eMoBo: Three Early Interactive Prototypes Supporting Positive Relational Processes between Children and Adults in Residential Care Settings

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ABSTRACT

Children who live in out-of-home, residential care facilities have typically experienced adversity and trauma and consequentially exhibit psychological distress (e.g., despair, detachment). Residential care facilities are understaffed while needing to establish a healthy liaison between staff and children. This lamentable state of affairs has become more pressing following the Covid-19 pandemic. With expertise in design, robotics, interaction design, cognitive science, developmental psychology, and early childhood education, our research team has designed three early robotic prototypes that we call "e," "Mo," and "Bo," in our longer design endeavor to develop "eMoBo," an interactive, non-humanoid robot for young children living in residential care facilities to playfully express themselves. The aim of this child-centered project is to provide the opportunity for children who have experienced hostile environments and inappropriate care to become aware of, regulate, and express their inner socio-emotional world via tactile and visual experimentation with eMoBo so that they might more easily communicate their feelings and needs with non-biological caregivers, striving for a significant, long-standing improvement in the wellbeing of these children. In this paper, we present our designs and envision their use in two use cases. The three prototypes will be shared with our research partners, the Hillside Residential Center (Rochester, New York) towards advancing the design of eMoBo with the Center's stakeholders.

IDC '23, June 19–23, 2023, Chicago, IL, USA

ACM ISBN 979-8-4007-0131-3/23/06.
https://doi.org/10.1145/3585088.3594488

CCS CONCEPTS

• **Human-centered computing**; • **Scenario-based design**; • **Activity centered design**;

KEYWORDS

child-robot interaction, socio-emotional development, residential care facilities, prototype design

ACM Reference Format:
Joshua Blair, Eli Vicarte, Hsing-Ming Chao, Lucia Pannunzio, Fannie Massarsky, Alyssa Yoon, Yarden Kedar, and Keith Evan Green. 2023. eMoBo: Three Early Interactive Prototypes Supporting Positive Relational Processes between Children and Adults in Residential Care Settings. In *Interaction Design and Children (IDC '23), June 19–23, 2023, Chicago, IL, USA.* ACM, New York, NY, USA, 4 pages. https://doi.org/10.1145/3585088.3594488

1 INTRODUCTION

Children who have experienced early childhood trauma demonstrate a fragility to assimilate sensory input from their environment often resulting in emotional dysregulation. Targeting emotional regulation among traumatized children in residential homes has been demonstrated to be effective in assisting children to identify and modify their emotional experience (Knoverek, 2013).

In another line of research, robots have been shown to have an affective and cognitive impact on children (Belpaeme, et al, 2018). According to Stefandi, building an understanding of the population to design for, designing technology that empowers children, and fostering connectedness is crucial for digital well-being (Stefandi, 2022).

Our design process of the eMoBo robotic prototypes corresponds with such findings from the developmental psychology and child-centered design fields. Specifically, our project aims at two interconnected goals: First, create an opportunity for children in residential care to regulate their emotions via a child-robot interaction that stimulates and motivates curiosity and ultimately improves the children's wellbeing by expressing their feelings and needs to an adult. Second, to ease the burden on residential care staff while optimizing and enriching their relationships with the children for whom they care.

The ongoing evolution of the three eMoBo prototypes is based on continuing, meaningful conversations and feedback from our partners: The Hillside Residential Treatment Services (https://hillside.com/), a long-established agency providing residential treatment for children across New York State; and Cornell University's Residential Child Care Project (RCCP: https://bctr.cornell.edu/projects/the-residential-child-care-project/). These two partners have been collaborating for decades now, in particular, in implementing the RCCP's Therapeutic Crisis Intervention (TCI) System as well as its Children and Residential Experiences (CARE) project that helps child-care agencies re-align their organizational practices around the best interests of children. Accordingly, our prototypes take into account both the personal needs of children who live in residential homes, as well as the organizational characteristics of such settings, in order to come up with an impactful aid for both children of different age groups and their caregivers.

Our research closely relates to Attachment Theory (Bowlby, 1988), which posits that children are predisposed to seek social interactions leading to enduring attachment bonds with a small number of primary caregivers. Longitudinal studies of attachment have long demonstrated that the quantity and quality of caregiver-child interactions play a critical and continuous role in children's socio-emotional development, personality formation, and well-being, from infancy to later childhood and adulthood; and that providing children their physical needs (e.g., housing, food) is not adequate for normal development (Ainsworth, et al, 1978). One crucial characteristic of children who experience out-of-home care in residential facilities, which lies in the heart of our project, is that these children often lack sufficient and consistent attention, responsiveness, and enjoyable interactions with their non-biological attachment figures (Van IJzendoorn, 2011). Such circumstances may lead to long-term deficits in a person's social and emotional functioning (e.g., becoming an abusive parent; incapability to form romantic bonds in adulthood) (Gunnar, 2001). Bonding with adult caregivers while children are in out-of-home care facility is fundamental for their physical and psychological development; and for the quality of relationships later in life (Carra, 2012). In fact, smaller teacher-child ratios and appropriate group sizes have repeatedly been associated with quality childcare, such as a reduction in behavior problems (Downer, 2010). However, the number of children in out-of-home care has doubled since 1986, and finding suitable caregivers while avoiding staff attrition has been a challenge nation-wide (Knoverek, 2013).

Our project also relates to IDC's 2023 theme – 'Rediscover Childhood'. The COVID-19 Pandemic has affected the population worldwide. Specifically, the closure of schools, day cares, and playgrounds has cut young children from interacting and developing crucial social and motor skills, becoming dependent on digital interactions more than physical ones. *eMoBo* aims to help children re-engage and re-connect with the essence of childhood by handling, touching, and operating a child-centered robotic design, watch how the robot responds to their actions, and then communicate their experience to meaningful adult figures.

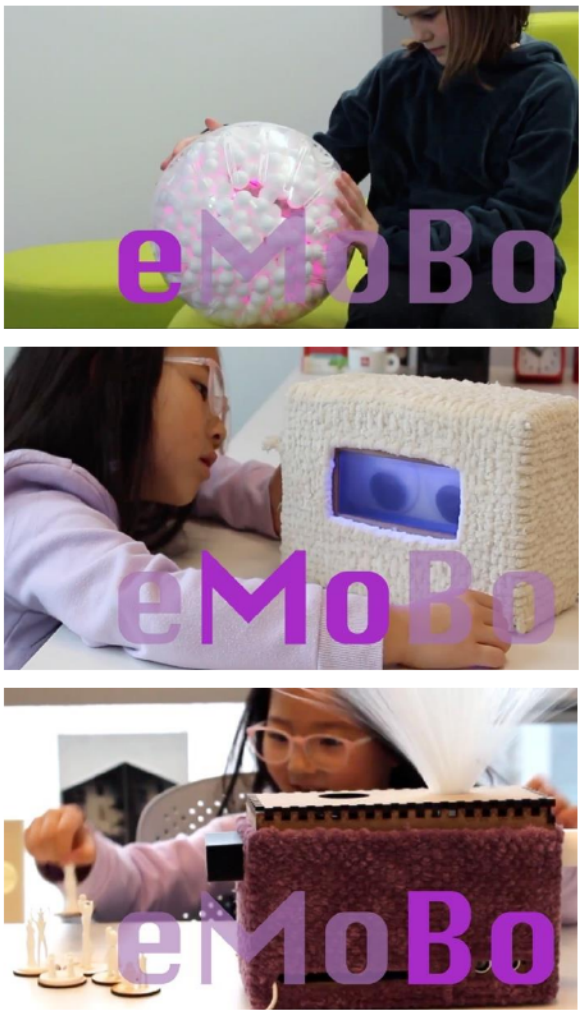

Figure 1: "e," "Mo," and "Bo" –three early prototypes in our development of "eMoBo," an interactive device aiming to support positive relational processes between children and adults in out-of-home care settings.

As far as selection and participation of children, we have not tested any children at this point. We have had two colleagues' children volunteer to take part in a video demonstration of *eMoBo*, with parental consent.

2 DESIGN

The *eMoBo* prototypes seek to engage children in motor, touch-based activities, as well as communicative, visual and auditory-based experiences that allow the child to interact with the robot.

Our first prototype, *e,* is box-shaped and wrapped with light yellow colored soft fabric. It has a rectangular opening on one of its sides where you can see open or closed wiggle eyes. This design has sensibility features that welcome touch. One of its sensibility features will remain *e*'s eyes closed if it is in a really bright ambience. We have chosen wiggle eyes to provide the box with some degree of life and to avoid limiting children's imagination or interaction. Another way this design features sensibility is that as the child gets close to the box, the eyes will show, and the inside will light up yellow, eliciting excitation. When the child comes really close, the inside will light up with multiple switching colors and it will play a melody. All these responses are a way to demonstrate positive feedback from child proximity. When we came up with *e*, we wanted to target children that have often been neglected and may have a negative relationship with proximity and touch.

Our second prototype, *Mo,* is spherical-shaped enclosed in a clear plastic material. The shape and foam ball interior encourages aerodynamic movement, which motivates children to engage with it physically, such as twirling it and shaking it. When the child shakes the ball, *Mo* reacts by changing the LEDs from cyan to purple in quick succession. These functions encourage the child to move the sphere in a multitude of ways, allowing the staff worker or therapist to use play with the sphere as a jumping off point to encourage the child to open up. We hope the child's behavior with the ball can give the staff worker or therapist some insight into how they are doing emotionally that day, and/or serve as an icebreaker to a therapy session.

Our third prototype, *Bo,* is box-shaped and wrapped with purple colored soft fabric. This design contains a compartment where children can insert small figures of their choice. The father figure, mother figure, nuclear family, grandparents, and teacher silhouette figures were found on *Thingiverse* to print. The compartment, in which 3D figures can be placed, can be opened or closed with a gear so it can be kept private. Once the figures are dropped into the compartment, it provokes anemone-like structures to come out in response to the user's interaction – in this case, dropping icons into the secret compartment. These figures represent different statuses of a social relationship, and the caregiver is to instruct the children to drop the one correlating to their current emotional state. The box welcomes touch by shining its light brighter as one comes close to it, functioning as a positive feedback loop.

2.1 How children benefit from *eMoBo*

According to Maxwell, there is a lack of physical and psychological privacy for children in residential care, and "higher levels of household density... may increase the psychological need for privacy among children" (Maxwell, 1996). The secret compartments in *Bo* would provide children with some semblance of privacy, where they can express their feelings without a third party directly overlooking. Likewise, the personalization element of our designs would begin to reverse the depersonalizing effects of being in overcrowded facilities. Likewise, *eMoBo* would function as mini versions of stimulus

Figure 2: Two Use Cases: (top) eMoBo just ahead of weekly therapy; (bottom) eMoBo redirecting an agitated child.

shelters, which Bartlett defines as "alcoves or small rooms [...] that can be accessed by children [and] can offer them a place to withdraw from chaotic or noisy surroundings" (Bartlett, 1997).

2.2 Two Use Cases

The following are two short examples of how the triadic dynamics among the child, robot and adult in the residential care facility may work.

2.2.1 Use Case-1. While interacting with *Mo*, the child chooses to repeatedly shake the robot. A therapist who is watching the child (either live or on video) interprets the repeated action as a sign of agitation or being overwhelmed (Figure 2). The child's behavior with Mo can serve as an ice breaker to a therapy and/or provide insight to how the child is doing emotionally in that moment.

2.2.2 Use Case-2. A child repeatedly inserts the father-son figure into the compartment of *Bo*, and a staff member or therapist may initiate a conversation about the child's feelings toward his/her father. The figures were inspired by Furman's research showing that mother and father figures were turned to most often for affection, enhancement of worth, and more (Furman, 2010). Like *Mo, Bo* is working as an icebreaker and/or as a tool to obtain insight into a child's emotions or desires.

3 EXPECTED DEMO EXPERIENCE AT THE CONFERENCE SITE

The research team will bring the three working prototypes to the conference. The accompanying video for this paper will be screened

while conference attendees are invited to interact with the prototypes. We might ask attendees if they would be willing to assume the role of a stakeholder and role-play our use cases to get better acquainted with our design objective. "Talk aloud" interactions with a kit of parts may help us generate alternative designs. Such activities offer something substantive (and playful) to the attendee and the research team. Our video at https://vimeo.com/808529770.

4 LIMITATIONS

eMoBo research has involved the clinical and administrative staff of *Hillside Children's Center* [9] in Rochester, NY and the *Residential Child Care Project* [12] at Cornell University. We plan to conduct a first user study in Summer of 2023 to test the effectiveness of our proposed robot designs with children in at the Sciencenter of Ithaca.

ACKNOWLEDGMENTS

The authors thank the Residential Child Care Project at Cornell University for its support of this research.

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