What future for European Robotics?

AI Augmented Learning with Socio-Emotive Companions

Focus: technical readiness

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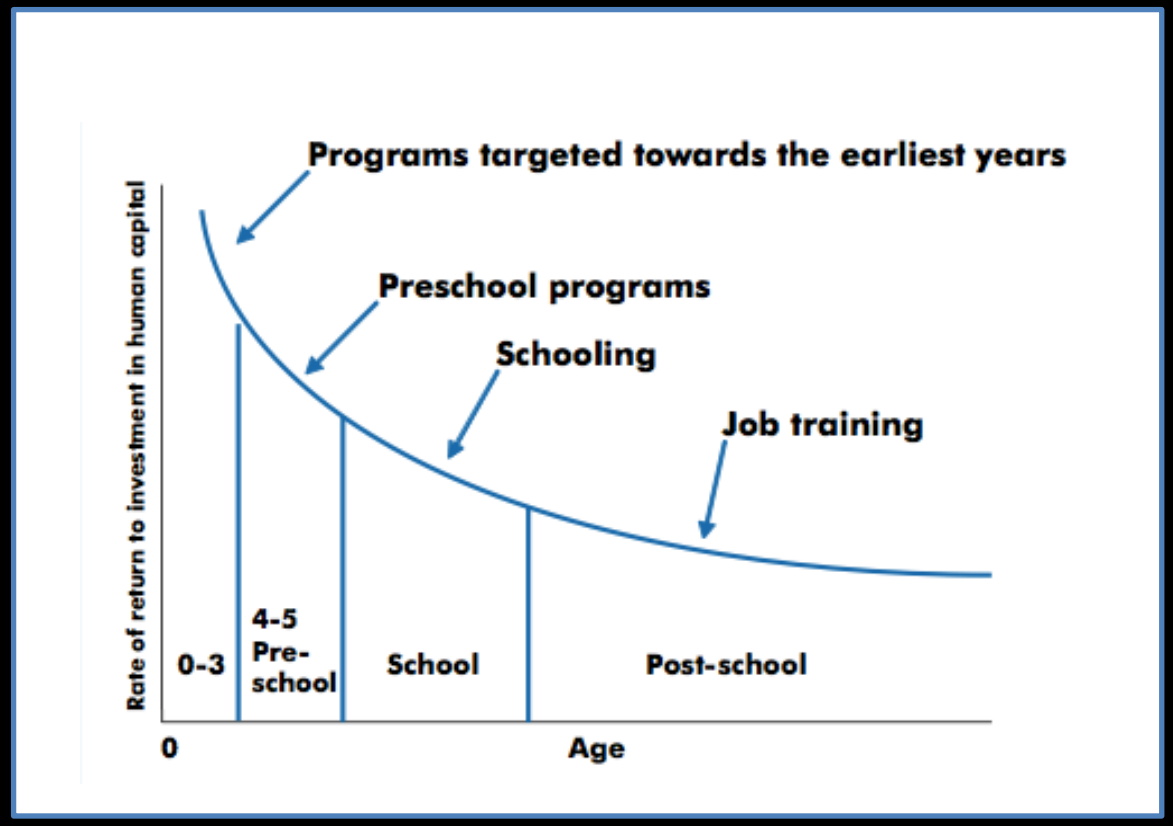
Inequality of Education

Early Childhood Education: A Key Time to Intervene

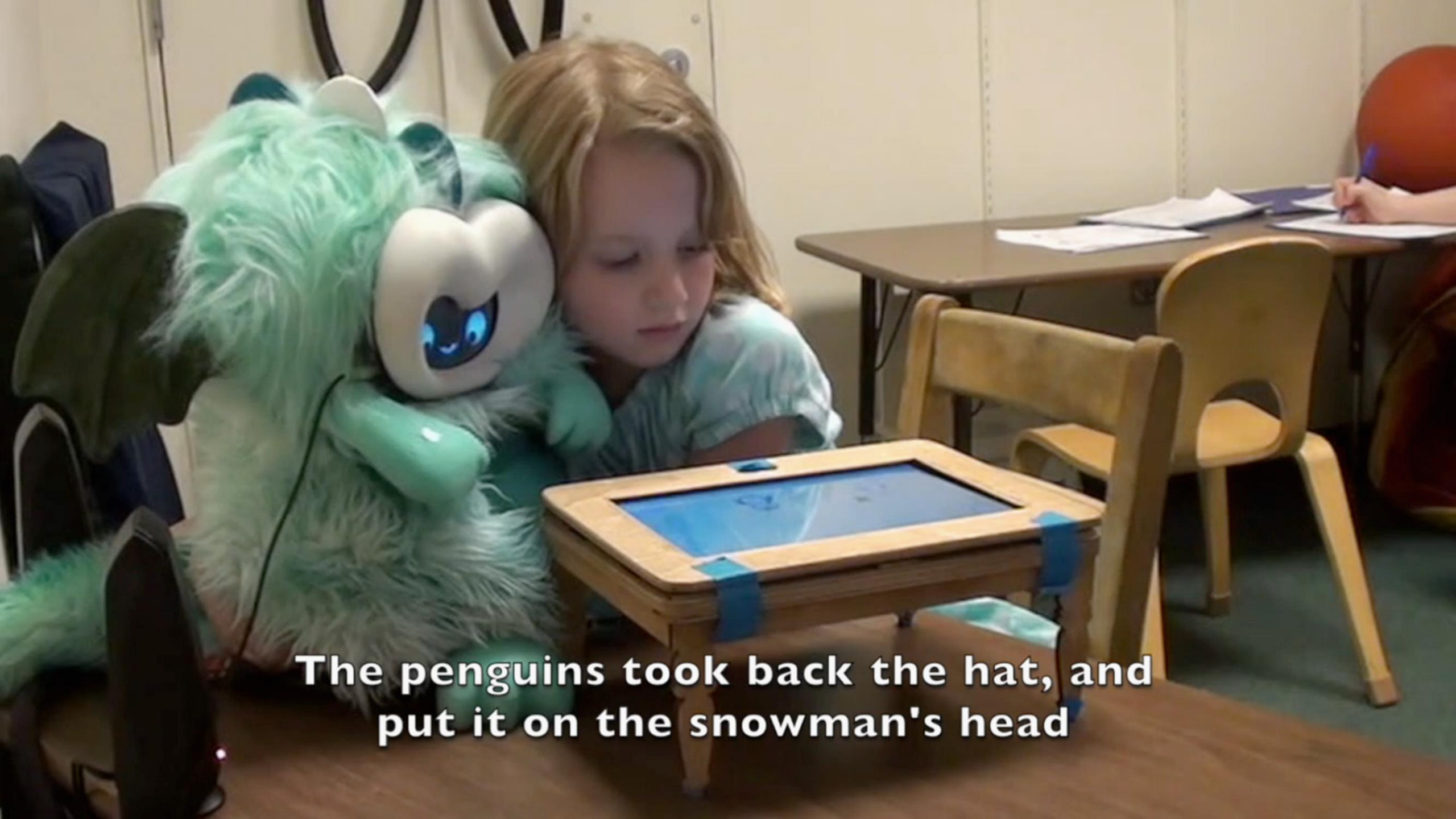


- More than 175 million children (~50% of pre-primary-age children globally) are not enrolled in pre-primary education, missing a critical investment opportunity and suffering deep inequalities from the start (UNICEF, 2019)
- As of January 14, 2021, nearly 214 million children are out of school worldwide due to nationwide school closures linked to the COVID19 pandemic. (UNESCO, 2021)

Learning is *Cognitive*, *Social*, *Affective*, and *Relational* !

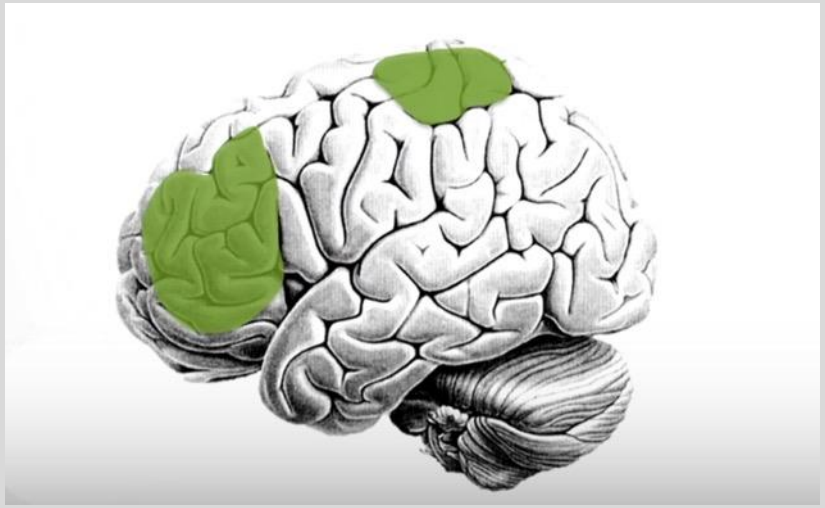
- Learning engages many functionally distinct brain regions.[1]
- Learning is “socially gated.” [2,4]
  That is, interaction with other agents improves efficiency and retention.
- Emotions are deeply involved through each step of learning: attention, comprehension, integration, and memory consolidation.[3]

[1] Meltzoff, Andrew N., et al. "Foundations for a new science of learning." *science* 325.5938 (2009): 284-288.
[2] Kuhl, Patricia K. "Is speech learning ‘gated’ by the social brain?." *Developmental science* 10.1 (2007): 110-120.
[3] Tyng, Chai M., et al. "The influences of emotion on learning and memory.”, *Frontiers in psychology* 8 (2017): 1454.
[4] Romeo, Rachel R., et al. "Beyond the 30-Million-Word Gap: Children’s Conversational Exposure Is Associated With Language-Related Brain Function." *Psychological science*29.5 (2018): 700-710.

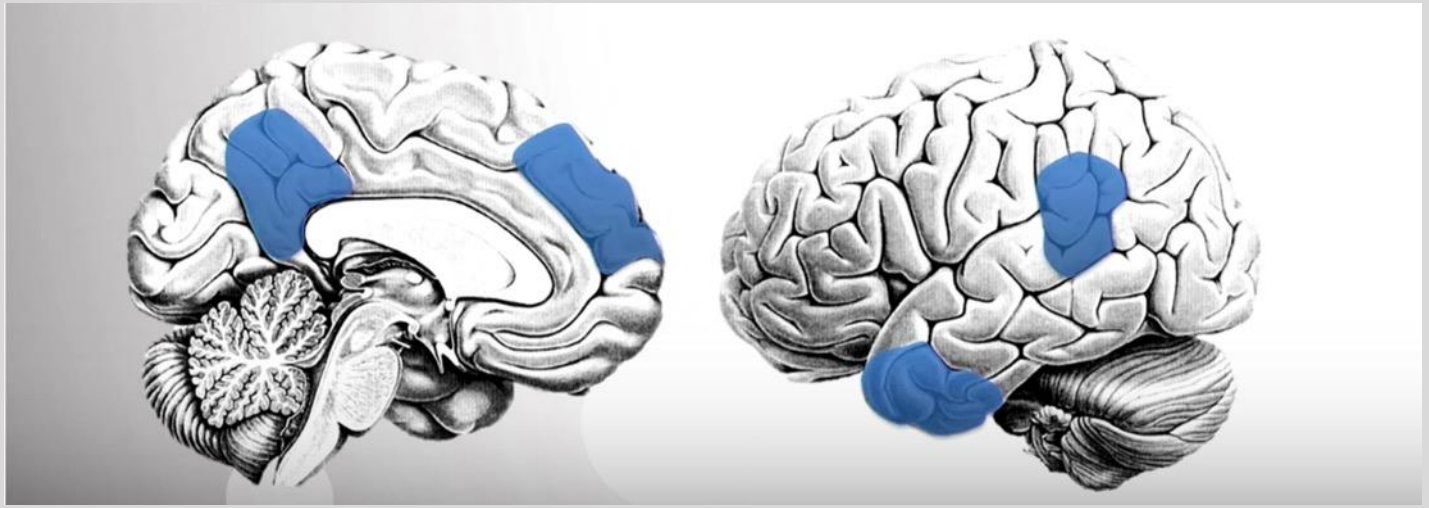

The penguins took back the hat, and
put it on the snowman's head

Interaction with social robots activates *social thinking*

“Social Thinking is Our Human Super Power” Matthew Liberman



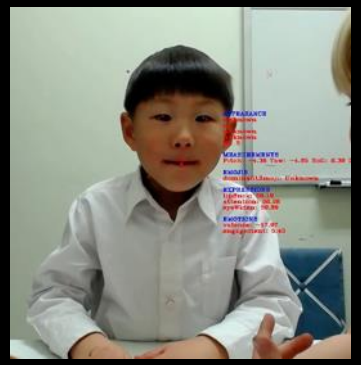
Analytical Thinking



Social Thinking

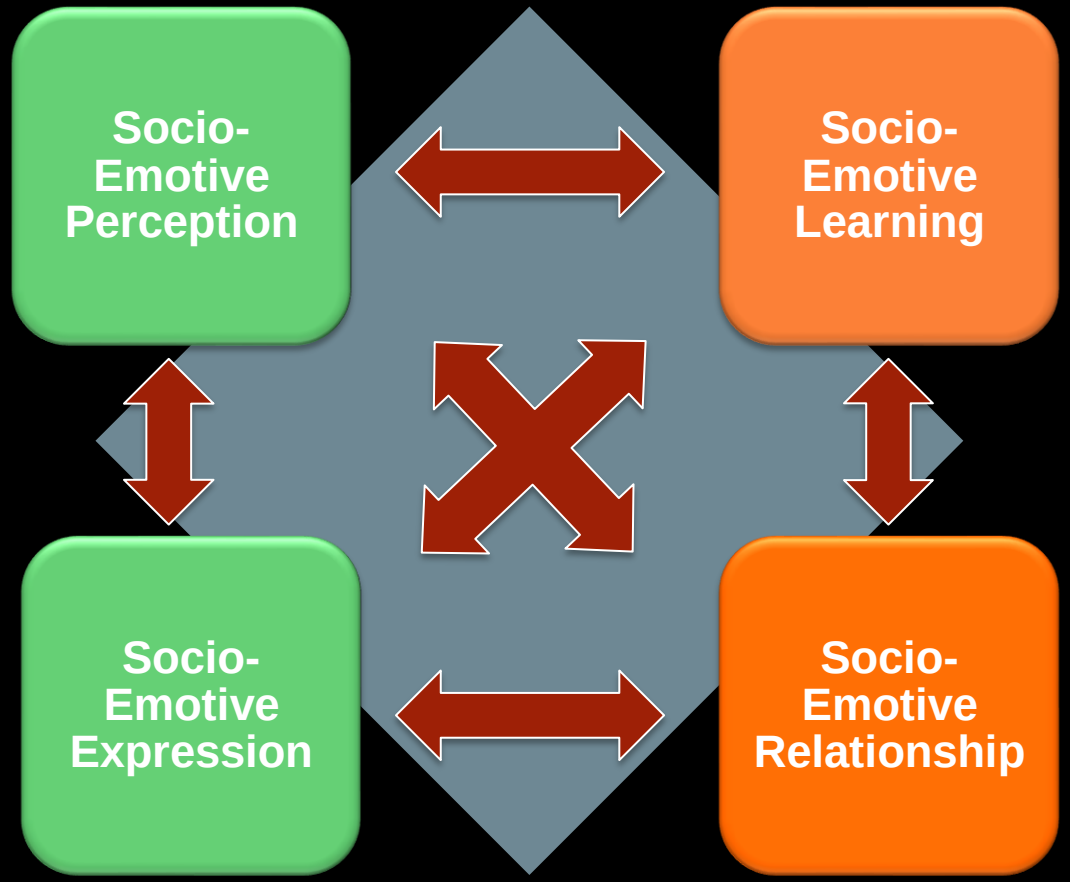
Oberman, Lindsay M., et al. "EEG evidence for mirror neuron activity during the observation of human and robot actions: Toward an analysis of the human qualities of interactive robots." *Neurocomputing* 70.13 (2007): 2194-2203.

Socio-Emotive Relational AI



Machine perception of interpersonal cues

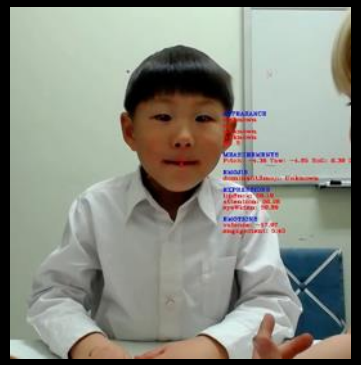
Expressive cues that reveal “state of mind”



Learn via social interaction and observation

Build rapport & emotional bond as attentive, empathic other

Socio-Emotive Relational AI



Machine perception of interpersonal cues

Expressive cues that reveal “state of mind”

Socio-Emotive Perception

Socio-Emotive Learning

Socio-Emotive Expression

Socio-Emotive Relationship

Learn via social interaction and observation

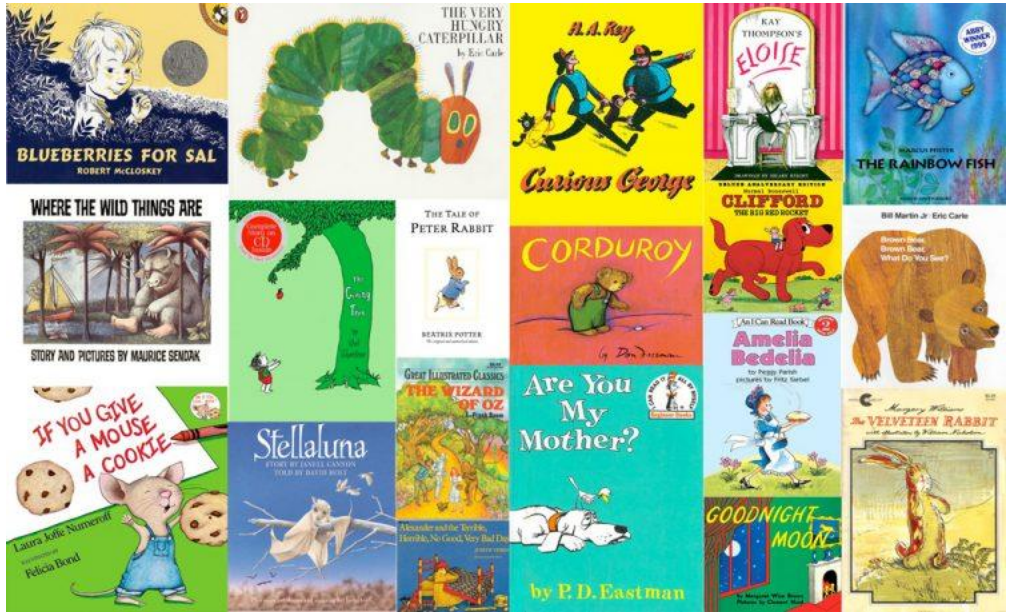
Build rapport & emotional bond as attentive, empathic other

Adapt over time and across interactions

School Readiness & Diversity in Classrooms

Image credit: New York School Talk http://newyorkschooltalk.org

Adaptation and Personalization



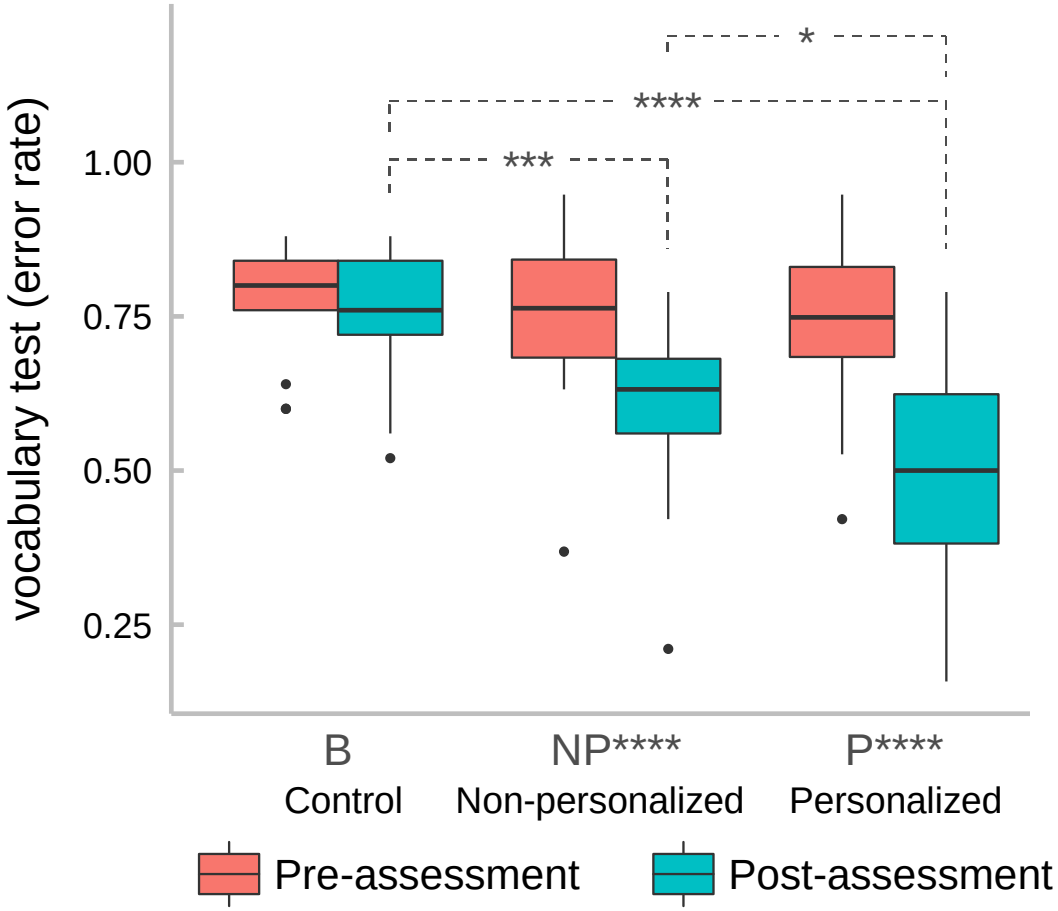
curriculum

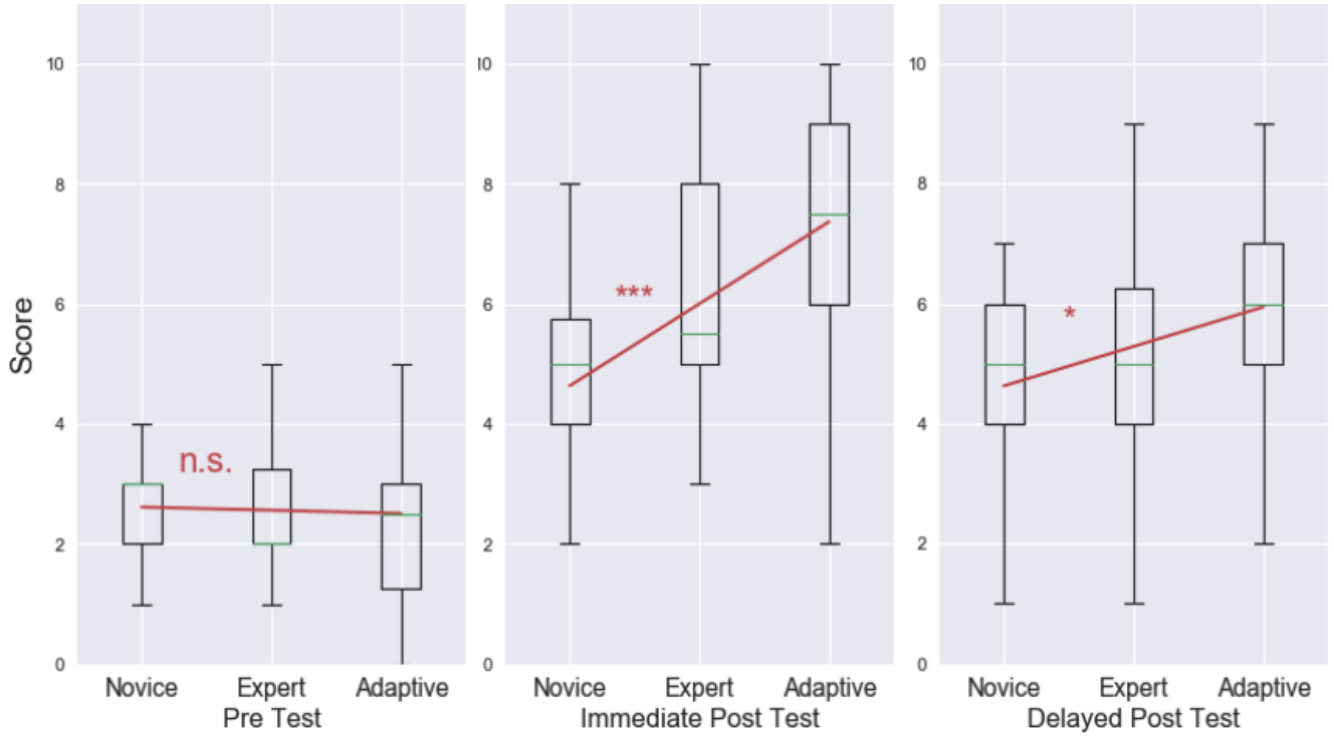
Hmm.. can you help me find something *gigantic*?

Oh! I know, you need to rotate the piece to fit it.

robot behavior: personality, role, affective display, turn taking, dialog act, …

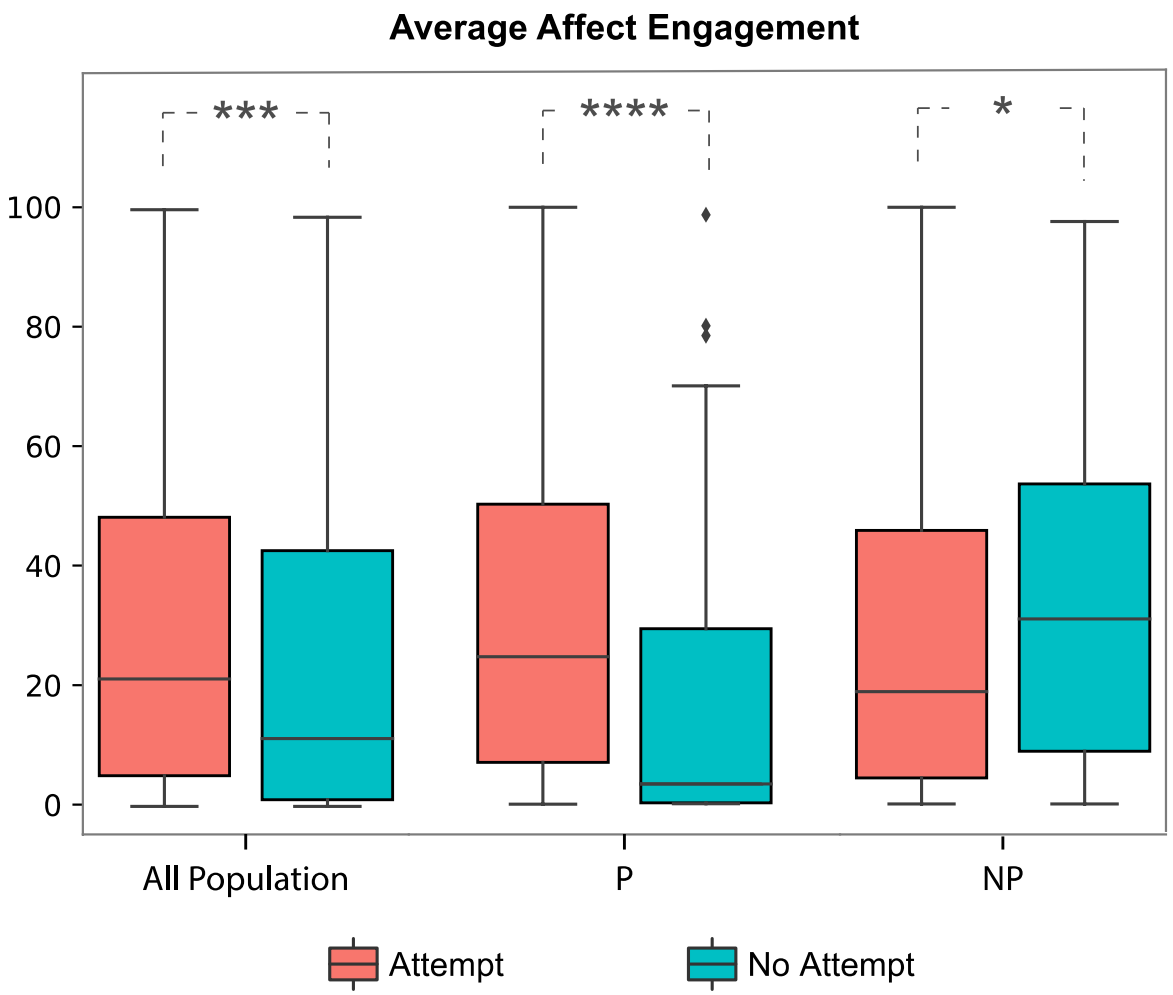
All children who interacted with the robot learned more words, **but the effect was greater with the personalized robot**

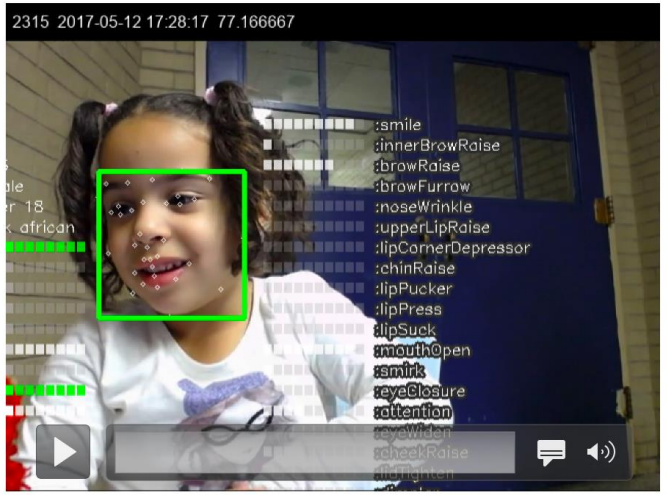




Robot role: Novice vs. Expert vs. Adaptive

Children were more engaged with the Personalized Robot (Affective display analysis)

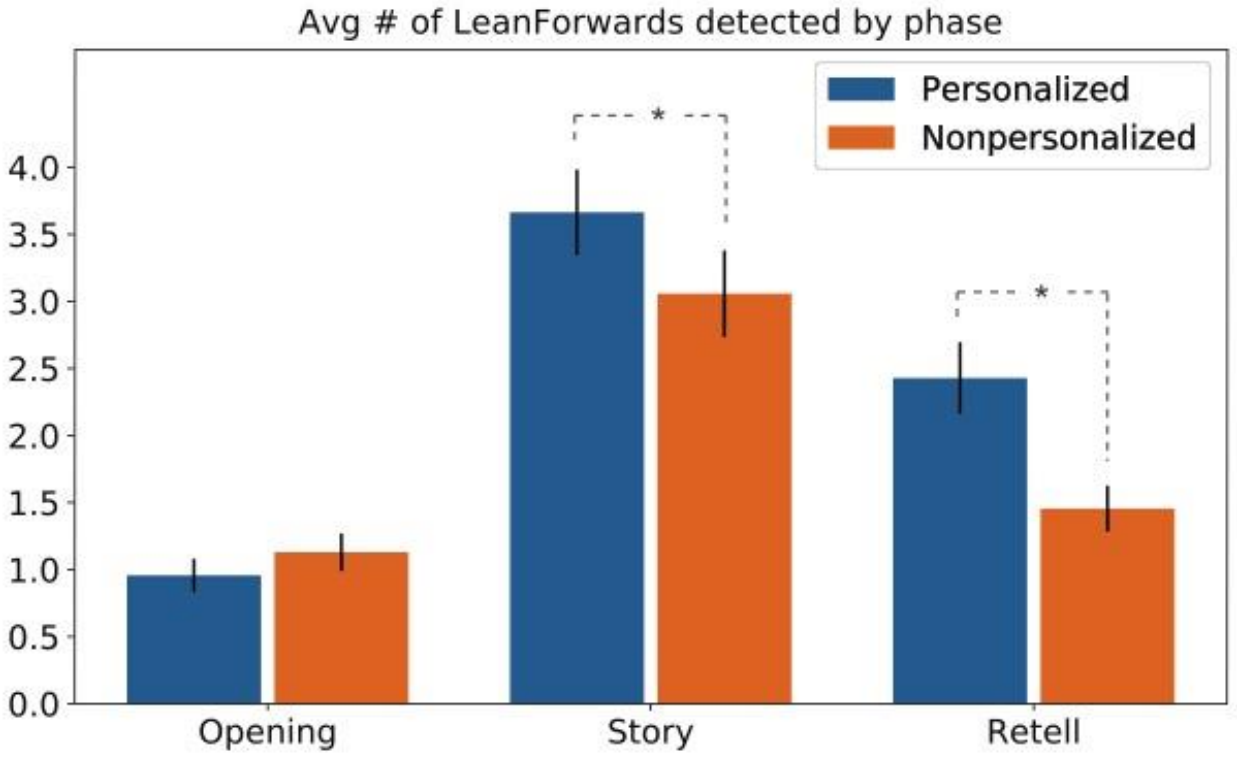




Personalized

Non-Personalized

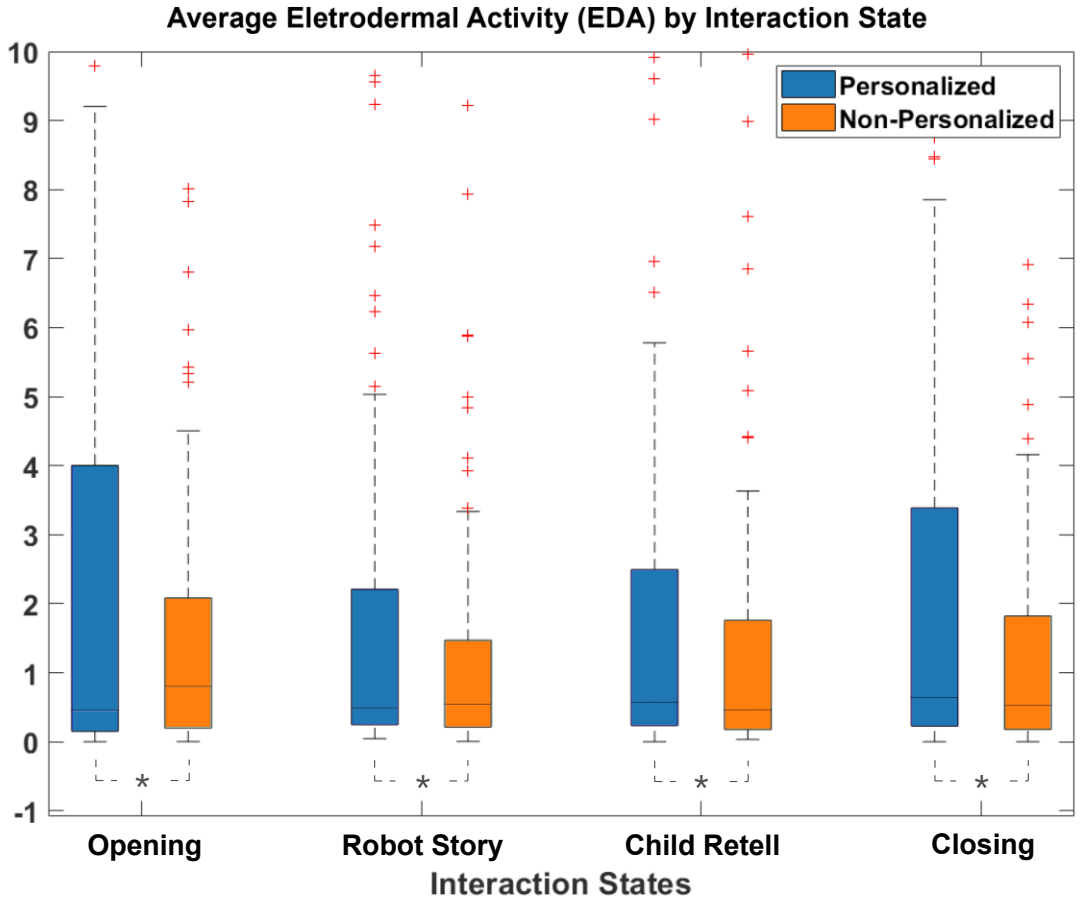
Children were more engaged with the Personalized Robot (Body pose analysis)



Personalized

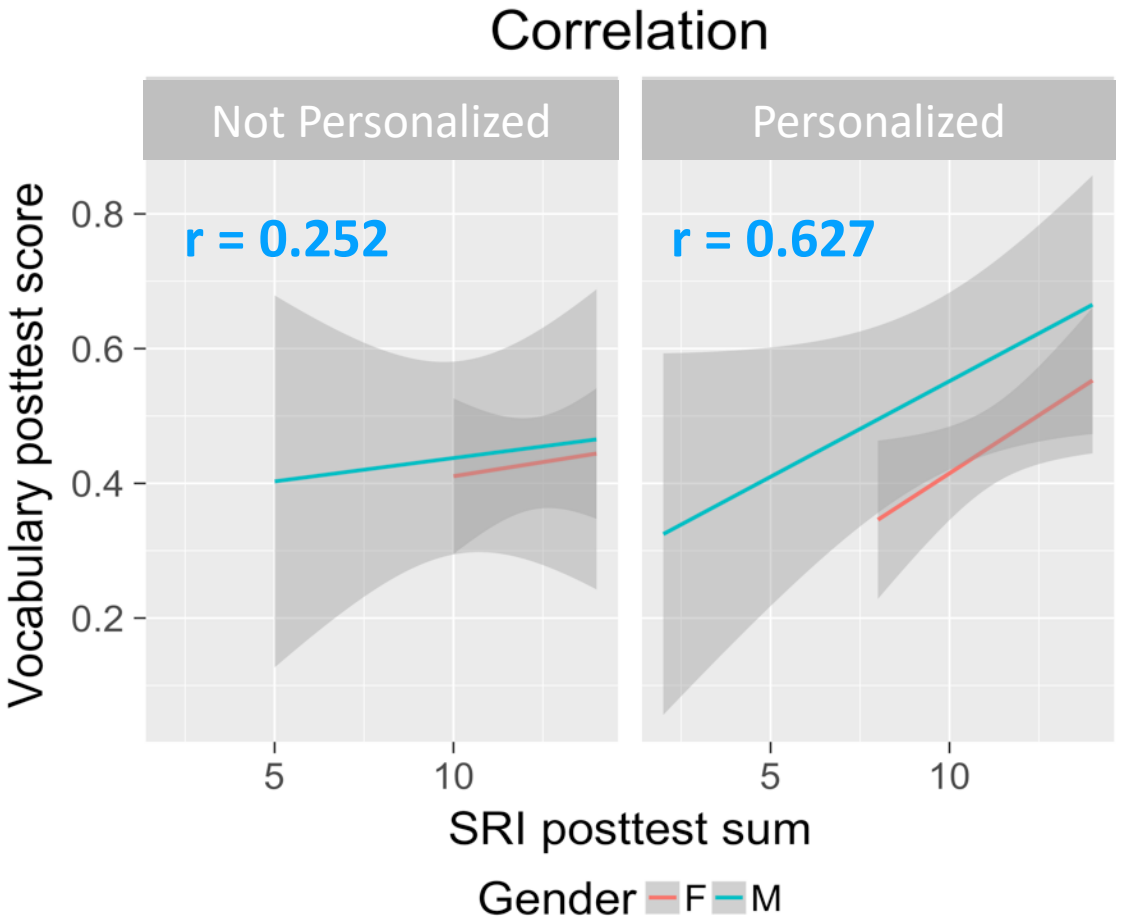
Non-Personalized

Children were more engaged with the Personalized Robot (Physiological signal analysis)



Electrodermal Activity (EDA) Sensors

Children who bonded with the robot more showed higher Learning gain



Social Relational Interviews (SRI)

Children who rated robot as more social-relational had:

- Higher vocabulary scores
- Told longer stories
- Mirrored language more in their story retell

Personalized = stronger correlation

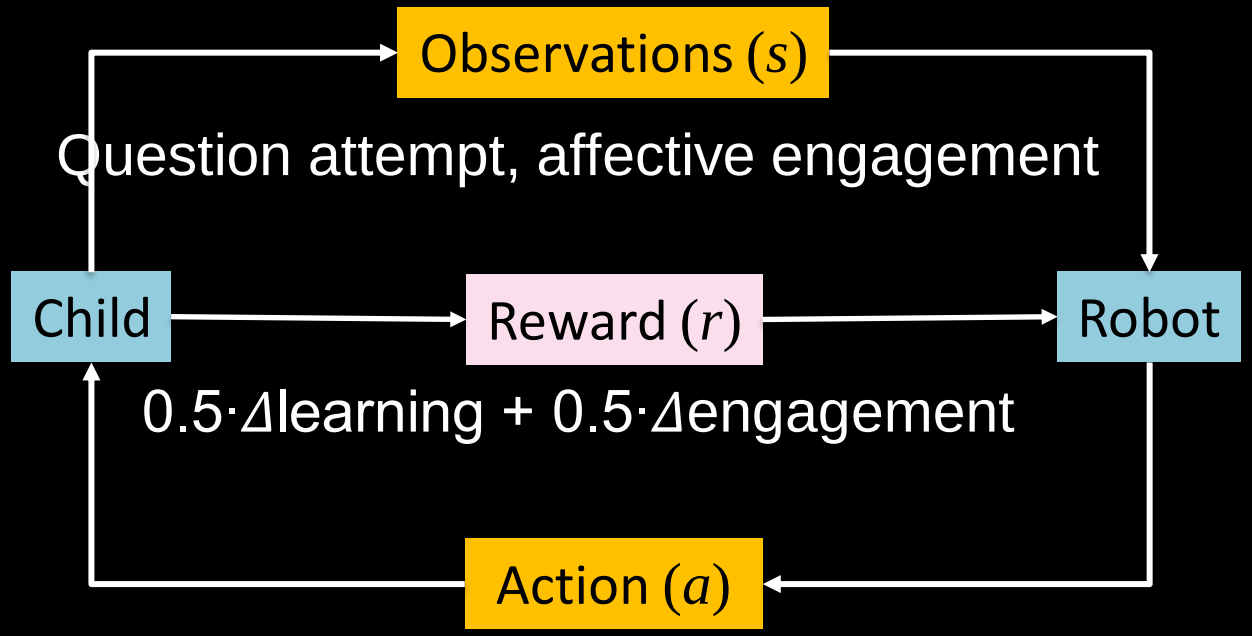
J. K.Westlund, H.W. Park, R. Williams, and C. L. Breazeal. *"Measuring Young Children's Long-Term Relationships with Social Robots."* IDC 2018.

Socio-Affective Reinforcement Learning

Learning from how children engage and learn

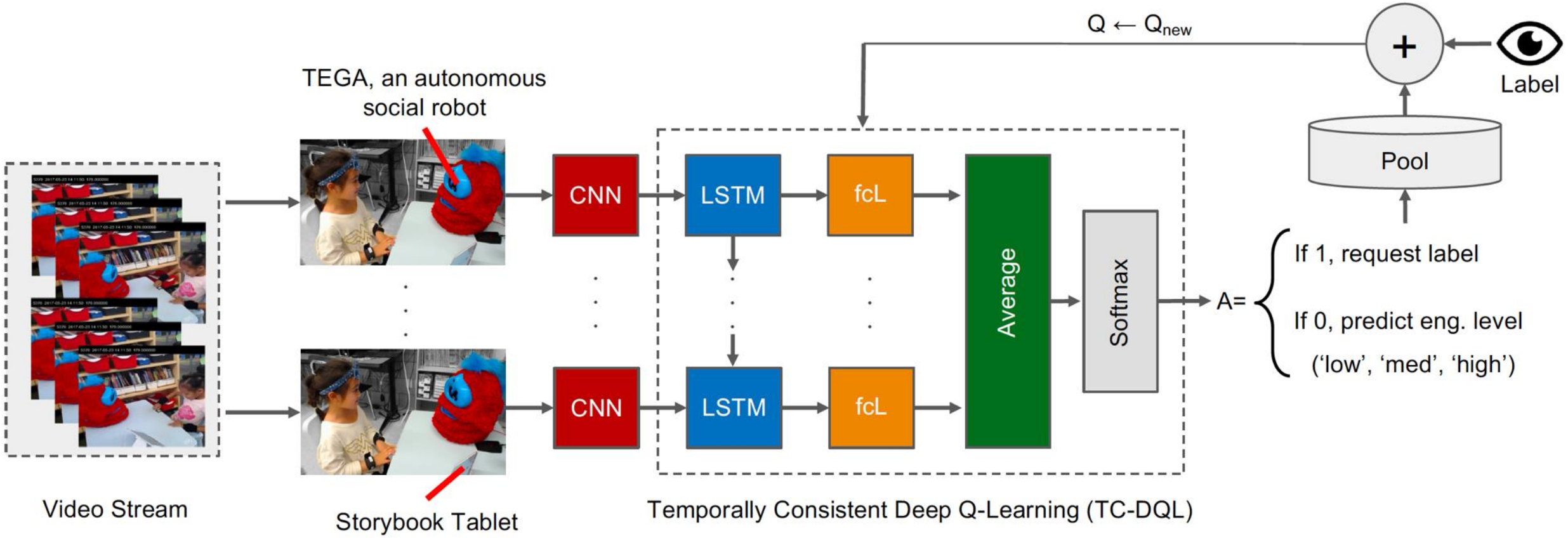
Interaction episodes are collected from repeated encounter with each individual.

RL Q-Learning ε-greedy policy



Robot delivers storytelling using its verbal & nonverbal expressive cues. The robot selects a personalized story for the next interaction based on the updated policy.

Personalized Engagement Detection



Ognjen (Oggi) Rudovic, Hae Won Park, John Busche, Bj¨orn Schuller, Cynthia Breazeal, and Rosalind W. Picard. **Personalized Estimation of Engagement from Videos Using Active Learning with Deep Reinforcement Learning.** CVPR-AMFG 2019

Supporting Early Childhood Education

212 children, their families, and schools