Child Trauma and Designing Technological interventions | Keith Evan Green

Your device is expected to assist children who suffered traumatic stress to **recognize and verbalize** their own and others' emotions, to **express** emotions effectively to their caregivers, and to **regulate** their emotions in response to immediate or ongoing stressors in their residential homes and elsewhere. The general aim of this intervention is to help children strengthen social bonds and build trust with others—one of the greatest challenges in social-emotional learning (SEL) [17] for a child.

Here, we define "child trauma" and consider previous efforts to develop robots as therapeutic tools.

2.1 Child Traumatic Stress

The United States *Substance Abuse and Mental Health Services Administration* (SAMHSA) defines the following life experiences as traumatic:

> *Psychological, physical, or sexual abuse; Community or school violence; Witnessing or experiencing domestic violence; National disasters or terrorism; Commercial sexual exploitation; Sudden or violent loss of a loved one; Refugee or war experiences; Military family-related stressors (e.g., deployment, parental loss or injury); Physical or sexual assault; Neglect; Serious accidents or life-threatening illness* [18].

According to the U.S. *National Child Traumatic Stress Network*, children who experience trauma have been exposed to "one or more of the above-listed traumas" and "develop reactions that persist and affect their daily lives after the events have ended" [18]. Traumatic reactions include "difficulties with self-regulation" and "problems relating to others or forming attachments" [19].

The World Health Organization estimates that around 1 in 4 children experience trauma that can impact their mental health and development [20]. In the U.S., at least 1 in 7 children have experienced child abuse and/or neglect in the past year [18]—identified by SAMHSA as life experiences that account for child trauma. In Israel, according to one study of the general population of children there [21], 44% of children were exposed to terrorism personally or had one relative exposed to terrorism – identified by SAMHSA as a life experience that accounts for childhood trauma.

At its core, childhood trauma interferes with a child's ability "to function and interact with others" [18] and can lead to learning disabilities and aggression against self and others. "Chronic childhood trauma interferes with the capacity to integrate sensory, emotional and cognitive information into a cohesive whole and sets the stage for unfocused and irrelevant responses to subsequent stress" [22]. In addition to the traumatic experience, once placed in an out-of-home setting, a child who is exposed to institutional care may often suffer from structural neglect, resulting in delays in several developmental aspects [23].

Attachment theory [24] serves as a crucial framework for examining developmental outcomes for children who reside in institutional environments. This theory emphasizes the significance of the bond between child and primary caregiver that plays a vital role in shaping the child's future social, emotional, and behavioral development. Children living in alternative care settings with caregivers who are less available are considerably more prone to developing insecure attachment styles such as *Avoidant*, *Ambivalent*, or *Disorganized* attachments compared to those raised by their biological parents [25, 26].

Your aim is to develop a device that helps children who have experienced trauma **recognize, label, and express emotions**, with the goal of strengthening social bonds with their in-home and out-of-home caregivers alike.

Children who have experienced trauma are often assigned by the State or caregivers to live in or attend school and treatment at trauma-care centers [27], such as Hillside in Rochester, NY. At the trauma-care center, the center's therapists aim to strengthen the child's capacity to recognize, label, express and regulate emotions in accordance with specific social contexts. The success of such a strategy is, however, dependent on the training performed at trauma-care centers which, in the US and elsewhere, oftentimes suffer from factors such as shift systems , staff shortages, significant staff turnover, insufficient training, and a high ratio of children per staff member that leads to unavailability of caregivers (both physically and emotionally) – all of which may lead to significant, acute delays in a child's physiological, cognitive, and socio-emotional development [25, 26, 28, 29]. Furthermore, severe and pervasive effects of language and communication impairment were found in the UK among adopted children as well as children in foster homes and in residential care. While these impairments have been shown to be associated with the children's psychological well-being, they are often not detected and/or not treated [30, 31].

2.2 Designing Technological interventions for the Needs of Children

Your device is not envisioned to be a "silver-bullet" that will overcome the critical shortcoming at trauma care centers for children but, instead, an intervention that might better serve caregivers in delivering the best possible care to the children who desperately need it. It is important that your device is not perceived as a full-time surrogate, but rather as a "third edge" in a communicative triangle formed by the child, the therapist/caregiver, and the robot [1 ,32].

In the field of social robotics, research that aims to investigate the effects of robot-assisted child and adult psychotherapy is growing [33-45]. Robots can serve as instruments in psychotherapy to bring about change in the child in the context of classical, evidence-based psychotherapy and within cognitive-behavioral therapy (CBT) [39]. Technological interventions have excellent potential for children's learning of socio-emotional and communicative skills in therapy, which can translate to real-world situations, helping children identify situation-based emotions [e.g., 46] and verbalize (e.g., [47]), express [e.g., 48], and self-regulate [e.g., 49] their emotional state.

Some approaches to studying socio-emotional learning using robots include: Capturing motion data from children to study play patterns and analyzing how these relate to affective responses [47]; exploring how robotic assistants might help to improve verbal communication in children with different disabilities [50]; exploring the ability of children to understand emotions exhibited by a robot with only movement as feedback [51]; investigating the potential to help children learn basic psychosocial skills from interactions with robots [52]; testing robots and their social benefits in the context of collaborative play [53]; exploring how robots could recognize a child's intent during play [54]; investigating how robots could be used to train turn-taking skills through robot-child interaction [55]; and aiming to improve social behaviors through HRI [56].

A targeted review of state-of-the-art robots previously developed for improving socio-emotional skills in children, includes relevant theoretical foundations in HRI on embodiment (e.g., [57], communication modalities (e.g., [58]), and AI safety [59]. Such robots come in different forms: human-like, animal-like, toy-like, or machine-like [30]. Some of the robots in the literature have been developed to detect emotions in users through behavioral reading and provide feedback according to acquired data [60].

Most of these robots focus on helping children regulate emotions. Others exhibit emotions through multimodal stimuli to promote empathy-building skills [40, 42]. For example, robots may use verbal feedback [e.g., [61], visual stimuli (lights and screen visuals), auditory stimuli (sounds and music), and tactile stimuli (vibrations, movement, and smell). Robots have also been utilized as agents encouraging reflective and social storytelling in children. Storytelling has been shown to be effective in reducing disruptive behaviors and enhancing social interactions, particularly among children with autism spectrum disorder (ASD) [33, 62].

Many robots effectively apply behavioral recognition through cameras, microphones, heartbeat sensors, temperature sensors, and other sensors dedicated to behavioral capture [60]. One of the most widely tested robots for this purpose is the NAO humanoid robot [62]. For our research, the standard means for behavioral recognition (cameras, microphones, on-body sensors) may be too intrusive for the targeted population, raising ethical issues and logistical challenges for staff, therapists, and caregivers. Moreover, many of the robots cited from the literature are prohibitively costly for public, residential institutions like Hillside. Less costly, less intrusive, your device should exhibit potential to help adults teach children how to express their emotions without the robot generating assumptions about the child.

Finally, recognize that your design challenge is related to but still distinct from the numerous human-robot interaction studies on children with ASD—documented in 439 papers according to a 2023 scoping review [63]—by focusing on a distinct and equally vulnerable group: children who have experienced trauma.

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