, 47
Position Paper	37				37, 52	1, 17, 22	26
Review Paper				10	2	33, 51	

DiPaola, D., Charisi, V., Breazeal, C., Sabanovic, S. (2023). Children's Fundamental Rights in Human-Robot Interaction Research: A systematic Review. In ACM/IEEE International Conference on Human-Robot Interaction (HRI2023) To appear

mit media lab

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Future directions: Recommender Systems, Conversational systems (GTP), Metaverse

Recommender systems

- Provide **access** to large sets of material

- **Support of cognitive self-regulated learning skills** (Tsiakas et al., 2020)

- Provide **personalised scaffolding and adaptation** (Ashlee et al., 2019; Aisha Yaquob et al, 2019).

Conversational systems

- Improvement of **accessibility**

- Interfaces that facilitate t**ransparency and communication of explanations** especially towards children

- **AI-based co-construction** and **co-creation**

Metaverse

Transformation
- in human-human social interaction

- in children's play activities

- potentially in learning and education

How to develop systems that allow us to learn more about children's cognitive processes, facilitate education and minimize the emerging risks?

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Ευχαριστώ πολύ!

Βίκυ Χαρίση
vasiliki.charisi@ec.europa.eu
https://twitter.com/CharisiVicky

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in the corresponding publications