CuddleConnect: Designing Child-Initiated Emotive Communication and Mediated Hugs for Remote Parent–Child Connection

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Figure 1: CuddleConnect enables child-initiated emotive communication and hug requests through an interactive plush toy. Children convey how they feel and request hugs, which are sent to a parent's mobile app. Parents can respond remotely, with hugs materialised in the plush toy through warmth and vibration.

Abstract

Children often experience emotional distress during periods of separation from their parents, while parents may feel guilt about their limited availability. Yet, existing remote parent–child communication technologies rarely accommodate children's communicative capacities or provide meaningful support for their agency. Thus, we present CuddleConnect, an interactive system that supports child-initiated, affective remote communication. CuddleConnect combines a weighted plush toy for children with a mobile application for parents, enabling children to express emotions and request hugs through light cues, while allowing parents to receive these requests on their smartphones and respond with mediated hugs delivered via haptic feedback and warmth on the plush toy. We report findings from a one-week in-situ study with four parent–child dyads, highlighting both opportunities for fostering closeness and challenges related to ambiguity and responsiveness. These insights inform design implications for future synchronous and asynchronous parent–child communication technologies.

CCS Concepts

• **Human-centered computing** → **Empirical studies in collaborative and social computing**; *Empirical studies in interaction design*; **Collaborative interaction**.

Keywords

Children, Design, Artefact, Proxy, Emotion, Asynchronous Communication, Synchronous Hug, Remote Interaction

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1 Introduction

Children often experience emotional distress during periods of separation from their parents and seek reassurance or contact, yet opportunities to initiate communication are limited by parents' work schedules and daily routines [14, 27, 50]. Parents frequently leave early and return late, leaving children separated for extended periods during the day. Although children may wish to reach out independently, this is rarely feasible: young children typically do not own personal communication devices and often lack the developmental skills to use phones or text-based interfaces on their own [2, 29, 50, 53]. At the same time, concerns around screen time and distraction make smartphones and tablets problematic interfaces for young children. This creates a tension between children's desire to initiate contact and the limited suitability of screen-based communication technologies.

Remote parent–child communication is therefore a critical area of research in HCI, given the central role of the parent–child bond in children's social, emotional, and behavioural development [1, 24, 33]. Frequent and meaningful communication supports children's sense of security and long-term relational health [1]. Separation between parents and children is common and often unavoidable, occurring both in everyday work contexts and in longer-term situations such as divorce or business travel [14, 53]. In these cases, reduced contact has been linked to emotional and developmental challenges for children [15, 32, 45, 46], highlighting the importance of technologies that support meaningful remote interaction [31, 53].

Despite the widespread use of phones and video calls, prior research has shown that these technologies do not adequately meet the needs of young children or parents [1, 27, 53]. Children are easily distracted during calls and often struggle to stay engaged [4, 11]. Communication frequently depends on the involvement of a co-located adult, limiting children's agency and complicating contact in contexts such as divorced families [53]. Parents, in turn, may experience stress and guilt due to limited availability or delayed responses [19]. Existing technologies also provide little support for physical intimacy, despite the importance of touch for emotional well-being and relationship maintenance [13, 30, 44]. Similarly, emotional expression remains challenging, particularly for young children who struggle to articulate feelings verbally [1, 36, 53].

In response, HCI research has explored alternative approaches to remote parent–child communication, including tangible and playful interfaces, proxy objects representing the parent, mediated touch, and asynchronous interaction [27, 36, 53]. Plush toys have emerged as approachable and comforting interfaces [12, 34], and physical proxy objects may help children feel reassured in the absence of their parents [17, 36, 53]. Prior work has also explored mediated hugs and warmth-based interactions [16, 23, 41, 44], as well as asynchronous and lightweight emotive communication [2, 11, 39, 50]. However, many systems address only subsets of these design considerations or were evaluated in short-term or artificial settings, often targeting older children [11, 12, 23]. To date, no system has integrated these approaches and examined their use in families' everyday lives over an extended period.

To address this gap, we present CuddleConnect, an interactive system designed to support child-initiated, affective remote communication between parents and young children without relying on screen-based interaction for the child. CuddleConnect consists of a weighted interactive plush toy for the child and a mobile application for parents (see Figure 1). The plush toy acts as a tangible proxy for the remote parent [27, 36], incorporating weight, haptic feedback, and warmth to convey mediated hugs to the child, drawing on prior work on weighted objects and anxiety reduction [26, 35]. Children can express their emotional state and indicate a desire for closeness through simple light-based cues, while parents can respond via the mobile application in a manner compatible with work routines [11, 50]. The system supports both synchronous and asynchronous interaction. In particular, this paper explores the following research questions:

- RQ_1: How do parents and children integrate CuddleConnect into their everyday routines?
- RQ_2: How do mediated emotive communication and remote hugging shape children's and parents' experiences and their relationship, particularly regarding emotional closeness and perceived reassurance?

We evaluated CuddleConnect as a technology probe in a one-week in-situ study with four parent–child dyads. Using interviews, questionnaires, and interaction logs, we examined how CuddleConnect was appropriated in everyday family routines and how mediated emotive communication and remote hugging shaped experiences of agency, reassurance, and emotional closeness.

In summary, this paper contributes (1) the design and implementation of CuddleConnect as an interactive, weighted, thermal, tangible proxy plush toy enabling child-initiated emotive communication combined with a mobile app for parents for remote parent–child communication, (2) empirical insights from an in-situ study of everyday use, and (3) design implications for future systems supporting remote parent–child relationships, with a focus on children's agency, mediated intimacy, and emotional expression.

2 Related Work

In the following, we discuss related work in HCI targeting remote parent-child communication and children's agency, mediating physical intimacy and emotive communication, and using tangible proxies such as plush toys.

2.1 Remote Parent-Child Communication and Children's Agency

Research in HCI has long examined how technologies can support communication between parents and children during periods of separation, with a particular focus on work-separated and geographically distributed families [27, 29, 36, 50, 53]. These studies consistently show that existing communication tools such as phones and video calls are poorly suited to young children, who are easily distracted, struggle to remain engaged, and often lack the developmental skills required for independent use [4, 11, 53]. Other prior work about technologies supporting family interaction and communication has focused on capturing and sharing everyday

personal memories [5, 21]. Yet, most of this research centres on parents documenting children's lives, and communication being frequently mediated by a co-located adult, limiting children's autonomy and potentially creating friction in contexts such as divorced families [53].

However, several studies highlight that children value being able to initiate contact themselves, rather than relying on adults to schedule or facilitate interaction [2, 36, 50, 53]. In fact, designing for children's agency has become one of the core design recommendations in HCI in recent years [47], and it has been repeatedly shown how technology-based, child-led, situated interventions could empower children and parents for emotion regulation by providing actionable support directly within their everyday life [37]. Systems that support child-initiated interaction have been shown to increase engagement and encourage emotional expression, such as through a multi-stakeholder mobile app for children with ADHD [38].

To address parents' busy schedules and time-zone differences, prior work emphasises the need to combine synchronous and asynchronous interaction [2, 50]. For example, ShareTable enables children to initiate contact with their family simply by entering a shared interaction space but primarily supports synchronous interaction, leading to scheduling conflicts that reduce its practicality for everyday use [52]. Yet, existing asynchronous media often rely on literacy, abstract representations, or device-based interaction that exceed young children's capabilities [2]. Together, these works show that while children benefit from agency and flexibility in remote communication, few systems enable child-initiated, developmentally appropriate interaction that fits seamlessly into family routines; a gap that CuddleConnect aims to address.

2.2 Tangible Interfaces as Proxy Objects

Tangible interfaces have been widely recognised as particularly suitable for children, offering playful, approachable, and embodied interaction [27, 34]. Within the context of parent–child communication, physical objects that symbolically represent the remote parent (often described as proxy objects) have been shown to provide comfort and reassurance during separation [27, 36, 50]. Children frequently use such objects to cope with absence, for example, by hugging a doll given to them by a parent or incorporating it into their bedtime routines [49, 53].

Plush toys, in particular, have emerged as effective tangible interfaces for children [11, 12, 25]. Children are familiar with plush toys, perceive them as non-threatening companions, and often form emotional bonds with them [12, 43]. Research shows that children attribute mental states to stuffed animals and use them as sources of emotional support [18]. Interactive plush toys further reinforce these bonds by enabling meaningful emotional interaction [43], which overall makes them a promising medium for proxy-based communication, informing the design of CuddleConnect.

Beyond symbolic representation, research on weighted objects suggests additional benefits for emotional regulation and comfort. Weighted blankets have been shown to reduce anxiety and promote relaxation through deep pressure stimulation [7, 26, 28]. Similar effects have been observed in weighted plush toys, both in co-design studies with children [35] and in therapeutic contexts such as dementia care [42]. Despite these findings, weighted plush toys have not yet been explored as proxy objects in remote parent–child communication; a research gap that we address with CuddleConnect.

2.3 Mediating Physical Intimacy and Emotive Communication

Physical intimacy plays a crucial role in parent–child relationships, with touch serving as a primary non-verbal channel for expressing affection, reassurance, and emotional support [13, 48]. Prior research in HCI has therefore explored how physical intimacy can be mediated over distance, often through haptic and thermal feedback [11, 16, 23, 41, 44]. Studies suggest that warmth is commonly associated with affection, while vibration conveys touch, making these modalities promising for mediating emotional closeness [11, 23] and driving the design of CuddleConnect.

Several systems have investigated mediated hugging and touch in parent–child communication through tangible and wearable interfaces. Early work such as Embodied Teddy Bear [44] explores embodied, non-verbal communication using a conceptual teddy-based proxy evaluated through low-fidelity prototypes and short-term studies. Similarly, Huggy Pajama [41] focuses on the technical realisation of remote hugging through a pressure-sensing doll and a wearable haptic garment that reproduces touch and warmth. Other systems, such as Bear-With-Me [16] and ChiParCo [11], investigate bi-directional interaction through connected tangible devices either through two teddy bears for couples (Bear-With-Me) or through plush toy and a vibrating glove (ChiParCo), enabling real-time exchange of touch-based signals between users. Additionally for ChiParCo, remote hand-holding was also perceived as unintuitive or emotionally weak for children [11].

In parallel, emotive communication has been identified as a key challenge in remote parent–child interaction. Young children often struggle to verbally articulate their emotions, while conventional communication technologies rely heavily on speech or text [36, 53]. Prior work suggests that lightweight, non-verbal representations (such as coloured lights) can effectively convey emotional states and support emotional awareness [11, 22]. Parents, particularly in work-separated families, value emotive communication as a way to remain emotionally present and provide support asynchronously, potentially alleviating guilt and stress associated with limited availability [27, 50].

Although these systems demonstrate the potential of mediated touch, they often suffer from practical limitations, including bulky form factors (e.g., wearable haptic garments in Huggy Pajama [41]) and reliance on additional devices (such as wearable components in Huggy Pajama and ChiParCo [11, 41]), which may hinder integration into everyday use. Moreover, many of these systems emphasise synchronous interaction (e.g., Bear-With-Me [16], Embodied Teddy Bear [44]) and are evaluated in short-term and controlled lab settings removed from authentic separation contexts (e.g., Embodied Teddy Bear [44], Bear-With-Me [16], ChiParCo [11]), limiting insights into how such interactions are appropriated in real family routines.

Our system CuddleConnect is inspired by these findings by using thermal feedback, vibration, child-friendly soft materials and colour as lightweight option for emotive communication. However, in contrast to those related works, CuddleConnect avoids wearable

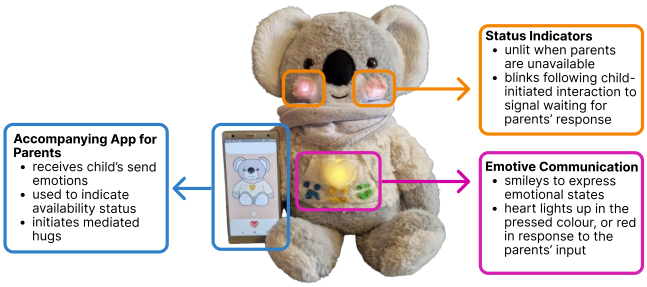

Figure 2: Elements of CuddleConnect, combining a plush toy with LEDs for indicating the status and communicating emotions, and a mobile app for parents to receive those emotions and initiate a mediated hug.

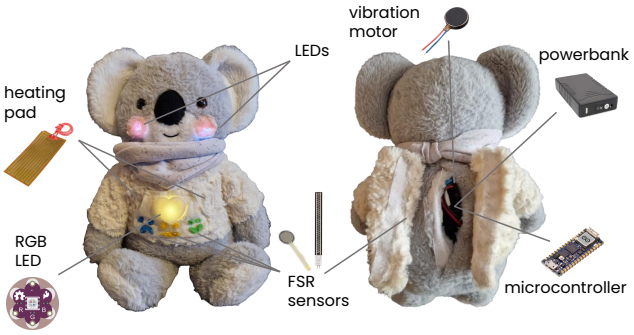

Figure 3: An exploding view of the technical elements implemented in CuddleConnect.

dependencies, supports asynchronous and low-threshold interaction, and combines the concept of a tangible proxy, mediated touch, and emotional support, forming a single, child-centred interface. We further set ourselves apart by investigating how mediated touch and emotive communication are meaningfully integrated into everyday family routines through an in-situ, longitudinal deployment.

3 Designing CuddleConnect

We present CuddleConnect, an interactive plush toy that children can use to initiate emotional communication and send hug requests to their parents' phone when apart. This section covers its design rationale and technical setup.

3.1 Designing a Plush Toy as a Child-Centered Proxy

Prior work highlights the value of tangible, playful, and approachable interfaces for young children in remote parent–child communication [27, 50, 53]. In particular, physical proxy objects that represent the remote parent can help children cope with separation by mediating presence, comfort, and emotional security [36, 49, 50]. Plush toys are well-suited for this role, as children are familiar with them, perceive them as non-threatening, and often form emotional bonds with them [12, 18, 25, 43].

These design considerations directly informed the physical realisation of CuddleConnect (see Figure 2). The system is embodied as a soft plush koala, selected for its associations with cuddliness and hugging, as well as its friendly, expressive appearance. The plush toy's large eyes and rounded facial features were chosen to increase approachability and emotional expressiveness, drawing on the concept of the baby schema, which has been shown to enhance perceived cuteness and attention in children across human and animal faces [8], as well as supporting children's tendency to attribute mental states to stuffed animals [18]. To enhance comfort and emotional reassurance, the plush toy is weighted, drawing on findings that weighted objects can reduce anxiety and promote a sense of security [26, 35, 42]. The toy's soft outer materials and cuddly size encourage close bodily interaction, such as holding or hugging, which aligns with research identifying softness as a key contributor to comfort and attachment [43].

To preserve the toy's familiar and non-technical character, all electronic components are concealed within the plush body and a custom hoodie (see Figure 3), ensuring that the artifact remains readable as a comforting object rather than a device [12, 25]. Finally, the plush toy is designed to be independently usable by the child, without requiring mediation by a co-located adult, thereby supporting children's agency and child-initiated interaction as emphasized in prior work [36].

3.2 Enabling Child-Initiated Emotive Communication

Prior research shows that young children often struggle to verbalize emotions, while commonly used remote communication technologies rely heavily on speech or text [36, 53]. To address this mismatch, HCI work on parent–child communication emphasizes the importance of lightweight, non-verbal, and child-initiated forms of emotional expression that align with children's developmental abilities [2, 50, 53]. Visual metaphors, particularly color-based representations, have been shown to be intuitive for children and effective in conveying emotional states [11, 22].

These insights directly informed the emotive communication design of CuddleConnect. As illustrated in Figure 4 (left), the plush koala features a heart-shaped light embedded in its chest, serving as a central and emotionally meaningful display. Children express their emotional state by pressing one of three tactile emoji buttons, each mapped to a distinct colour (blue for sad, yellow for neutral, green for happy). The buttons are physically integrated into the plush toy's body and designed for targeted pressing, allowing children to interact deliberately rather than through incidental touch. When a button is pressed, the heart immediately glows in the corresponding colour, providing direct and legible feedback that reassures children that their message has been sent.

The child's emotional input is simultaneously mirrored in the parent's mobile application, where the illustration of the plush toy updates to reflect the selected emotion. This mapping provides parents with interpretable and meaningful feedback, which has been identified as important in prior work [34]. Extending earlier systems such as ChiParCo [11], CuddleConnect supports bidirectional emotive communication, allowing parents to respond

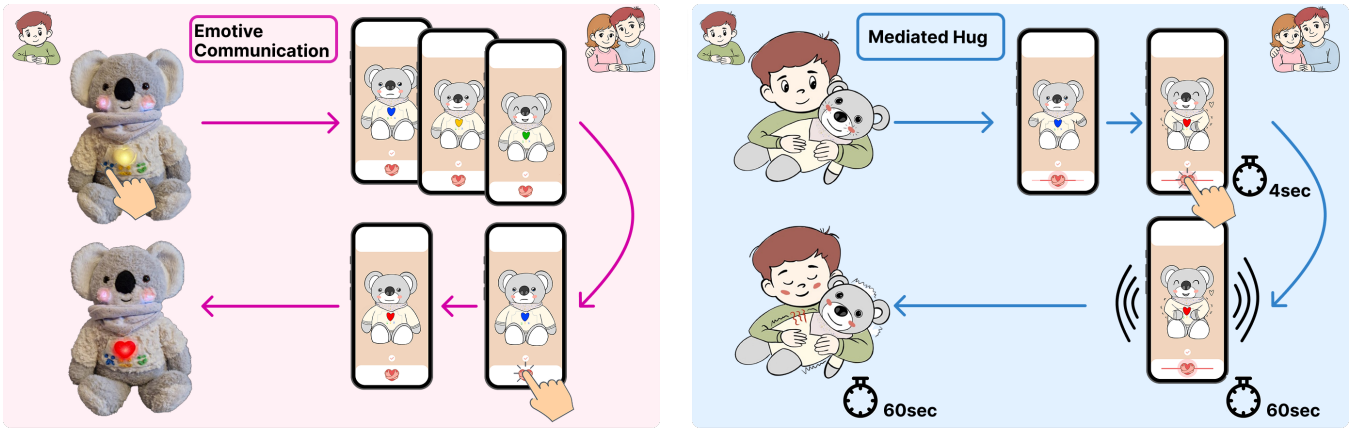

Figure 4: The interaction possibilities with CuddleConnect. Left: Emotive Communication. If the child presses the smileys on the plush toy, the parents' app displays the pressed emotion. The parent is then able to react by giving love, changing the light on the plush toy to red. Right: Mediated Hug. FSR sensors register a hug request, and the cheeks of the plush toy start blinking to represent a "waiting for response". The parents' app displays the hug request, parent reacts by pressing the hug button for 4 seconds until the progress bar is filled. Then, a mutual hug is initiated for 60 seconds, both on the phone and with the plush toy indicated by warmth and vibrations.

asynchronously by sending a colour-coded signal—most notably a red light to express affection. In this way, CuddleConnect enables children to initiate emotional communication independently, while allowing parents to remain emotionally present despite temporal or situational constraints [50].

3.3 Mediating Hugs for Emotional Reassurance

Physical touch is a central component of parent–child relationships and plays a critical role in conveying intimacy, comfort, and emotional reassurance [13, 48]. Prior work in HCI has highlighted hugging as a particularly meaningful routine for maintaining emotional closeness during separation [13, 36]. Several systems have explored mediated touch through haptic and thermal feedback, demonstrating that warmth and vibration are commonly associated with affection and presence [11, 16, 23, 41, 44]. However, many of these systems rely on bulky or specialized form factors or have been evaluated primarily in short-term or laboratory settings.

As illustrated in Figure 4 (right), CuddleConnect translates these insights into a familiar and everyday interaction by embedding mediated hugging into the plush koala proxy. When a child hugs the toy, the system detects sustained pressure across the plush body, allowing the hug to be initiated naturally through a familiar gesture rather than a symbolic button press. This design leverages children's existing hugging routines with comfort objects [43, 53]. Upon a parent's response, the plush toy provides multimodal haptic feedback, combining warmth, vibration, and weight to simulate being hugged back. Warmth is delivered through heat pads embedded in the toy's torso, reflecting findings that children often associate warmth with love and care [23]. Vibration is used to simulate a calm, heartbeat-like rhythm, drawing on research showing that rhythmic tactile cues can have soothing effects and reinforce feelings of presence [16]. The toy's weight further enhances the sensation of physical closeness, reinforcing its role as a comforting proxy [26, 35].

The hugging interaction is designed to be bidirectional and asynchronous, allowing either the child or the parent to initiate the interaction and accommodating differences in schedules [2, 50]. By grounding mediated touch in an intuitive, emotionally meaningful routine, CuddleConnect aims to provide children with emotional reassurance during moments of separation while avoiding the complexity and impracticality of prior systems.

4 Evaluating CuddleConnect

CuddleConnect has been evaluated in a week-long exploratory in-situ study with $n = 8$ participants. The study received prior ethics approval by the ethical review board of Saarland University (number 25-04-2). The overall aim was to evaluate how CuddleConnect was integrated into everyday routines (RQ1) and its effect on children's and parents' experiences and relationships (RQ2). This section introduces our participant sample, data collection and analysis processes, and the study procedure.

4.1 Participant Sample

In total, four families participated in the study. Participants were recruited through extended personal networks, recruitment in kindergarten and a snowballing system. Each dyad consisted of a parent and their child. Participating children were between 5 and 6 years old. Table 1 provides an overview of the demographic characteristics of the participating children and parents, respectively.

4.2 Data Collection & Analysis

Given the involvement of young children, particular care was taken to ensure ethical and safe participation. At the start of the first home visit, informed consent was obtained separately from both the parent and the child using age-appropriate consent forms .

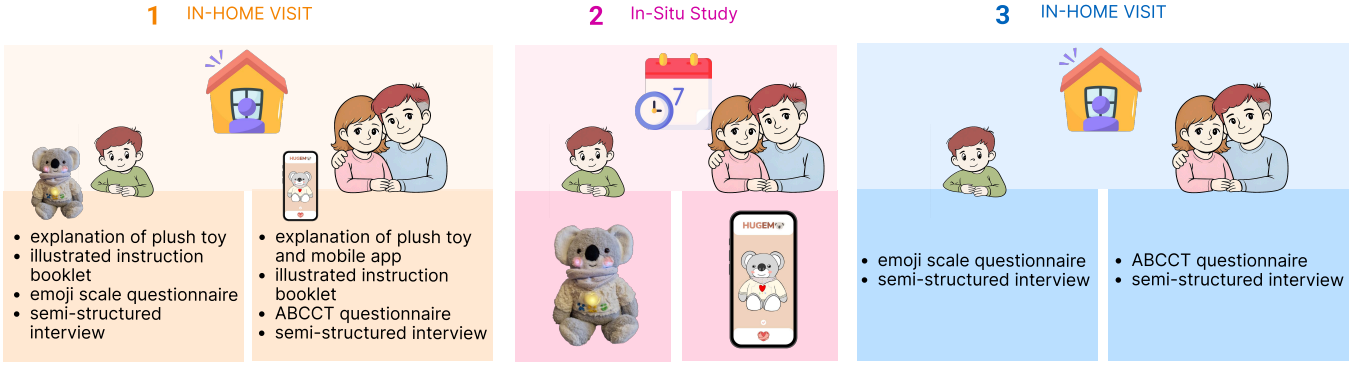

Figure 5: The procedure of the CuddleConnect in-situ study, including two home visits with questionnaires and semi-structured interviews, as well as a week-long open experiment phase.

Parents additionally provided explicit consent, and children gave assent, for audio recordings during the home visits. Children were informed in age-appropriate ways that their participation was voluntary and that they could withdraw at any time without negative consequences. During both home visits, children were not separated from their parents. The study protocol was reviewed and approved by the university ethics board [blinded for review].

We adopted a mixed-methods approach with a primary focus on qualitative insights. System interactions (e.g., when the emotion light was changed or a hug initiated) were logged automatically to capture frequency and timing data. Logging data was analysed descriptively due to the exploratory nature of the research endeavour.

We also captured questionnaires. The parent questionnaire (5-point Likert) was adapted from the ABCCT questionnaire [51], while children used a child-friendly emoji-based response scale [40] that we mapped to Likert ratings (see Table 2 and Table 3). In the following, we refer to the parent of a dyad x as Px and the child as Cx.

Furthermore, we conducted two semi-structured interviews, one at the beginning and one at the end, averaging 44:10 minutes (min: 35:35, max: 56:37). Participants discussed envisioned use, challenges they foresee and first impressions (pre), as well as shared insights of the schedule of the week, challenges they experienced, and anecdotes related to CuddleConnect (post). All audio recordings of the anonymized interviews were transcribed verbatim and imported into Atlas.ti software. We first familiarised ourselves with the data through repeated readings and informal discussions of emerging patterns. We then conducted a structured thematic analysis [10]. To support a consistent collaborative process, two authors independently performed initial open coding of both interview sessions for all participants to establish an initial coding tree, resolving disagreements through discussion [9]. During these discussions, the researchers discussed how their backgrounds and assumptions influenced data interpretation, refined the coding tree and made implicit assumptions explicit to enhance coherence and reduce bias. To synthesise findings, we followed Blandford et al. [6]'s pragmatic approach to thematic analysis, where three authors engaged in iterative discussion to construct themes based on the codes from both pre- and post-interviews.

Table 1: Demographic information of participating child-parent dyads.

Children				Parents		
ID	Age	Gender	Schooling	Age	Gender	Job
C1 / P1	5	female	Kindergarten	35	female	Office job
C2 / P2	6	male	Kindergarten	36	female	Office job
C3 / P3	6	female	Elem. school	36	female	Teacher
C4 / P4	5	female	Kindergarten	38	female	Physiotherapist

4.3 Procedure

Our procedure is visualised in Figure 5. The first in-home visit began with informed consent and demographic data collection. The child received the interactive plush toy along with an illustrated instruction booklet designed to support independent use. Parents were provided with a smartphone pre-installed with the CuddleConnect application and a second smartphone configured as a mobile hotspot.

Participants were guided through the complete interaction with CuddleConnect, including emotive communication and mediated hugging, and encouraged to engage with it. During this walk-through, the Think-Aloud method [3] was used to capture participants' immediate reactions. A first semi-structured interview was then used to assess initial impressions of CuddleConnect, perceived usability, and foreseen challenges when integrating the system into daily routines.

Both parent and child participants subsequently completed questionnaires.

CuddleConnect system was then deployed in participants' homes for one week. Families were encouraged to integrate the system freely into their daily routines, without specific requirements for how or when it should be used. Children interacted with the plush toy, while parents used the provided mobile phones when away from the child, e.g., at work or when being at home while the child is in kindergarten or with grandparents.

After one week, a second in-home visit was conducted. A second semi-structured interview examined longer-term use, perceived benefits, and challenges of integrating CuddleConnect into everyday life. Participants then completed the same questionnaires as

those used during the first visit. Devices were returned. Study participation was remunerated with 50 €.

5 Findings

Based on the evaluation, we gathered quantitative results from the interaction logs and questionnaires, as well as qualitative insights from the pre- and post-study interviews, both with children and parents. Our findings will be presented in this section.

5.1 Quantitative

5.1.1 Frequency of Use During the Study. Across the four dyads, the quantitative interaction logs reveal several consistent patterns in system usage, despite differences in family routines and contextual circumstances.

Novelty Effect and Integration into Daily Routines. All dyads exhibit a clear novelty effect where the interaction frequency was highest during the first one to two days of deployment and declined thereafter. Following this initial drop, usage generally stabilised at a lower but steady level during weekdays (across dyads 1, 2, and 4).

Interaction Highest When Physical Distance is Salient. Interaction frequency was consistently lower on weekends, best seen in dyads 1, 2, and 4 (Dyad 3 represents an outlier due to technical failure, limiting the data gathering to two days). In particular, Saturdays showed either minimal or no interactions at all. Across all dyads, usage peaked immediately before and on the day of physical separation, highlighting the system's situational relevance during moments of transition from being together and being remote. Furthermore, usage patterns were strongly influenced by the time of day (see Figure 6 and Figure 7), mostly peaking during morning and afternoon hours.

Emotive Communication Used More Frequently Than Mediated Hugs. Child-initiated hugs were returned by the four parents in 33.9% of the time. In these cases, the hug was returned after child initiation within 32.5 seconds (SD 54.3). Yet, across all dyads, emotive communication occurred more frequently than hugging interactions (see Figure 7). While hugging was often prominent during the initial days, its frequency declined more sharply over time, whereas emotive communication remained comparatively stable.

Individual Usage Patterns. Despite these overarching trends, notable inter-participant differences emerged. Dyad 2 showed substantially fewer hugging interactions overall, which aligns with the parent's description of C2 as a child who generally avoids physical contact. Dyad 3 experienced technical issues as the child visited the grandparents during the week, and the phone was insufficiently charged. Thus, no data could be gathered from Tuesday onwards. In Dyad 4, hugging interactions dropped after the parent missed hug requests early in the week. Yet, emotive communication remained more frequent and relatively stable across the remaining workdays. By contrast, no interactions were recorded on the weekend, which can be explained by P4 and C4 being away on a trip together.

5.1.2 Timing of Use During each Day. In Dyads 1, 2, and 4, interaction frequency was high during morning kindergarten hours and increased again in the afternoon or early evening, with lower activity around midday (see Figure 6 and Figure 7). Dyad 2 showed comparatively higher interaction frequency in the early afternoon and evening. Dyad 3 displayed a different temporal distribution, with interaction frequency peaking around midday and again in the evening. Across dyads, emotive communication occurred throughout the day, whereas hugging interactions were less frequent and more concentrated in the afternoon and evening. In Dyad 4, hugging interactions occurred primarily in the afternoon.

5.1.3 Questionnaires. Both parents and children filled out a questionnaire at the first and second home visits.

Parent Questionnaire. As depicted in Table 2, the parent questionnaires present overall positive results, with no median value falling below 3. Parents reported enjoyment in using the system, as reflected in question 4. Question 9 received the highest ratings, indicating that parents particularly appreciated the metaphorical hugging interaction. This rating remained unchanged over the study period, suggesting that parents did not have particular negative experiences with this interaction. P4 annotated on the questionnaire that the feature is most valuable when the parent is able to respond to the hug request within the 60-second time frame. She noted that missing hug requests while at work frustrated her child considerably, highlighting a situational limitation.

We observed the most notable changes between the first and second home visits in question 3. P1, P2, and P3 explained that they envisioned the system being more useful in contexts outside of everyday separation situations.

Question 2 also showed a slight decrease in rating, still nevertheless maintained a relatively high rating, indicating that contact through CuddleConnect was perceived as interesting. Finally, questions 1 and 8 received the lowest ratings. This result reflects a recurring theme: although the system enables emotive communication, the context of use is not always clear.

Child Questionnaire. Similar to the parents' questionnaire, the children's responses (see Table 3) are overall highly positive, with all median ratings above 3.5. Questions 2 and 3, which relate to the hugging interaction, show the strongest increase after the 7-day period, indicating that hugging was very well received by the children and that they felt increasingly comfortable with this interaction over time. While we observed a slight decrease in median ratings for question 5, overall, children reported having fun with the system, as reflected in the strong ratings for question 6, which increased after the 7-day period.

5.2 Qualitative

Based on our qualitative inquiry, three themes were derived from the data: CuddleConnect as a (1) *Medium, Proxy, and Companion*, (2) *Conversation Starter*, and (3) *Emotional Support Tool and Stressor*. Our findings are described below and illustrated with excerpts from the interviews.

5.2.1 CuddleConnect as a Medium, Proxy and Companion. Children primarily engaged with CuddleConnect as a meaningful companion, rather than as a pure communication device. Meaning emerged through *material qualities*, *imaginative play*, and *situated use*.

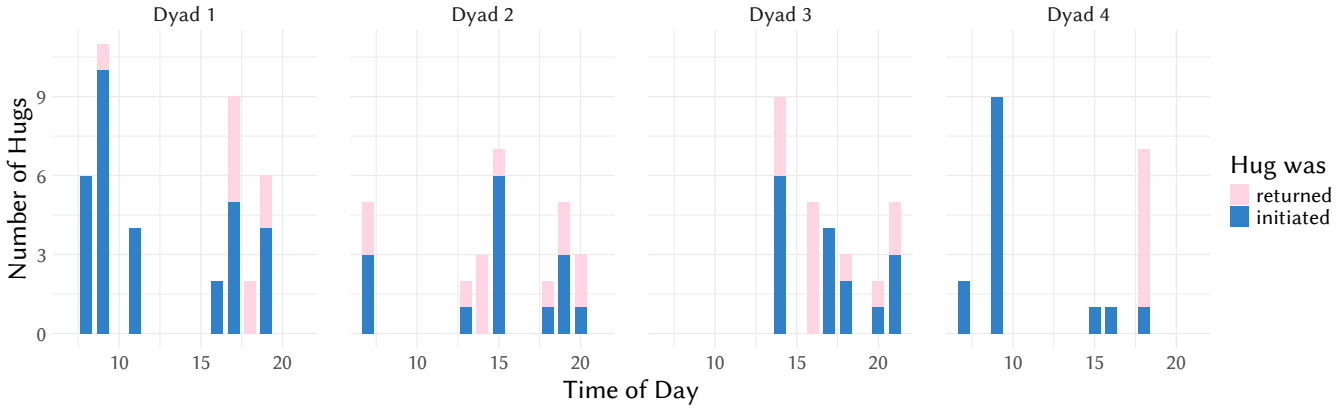

Figure 6: For each dyad, the number of hugs for the time of day (morning, afternoon, evening) initiated by the child and returned by the parent.

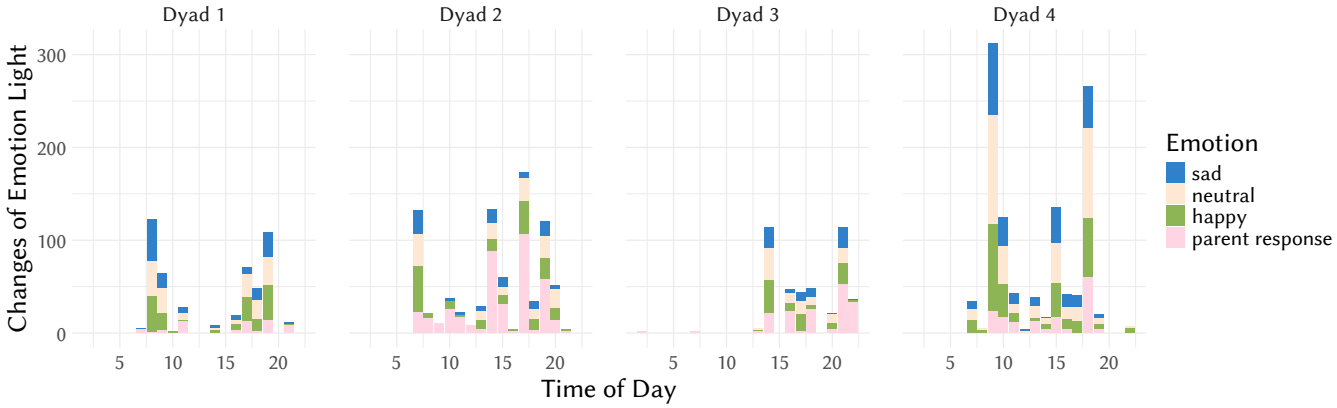

Figure 7: For each dyad, the number and type of change to the emotion light for the time of day (morning, afternoon, evening).

Children described the plush toy as "wonderfully fluffy" (C1), loved the lights of the heart and cheeks, and found the warmth and vibration as "pleasurable and cool" (C2). The weight of CuddleConnect was rated ambiguously, with C1 saying it was "a bit too heavy" while C2 and C3 enjoyed the heaviness as it helped create more character and a sense of presence for the plush toy. Parents also mentioned that "I think the design is great; I believe it really appeals to children too."

Beyond the emotional reaction towards the appearance, children often linked the material properties with emotions, for instance, mentioning that they "liked the green colour best, because it's a smile, and that means good" (C1). Children also often blurred the boundaries between interpreting CuddleConnect as a technological medium (such as a phone) and as a representation of their parents while they were gone. C1, for example, explained that she hugged the plush toy "because I wanted to hug Mummy" (C1) and that "when the lights [in the cheeks and the hearts turning white] is gone, then my mum also has time off" (C1). A quote by another child shows how the boundaries get blurred even further:

> "The vibration is like when Mummy calls. And then I listened to what Mummy wanted to say to me. (...) That she loves me."(C4)

Parents also confirmed that CuddleConnect was often used as a medium and proxy that allows for short but meaningful conversations. For instance, P4 shared that her child had often sent a blue heart to say that she misses her, then she had answered with a red heart and immediately received a green heart back from the child that was interpreted from both sides as being happy now with the interaction. Another parent also emphasized that "phone calls and video calls alone are not enough to hold [the child's] attention and convey closeness [unlike CuddleConnect]" (P3).

Apart from seeing the plush toy as a tool to express emotions through colours and as a medium to 'talk' to their parents, children also saw CuddleConnect as a separate imaginative character to play with. Children integrated it into play alongside other toys (C1, C4), reminded their parents every morning to take them along when heading to kindergarten (C2), created stories around it being cold, which is why it wears a pullover (C4), and "Willie [name for the

toy] is a companion. We like singing together there on the floor" (C1). One parent reflected:

> "I was surprised that she also plays with him at home. Willie [the name given to the plush toy] was quite a character in his own right. So he wasn't just a means of communication." (P1)

The interpretations of CuddleConnect as a medium, a proxy and a companion is accompanied by one more aspect, namely the limited situational use. While interesting for alone playtime or when apart from parents, in contexts when physical togetherness or environmental stimulation is high (such as kindergarten or weekends at home), participants reported using it less. During such moments, the need for a medium, proxy, or companion diminished, as physical co-presence reduced the relevance of mediated presence. Children naturally shifted their attention toward direct human–human interaction, using this time for shared, unmediated experiences. One parent reflected that this was not only expected but even reassuring:

> "At home on the weekend, it was rather unattractive because we were together anyway. (...) And it was good for me to see that she is so busy at kindergarten that she doesn't really miss me." (P1)

Table 2: Comparison of median responses by parents between the first (V1) and second (V2) home visit (5-point Likert).

Parent Questionnaire	V1	V2
1. Communication with my child through CuddleConnect helps me to understand how my child is doing.	3.5	3.5
2. I think that contact with me via CuddleConnect is interesting for my child.	5.0	4.5
3. I can imagine using CuddleConnect in everyday life.	4.0	3.0
4. I enjoy using CuddleConnect.	4.5	4.5
5. When I communicate with my child via CuddleConnect, I feel closer to my child.	4.5	4.0
6. I think that periods of separation are easier to overcome through the use of CuddleConnect.	4.0	4.0
7. The interactions with CuddleConnect are simple and easy to understand.	5.0	4.5
8. CuddleConnect makes me aware of my child's current emotional state.	3.0	3.0
9. I like being able to metaphorically hug my child via CuddleConnect.	5.0	5.0

Table 3: Comparison of median responses by children between the first (V1) and second (V2) home visit (5-point Emoji-based scale mapped to Likert).

Child Questionnaire	V1	V2
1. How much do you like your CuddleConnect koala?	5.0	5.0
2. How nice was it to hug CuddleConnect?	3.5	4.5
3. How cuddly was CuddleConnect for you?	4.0	5.0
4. How much do you like the colorful light?	4.0	4.0
5. Did you enjoy showing how you feel with the light?	4.5	4.0
6. How much fun did you have with CuddleConnect?	5.0	5.0

5.2.2 CuddleConnect as a Conversation Starter. As mentioned in the previous theme, children used CuddleConnect as a medium to 'talk' to their parents when missing them and as a proxy to 'hug their mum' despite being apart. However, participants also shared that CuddleConnect functions as a conversation starter, promoting emotional connection.

First, the lights for emotive communication were not only used for parent-specific feelings, such as missing the parent at that moment, but also to gather information. Thus, signals could also act as check-ins rather than explicit requests for emotional attention. Children did not always attribute strong emotional intent to every signal, and sometimes created their own interpretation for the meaning behind the signals, particularly when being a bit older. For example, one child recounted a story of using CuddleConnect as a mechanism to start a conversation about the mom's availability at that moment:

> "I also made contact with the koala at the end of school, because I don't know whether Mum is already at home or not. That's why I just pressed the button, to see." (C3)

Another situation that occurred was to use CuddleConnect to 'talk' about an emotionally-loaded situation that was unrelated to the parent. The important aspect for the child was to share the feelings with their parents, but not to be relieved or reassured by the parents' reaction, but solely to make them aware that this situation happened. To elaborate, one child shared a story while being at their grandparents':

> "I pressed blue because of my grandmother and grandfather. They were annoyed [story of why]. And then I was annoyed myself. And then I told grandma that I was changing the heart to blue. (...) I wanted to talk to mum about it. [I'm sending the signal] Because I want my mum to know. I wanted my mum to know that I'm annoyed right now by grandma." (C3)

Additionally, the interaction (or sometimes missing interaction with CuddleConnect) also prompted a later conversation for reflection purposes. One dyad shared that talking about the lights pressed during the day prompted a different, deeper level of reflection when sharing what had happened during the day that resulted in her "having felt more connected than usual" (P4). Similarly, on a day without child-initiated interaction, the parent inquired about this in the evening:

> "That evening, I asked her, 'You didn't press anything today, what was going on?' and she said, 'Oh, I was so busy, I didn't get around to it.' And then I could ask what was going on. That was nice to be able to

> talk about this and not just ask 'How was your day?' " (P1)

5.2.3 CuddleConnect as an Emotional Support Tool and Stressor. Parents emphasized the system's potential to support children during emotionally challenging transitions, such as sleepovers, kindergarten adjustment, or school entry. Notably, P3 also mentioned that CuddleConnect could be detrimental to readjustment periods. Still, several parents reflected that the device would have been particularly "helpful for more emotionally sensitive or attached children" (P4) or "in situations where he does not really want to leave" (P3). As such, CuddleConnect was considered as an emotional support tool for children. One parent shared:

> "This separation anxiety [of the child being at grandparents' while parents went for dinner] was so extreme again. She gets so panicky whenever I'm not there in the evening. Something like this [CuddleConnect] could maybe help with that in the long term." (P1)

However, all parents reported that ensuring the device was charged, functional, and responsive required effort, and signals received during busy moments sometimes felt intrusive rather than supportive. They often felt a sense of responsibility to intervene, for instance sharing that "if [the child] now presses this often, I feel that I *have* to respond (...) I briefly considered phoning the kindergarten to ask if [the child] is really sad or just accidentally hit the button" (P2), and "I know that everything is okay in kindergarten, if not I would have gotten a phone call, but it is still some kind of alarm bell" (P1), confessing that it is stressful to know something is off "especially, because I cannot do anything at that moment" (P3). For some parents, not knowing the reason behind a signal was emotionally stressful:

> "Exactly, but I don't know why it's highlighted in blue. No explanation. And then you're left hanging. That's unsatisfactory for me." (P3)

Notably, the system can have a negative effect on the child, namely when the parent had missed a hug request. P4 shared that her child had felt "frustrated" when hug requests were missed in the first days, resulting in less hug requests in the following days. Another dyad shared:

> P3: "Grandma said that [the child] had been sadder. And the koala made it more complicated than it would have been without it. Because without it, there would have been no way to communicate."
> C3: "I then thought that my mum might not like me anymore."
> P3: "It was difficult for [the child] to understand that I might just not have any time."

6 Discussion

In this work, we endeavoured to understand how to design systems for remote parent-child affective communication and mediated touch. Our interactive system CuddleConnect, consisting of an interactive plush toy for children and a mobile application for parents, is specifically designed to support children's agency (see section 3). In this section, we first discuss how CuddleConnect is embedded in daily routines (RQ1) and its effect on both children and parents' experiences of emotional closeness and reassurance (RQ2). We then reflect on the ethical concerns of CuddleConnect, including the implications of measures of success of such a tool. Within this section, key takeaway messages and design recommendations informing the future design of interactive systems for remote parent-child communication are highlighted in bold.

6.1 Asymmetry of Emotional Communication

Across all dyads, emotive communication was used more frequently and more consistently than mediated hugging. This difference points to a potential asymmetry between lightweight, asynchronous interactions such as emotive communication, where only a button has to be clicked, and more explicit or synchronous forms of mediated touch. Yet, parents also shared that the mutual interaction of the remote hug was the more meaningful for both parent and child. As such, **we recommend designing for both, asynchronous interaction modalities that are easier to sustain over time while still offering more planned synchronous interaction modalities for deeper emotional connection.**

6.2 Situational and Episodic Mediated Presence

Our findings show that CuddleConnect was not adopted as a continuously used communication channel, but rather as a situational resource that became relevant primarily during moments of separation and transition. Interaction frequency peaked around times when physical distance was salient and declined during periods of co-presence, particularly on weekends. Importantly, this reduction in use was not experienced as a loss of connection; instead, parents interpreted it as a positive indicator of children's emotional security and engagement in direct human–human interaction. CuddleConnect did not replace existing forms of care, communication or human-human-interaction but complemented them during moments of emotional vulnerability or reduced supervision. Therefore, CuddleConnect fulfilled its intended role of supporting connection during moments of physical absence, rather than functioning as a channel for continuous emotive communication. **We recommend designing for situational rather than continuous use, allowing technologies to step back when not needed.**

Further, temporal clustering of interactions around kindergarten drop-off, school transitions, and evening routines further demonstrates that use was tightly embedded in institutional and caregiving rhythms, including morning drop-offs, end-of-school transitions, and evening wind-down periods. This clustering around transition phases shows that the usage of CuddleConnect was closely tied to existing daily routines, not replacing human-human connection but creating more connection during those transition phases. **We learn that mediated communication systems for families may be particularly designed to accommodate institutional and caregiving rhythms, having the in-between free time as the main focal point.**

6.3 Ambiguity of Interpretation

We also showed that CuddleConnect supported children's emotional reassurance and emotional expression, both through its material qualities (such as softness, warmth, vibration, light, and weight)

that functioned as affective cues that enabled children to interpret the system emotionally, and through its embedding into the daily routines as shown by imaginative play and the blurring of interpreting it as a medium to 'talk' to parents, as proxy for their parents, and as companion with a complete unique toy character. For children, the design of CuddleConnect allowed for ambiguous signals that afforded expressive freedom and imaginative interpretation, as shown by individual intentions when using the buttons designed for emotional expression. **These findings underline the role of materiality and play not as peripheral features, but as central mechanisms through which children appropriate and integrate affective technologies into their everyday lives. We recommend paying special attention to the design of interactive parent-child prototypes, highlighting the benefits of warmth, weight, softness and cuteness, and integrating lights for a plush toy.**

However, while the open-ended nature of signals and material cues allowed children to project their own interpretations and emotions onto the system, it also resulted in ambiguity of meaning in the design – which we had already tried to keep as minimal as possible (see section 3). Parents complained about a lack of contextual information necessary to interpret the emotional communication. This resulted in increased uncertainty, worry, and stress. As such, **we recommend that the context of feelings should be able to be communicated in a yet lightweight and child-friendly way without oversharing.**

We also want to emphasize the importance of responding to child-initiated interaction. We found that children felt sad and even blocked further interaction after repeated missed hugs or technical failures. Although parents could indicate their unavailability, these situations did happen and were then not experienced as neutral system errors but as emotionally meaningful events that could lead to frustration or distress. **Thus, future systems for remote parent-child interaction should design for several fail-safe mechanism that make interaction more robust.**

6.4 Between Agency and Dependency

Our findings suggest a nuanced picture of children's desire about the type of interaction and the time when to interact with their parents. In particular, children did not engage with CuddleConnect continuously, nor did they show signs of over-reliance but use naturally declined during periods of physical co-presence or high engagement with their surroundings, and children shifted seamlessly to direct human–human interaction when available. We interpret this not as disengagement, but as a positive ethical outcome: the technology receded when it was no longer needed. This aligns with our intention **not to design technology for technology's sake, but to support children only when mediated interaction is meaningful.**

At the same time, our findings indicate that CuddleConnect can be particularly valuable for children with separation anxiety, those with a heightened need to share experiences from their day, and children who struggle to verbalize emotions. In these cases, the system functioned as a temporary scaffold for emotional expression, offering a low-threshold, child-initiated way to communicate feelings without enforcing constant parental involvement. **We therefore argue that these sub-groups of children may profit the most from interactive systems for remote parent–child communication.** This ethical stance resonates with child-centred design and value-sensitive approaches in HCI, which emphasize children's agency, autonomy, and participation rather than adult-defined notions of efficiency or engagement (e.g., [47]). It also aligns with critical perspectives on persuasive and attention-maximizing technologies, reinforcing the idea that high engagement is not inherently desirable, particularly in emotionally intimate domains [20].

Yet, we also found that systems such as CuddleConnect bear two main risks: First, it may reinforce children's expectations of the continuous availability of their parents. Particularly, small children seem not to be able to fully understand that their parents might just not be available or have forgotten to put themselves to "unavailable". Some children reacted with negative feelings to that, and might limit children's opportunities to cope independently with everyday separations. Second, CuddleConnect may also encourage heightened parental monitoring, as parents felt increased stress to be part of their children's lives. In the long term, such dynamics may contribute to forms of "helicopter parenting". Some parents also envisioned even more self-initiated interaction possibilities, which should be considered carefully. While this would alleviate stress and enrich interaction, such a feature could hinder parents' acceptance of separation from their children. These findings demonstrate that technologies designed to support emotional closeness redistribute care work unevenly. The same mediated connection that reassured children could heighten parents' emotional availability and sense of responsibility. **Designing for remote care-giving, therefore, requires careful consideration of who bears the emotional cost of mediated connection, as well as how ambiguity, reliability, and feedback mechanisms shape this burden. We suggest prioritizing child-initiated interaction over parental monitoring to avoid reinforcing over-surveillance.**

6.5 Rethinking Success for Remote Parent-Child Interaction

The observed novelty effect suggests a transition from exploratory engagement to routinised integration. From a methodological perspective, this highlights the importance of accounting for novelty effects when evaluating family technologies. **We learn that in cases where the implementation into the routine is intended to be measured beyond initial engagement, studies could disregard data from the first two days in their analysis.**

Our findings also challenge conventional success metrics in interactive systems, where frequent or sustained use is often equated with value. In child–parent contexts, success may instead lie in supporting autonomy, emotional security, and developmental needs, even if this results in reduced or discontinued use over time. This outcome is promising, as the goal is not to design technology for its own sake but to focus on ensuring that children have the agency to decide for themselves when they want interaction and in which format it should occur. From this viewpoint, **it can be a success when technology becomes unnecessary, because children do not require additional mediated reassurance of parental presence. Non-use or declining use, as long as not due to usability issues, should not be treated generally negative.**

By foregrounding children's agency and accepting disengagement as an ethical success, this work contributes to a more responsible framing of mediated emotional technologies for families, valuing well-being and independence over constant connectivity.

6.6 Limitations and Future Work

Several limitations of this study need to be acknowledged, which also point toward promising directions for future research.

First, the study was conducted with a small and relatively homogeneous sample. Four families participated, all parent participants were mothers within a similar age range, and the child sample was likewise skewed toward female participants. Moreover, interviewing children in the presence of their parents, combined with recruiting families through personal networks, may have introduced social desirability bias and demand characteristics. These factors could have skewed responses toward more positive accounts, contributing to the favourable findings and limiting generalizability.

Future studies should aim to include a broader and more diverse range of family structures, parental roles, ages, and genders to explore how mediated emotional technologies are appropriated across different care-giving constellations.

Second, the deployment period was limited to one week. Although this duration was sufficient to observe initial integration into daily routines, it does not allow for assessing long-term effects. Interaction logs revealed a pronounced novelty effect, followed by stabilized use, but longer-term deployments are needed to understand how emotional practices, expectations, and potential dependencies evolve over time. In particular, questions regarding sustained reliance, disengagement, or developmental impact remain open. In cases of longer interaction periods, such as a month or a year, there might be even more drops in engagement. This curve of the lived experience with a novel technology for remote emotive communication and mediated hugs should be evaluated carefully in future studies to discern all levels of novelty effect.

Third, the technical setup of the prototype introduced usability barriers that affected both experience and data collection. Parents were required to manage multiple devices, including a separate smartphone and a hotspot for connectivity, and ensuring sufficient battery levels was sometimes experienced as burdensome. Technical breakdowns in one dyad further limited quantitative data completeness. While these issues are partly inherent to early-stage prototypes, future iterations should prioritize seamless integration into the parents' existing devices to reduce cognitive and emotional load and to better reflect real-world use.

Finally, the study focused on everyday and relatively structured separation contexts, such as kindergarten attendance and workdays. While our findings suggest that CuddleConnect may be particularly meaningful during emotionally intense or unpredictable separations — such as hospital stays, prolonged absences, or major life transitions — these contexts were not examined in the present study. Investigating such scenarios represents an important direction for future work but also raises significant ethical and methodological challenges, particularly regarding vulnerability, consent, and emotional risk. Similarly, while we discuss ethical concerns such as parental over-monitoring and children's agency, the short deployment did not allow for assessing long-term implications of mediated emotional availability.

7 Conclusion

We present CuddleConnect, an interactive system designed to support child-initiated, affective remote communication between parents and young children during separation. By combining a weighted plush toy as a tangible proxy for children with a mobile app for parents, CuddleConnect enables children to express emotions and request hugs in a developmentally appropriate, non-screen-based way, while allowing parents to respond within everyday constraints. In a one-week in-situ study with four parent–child dyads, we found that CuddleConnect was integrated as a situational, episodic resource for expressing emotions, used most around moments of separation and transition. Children appropriated it as a medium, proxy, and companion through materiality, play, and imaginative interpretation. We found that emotive communication remained more sustainable over time than mediated hugging due to easier interaction with fewer possibilities to miss a reaction, but mediated hugging was the more meaningful interaction. While CuddleConnect was found to be an emotional support tool for children and can act as a conversation starter about emotionally-loaded situations, parents experienced greater emotional responsibility when interpreting ambiguous signals and managing responsiveness, highlighting an asymmetry in mediated care. Based on those findings, we provide design recommendations informing the design of child-centred remote intimacy systems that prioritize children's agency, treat disengagement and non-use as potentially positive outcomes, and foreground well-being and developmental appropriateness over engagement-based measures of success.

8 Selection and Participation of Children

Child participants were recruited via flyers distributed in kindergartens and elementary schools, complemented by a snowball sampling approach. Informed consent was obtained through a child-friendly flyer that explained the system's functionality, data gathering procedures, privacy considerations, and data handling practices using accessible language and extensive visual material. Informed consent and assent were further supported through an in-home visit by one experimenter, which included walk-throughs, open questions, and testing both with the child and the parent. All participating children and parents shared the same mother tongue and accent as the experimenter, supporting clear communication and comprehension throughout the study.

Participation in data collection was strictly voluntary and contingent on both parental consent and child assent. Families were informed of their right to withdraw from the study or from specific data collection procedures at any time without consequences. Ongoing assent was emphasized by re-confirming permission for audio recording during sessions. Throughout the study, we aimed to prioritize children's engagement, well-being, and autonomy over data collection goals. Ethical approval for the study was obtained through the university ethics review board [blinded for review].

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We utilized AI language models, Overleaf's built-in spellchecker, and Grammarly to correct spelling errors and improve the quality of our writing. The teaser image was partly generated with ChatGPT 5.2. All ideas and content remain the authors'.

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