

KidKeeper: Design for capturing audio mementos of everyday life for parents of young children

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ABSTRACT

Children grow up fast. Many parents want to capture the candid, fleeting moments of their young children's lives to treasure later, but these moments are difficult to anticipate and to capture without disruption. Current technologies to address this are limited to indiscriminately capturing everything, or are dependent on parents' presence and prescience to initiate capture and manually record the moment. To address these limitations, we introduce KidKeeper, a toy-like system to capture, select, and deliver everyday family memories with minimal effort and disruption to family life. It uses an innovative approach to capture that we call "integrated capture," that combines previous attempts to continuously capture family memories with the practice-oriented approach of "unremarkable computing" to embed capture capabilities unobtrusively into everyday activities. In our study, we explore how technologies like KidKeeper mediate and align the different interests and values of various family members, namely parents who want precious moments and children who want to play, towards accomplishing a family goal to capture memories of everyday life.

Author Keywords

Memory artifact; memorabilia; family memory; audio; digital memento; children; parents; tangible; candid; capture; curation

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

The everyday life of a young child contains moments both quotidian and remarkable to their parents. Capturing the impromptu moments in a young child's life can be difficult

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Figure 1. KidKeeper system prototype. Children press the stuffed frog's tongue to initiate and play back recordings. Children's faces have been obscured for anonymity.

to anticipate and often sensitive to the disruption of recording. Even parents who are vigilant and quick enough to reach for their favorite recording device may find the child not being their natural self, instead acting for the camera.

A wide range of research in HCI and CSCW has contributed to understanding and supporting the creation and curation of family memory in the home (for example, [5,11,12,17,21]). We build on this work by conceptualizing family memory capture as a technology-mediated social interaction that is not completely handled by current systems. We focus on the situation where parents are trying to capture natural behavior of their children. On the one hand, turning on recording devices often interrupts impromptu playful and other memorable behavior. On the other hand, while capture technologies may reduce the burden on parents by passively capturing everything, they also come with the accompanying baggage of privacy and surveillance concerns as well as content overload [24]. Is there a design space between these two? In short, we would like to find a way to capture natural behavior while avoiding the issues that accompany always-on capture devices.

To examine the potential design considerations for a solution, we designed KidKeeper, an audio recording and playback system embodied in toy-like form (Fig. 1) to augment and enhance a family's "spectrum of capture possibilities" [14]. In a weeklong deployment study and interviews with seven families, we sought to understand what intrigues parents about the everyday moments of their young children's lives, and parents' and children's reactions to the design of a system embedded into their everyday activities.

Our study of KidKeeper provides two main contributions to CSCW. First, it provides a system solution, using what we call "integrated capture," to capture these kinds of everyday family memories. Second, our study provides an understanding of the design considerations in creating a device enabling unobtrusive, non-disruptive capture of meaningful audio mementos featuring everyday activities of children.

Following, we walk through the related work in CSCW and HCI about capture devices, family memory, and the use of audio. We then describe the KidKeeper system and our design assumptions and rationale. We then present findings from a week-long deployment of KidKeeper's with 7 families, where we examine the design features in its actual use.

RELATED WORK

Capture Systems

Sellen and Whittaker [24] differentiate two main classes of lifelogging: total capture and situation-specific capture. An example of a total capture system is SenseCam [7], which is a wearable camera that passively (without direct user input) takes pictures to collect a visual log of one's everyday activities. The idea behind SenseCam, and market technologies that draw on it (e.g. NarrativeClip [28]), is for wearers to capture continuously and "never miss a moment." While Sellen et al. [23] found that SenseCam's passive capturing was an effective memory trigger on par with manually-captured pictures, the sheer amount of footage, variable quality of the stream, and lack of indexing made it difficult for users to return to significant memories. Thus, Sellen and Whittaker argue that designers should avoid total capture and, instead, to be more selective by focusing on areas users want to remember the most.

The second class of capture systems is situation-specific. These capture systems attempt to incorporate more of the intentionality of manual capture into passive logging systems, while still ensuring that significant events are not missed. In one example of a situation-specific capture system, designed for caregivers of children with autism, Hayes et al. [4] incorporated active input to a passive recording device by requiring caregivers to declare when they wanted to save logs. Users had to activate saving, and the system retroactively saved the last few minutes of footage. Truong and Hayes [26] extended that work by fully

automating situation-specific capture by incorporating context-aware triggers into passive capture systems.

We build on these approaches by proposing an "integrated capture" strategy, where interaction with objects that are a natural part of the activity initiates capture of that moment. This combines capture with the approach of "unremarkable computing" which theorizes that embedding systems into existing activities and practices is the key to seamless integration of technologies in everyday life, especially in the home [25]. Our design combines two activities of families – children who want to play with an object and a family goal of capturing memories of everyday life – into an integrated capture mechanism.

Supporting Family Memory

Particular attention in HCI and CSCW has been paid to understanding the sociotechnical context of technology-mediated family memory. Studies have examined the importance to families of having sentimental artifacts and their social role in the home to represent and enact family identity and values [12,22]. In a study asking families to build time capsules for themselves in the future, Petrelli et al. [20] found that mundane, everyday traces of life were just as important as significant events for families to keep for themselves for the future. In an in-depth study on everyday memories, Mols et al. [15] argued that everyday life should be a focus in designs for remembering, because the everyday could become "special", not only pre-determined special occasions. Further, "unanticipated memories," those unpredictable moments in daily life that grow unexpectedly significant over time, would not, by definition, be intentionally captured by families. Therefore, specialized design would be needed to create mementos of the everyday due to this hidden, emergent value.

In this work, we explored preserving these unanticipated memories by embedding capture into the everyday fabric of children's playtime with a toy-like device. We then had parents reflect on the content created by their children in these playful interactions to better understand what parents seek as they capture the everyday lives of their children.

Audio-based Mementos

Prior research has shown that audio is an engaging medium for mementos and could be especially useful for parents of young children. In a study on the value of sound in the home, Petrelli et al. [21] found that audio evoked a deeper reminiscence and emotional response since sound drew the listener more into the recorded moment. The activity of capturing audio is also less likely to intrude and disrupt the moment than other forms of capture, because devices can remain unobtrusive, even hidden, and require minimal interaction to operate fully [14,18]. Oleksik et al. [17] found that among audio recordings of home sounds, the recordings of children were "prized the most highly of all recordings"(p. 167), but parents in their study were unable to effectively capture them. Thus, much of the valuable soundscape of the home was found to "have some special

meaning, yet are rarely recorded, and as such are ‘lost’” [18, p. 1425].

Our study adds to this work by attempting to ameliorate the difficulty that parents have in recording memorable audio, by enabling children to capture audio of themselves. Petrelli et al. [21] noted that capturing audio was a fun and engaging activity for children as well as adults in the family. Thus, our work explores recasting the creation of family audio memories as an enjoyable activity for young children, and thereby lowers the burden for parents who wish to preserve valuable everyday moments in their young children’s lives.

SYSTEM DESIGN

Imagine the following scenario:

Sarah is four, and her parents are listening to her playing, spinning her characteristic fantastic tales of adventure with her stuffed horses. Her mother remarks that she wished that they had some way of preserving these everyday fleeting moments to look back on later.

Using this scenario, now Sarah interacts with KidKeeper, a stuffed frog (Figure 1), by holding the frog’s tongue while telling her story. Sarah releases the tongue when she is done, and the stuffed toy plays back what she just recorded. Pleased with her recording, she is eager to hear other ones she has made. She presses and releases the frog’s tongue quickly, which plays a random audio snippet she made yesterday. This gives her an idea for another recording, and she proceeds to make another.

In order to capture these moments without disrupting them, an integrated capture approach is needed. Underpinning KidKeeper’s implementation decisions are design rationales informed by prior literature and our intuitions. KidKeeper was designed and constructed according to three design assumptions:

- 1) Children can spontaneously and independently create their own content,
- 2) Parents can enjoy this content with minimal effort, and
- 3) The technology can mitigate the risk of privacy breaches that might concern parents.

In this section, we will detail the requirements that these design assumptions imposed on KidKeeper.

While there are several audio-based toys and commodity audio capture/playback systems on the market, none satisfied our design goals. The popular *Talking Tom*¹ mobile app uses audio that is not the user’s actual voice. *Hello Barbie*² uses only guided conversations for interaction, which we felt would unnecessarily limit the types of recordings children might make, and it does not

provide easy access to archived content. *Cloud Pets*³ requires parental involvement to share or play back audio messages, which we believed would limit the amount of spontaneous, independent play by children.

We therefore designed a custom system, with the second author carrying out the system design and implementation. The two main components of the KidKeeper system are a child-facing toy and an Internet-connected cloud server. A stuffed toy houses a Raspberry Pi (rPi) with wireless network connectivity to an Amazon Web Service cloud server running Ubuntu. Audio is recorded using an USB microphone. We used a capacitive touch sensor to initiate recording and playback, and an USB-powered speaker plays the audio. This system receives wired power from a wall outlet.

We have already presented our general approach of integrated capture, combining embedded interaction with capture. Below we detail some of the specific design assumptions and considerations in KidKeeper.

Promote spontaneous, authentic play

Design Rationale

Our intention was to enable very young children (ages 2-7) to create unmediated audio recordings themselves, because we felt this would reduce the parent’s burden on capturing these moments. We believed this activity would be encouraged if children could record audio spontaneously, without help, and in a fun way. Oleksik and Brown [17] found audio to be ideal for this situation, noting that children are “less likely to show off or get shy if an audio recorder was used” instead of video. Helmes et al. [5] discovered that children were willing to interact with a capture technology when it was embedded into a *life-like* object. Petrelli et al.’s FM Radio [21] project also found that *embodied* digital mementos were an effective way for families to access ‘sonic souvenirs’ from previous recordings. We wanted to draw on this idea of having a *tangible* way for the family, especially children, to access audio recordings, even if the access is limited to *random playback*. If such a life-like embodiment is *simple* to use, *interactive*, and *engaging*, then we expected children to accept it and integrate it into their natural playtime activities. We believed that an engaging toy would be used as a toy—perhaps constantly—but more likely in spurts. We assumed that if it were sufficiently engaging, children would return to it.

Implementation

KidKeeper is embodied as an oversized stuffed animal that is friendly-looking with visible facial features. The touch sensor is embedded in the animal’s tongue. The fabric enclosing the touch sensor is of a different color to emphasize where to touch, and the location of the sensor is easy to grab with small hands, making KidKeeper simple and intuitive to operate. Since children have to be within

¹ <http://talkingtomandfriends.com/tom/>

² <http://www.mattel.com/>

³ <https://cloudpets.com/>

arm's reach to make a recording (by pressing and holding the sensor), it forces them to be close and almost face-to-face with the toy. Not only does this promote a sense of talking to and hearing from a friendly, life-like object, but it also ensures that young children are close enough to the microphone to be heard. Audio playback, combined with the life-like embodiment, help make KidKeeper interactive and engaging.

Reduce parental effort to enjoyment

Design Rationale

We believed that constraining the recordings to a short duration would make listening to them less demanding for parents. Oleksik and Brown’s work with Sonic Gems [17] supported this intuition, where they concluded that users like *short* but significant audio ‘snippets’, or ‘gems’. To minimize parental effort to access recordings, we assumed *pushing* audio content to parents in a non-obtrusive way might be effective, similar to how Hsieh et al. ‘pushed’ sound media via phone calls to users of their SoundCapsule system [9]. As well, Peesapati et al.’s Pensieve system [19] emailed memory triggers (i.e., text questions) to users once per day, which they found to be an effective delivery method and reasonable frequency for memory triggers.

Implementation

We limited KidKeeper recordings to a one-minute maximum duration. Oleksik and Brown [8] concluded that users like short but significant sonic ‘gems’, but it was unclear how short they meant. In our own preliminary studies, we found a vast majority of child-generated recordings were less than a minute. From this, we assumed a one-minute cutoff on recordings would be long enough to result in valuable snippets of sound but short enough to minimize the burden on parents listening to them. Building upon Peesapati et al.’s emailer strategy [19], KidKeeper automatically emails one audio recording to parents each day. The cloud server keeps copies of all recordings (sent from the toy via secure copy), and a Python script on the server emails one audio recording once per day. From a pre-study, we determined that longer-duration recordings were more likely to contain interesting content, so we decided to email the longest recording that had not yet been sent; in our field study, this worked well. The auto-delivery of email is meant to be a “free” benefit to parents—they exert no effort to capture audio, yet they receive an audio

recording created by their child.

Reduce audio-based privacy concerns

Design Rationale

Naturally, recording children’s activities, especially without adult supervision, brings forth privacy concerns in the form of accidental disclosure of private information, either from background speakers or the children themselves. We did not believe that we could eliminate all privacy concerns with child-generated audio content, but our intention was to significantly reduce these concerns. We assumed that enforcing active recording, where it takes a deliberate act to initiate a recording, would substantially mitigate privacy concerns parents might have, and also give children more agency in recording only when and what they wanted to. By preventing always-on, surveillance-like recording, we believed we could avoid many scenarios where people are caught unaware or have forgotten they were being recorded. Lastly, we tried to mitigate concerns by giving parents complete control over what was sent to friends and family, and by securely transmitting the audio to a private server. Prior work has suggested that parents might assign less risk to recordings when content is not shared or publicly available [3].

Implementation

KidKeeper records audio only when the touch sensor is pressed—the physical interaction makes the act of recording or initiating playback a deliberate one, thus decreasing opportunities for accidental privacy breaches. Two other design decisions, which have already been discussed, should mitigate privacy issues as well: limiting the length of recordings to one minute, and playing back the recordings. Limiting the length would reduce the amount of exposure, and playing back the recording would give the user an opportunity to recognize that such a recording occurred. Storing the audio files on a cloud server meant we had to secure the data transfers, as well as general access, to the server. All transmissions from the toy to the server were encrypted using Linux’s secure copy utility, and we restricted access to the server to the research team only.

DEPLOYMENT AND EVALUATION

To evaluate whether KidKeeper was able to proactively preserve the everyday moments of young children’s lives, we deployed it to seven households. We started recruiting

<u>Family</u> M=Mom D=Dad	<u>Family Arrangement</u> Stay at Home (SaH), Part-time work (PT), Full-time work (FT)	<u>Children (Age)</u>	<u># of Audio Clips</u>
Family 1 (M1)	PT Mom, FT Dad	1 boy, 2 girls (7, 5, 2)	391
Family 2 (M2)	SaH Mom, FT Dad	3 boys (all 7)	216
Family 3 (M3/D3)	Both parents FT	2 girls (8, 6)	60
Family 4 (M4/D4)	SaH Mom, FT Dad	2 girls (7, 5)	304
Family 5 (M5)	PT Mom, FT Dad	2 girls, 1 boy (10,6,4)	201
Family 6 (M6/D6)	PT Mom, FT Dad	2 boys, 1 girl (all 6)	234
Family 7 (M7/D7)	SaH Mom, FT Dad	2 boys (7, 5)	189

Table 1: Description of Study Participants

parents from our own social networks and employed snowball sampling to recruit other parents. We were careful in analyzing data from participants recruited directly by a member of the research team, and not all participants had a relationship to the team. Our only criteria was that families have at least one child in our target age range (2-7 years).

These seven families participated in a weeklong deployment, with semi-structured interviews at the beginning and end of the deployment. (See Table 1 for participant details.) We felt one week was sufficient to gauge whether KidKeeper would be accepted as a normal part of children's playtime and to gather enough recordings for parents to reflect and respond to in the post-study interview. We wanted to examine the basic feasibility of our approach, reserving emergent and other long-term behavior for a subsequent study. Eleven parents and 18 children participated in the deployment, and all families were two-parent households with multiple children. We had a wide range of family arrangements with respect to the amount of time parents were able to spend directly interacting with their children. In three of the families, the parent who spent the most time at home participated in the interview (Family 1, 2, 6). In three of the families, both parents participated in the pre-study interview, and only one parent was able to participate in the post interview (Family 3, 4, 5). In Family 7, both parents participated in both interviews.

In the pre-study interviews, which lasted from 40 minutes to 1.5 hours, parents were asked to bring 2-3 mementos of their children, and discuss their values and goals in how they wanted to remember their kids. The interview questions addressed how they currently created mementos of their children, and how they managed their collections of memorabilia. After the interviews, the families were introduced to KidKeeper, including its purpose and instructions for use, and were given a toy to leave in their house for one week. In the post-study interviews, we asked about their experience using KidKeeper, especially in regards to its dual role as a toy and a memory capture device, and their thoughts about audio recordings as a part of their collections of memorabilia.

Interviews were transcribed and analyzed following interpretivist methods following the methods of Clarke's Situational Analysis [2], an updated version of grounded theory. The first author used open coding to draw out descriptions of memory keeping practices, parent's memory-related values, and reactions to KidKeeper. These practices and values were then discussed with the other authors to draw out themes and socio-technical challenges. Several iterations of discussions and analysis of interview transcripts were conducted among the team until consensus was reached.

This study was approved by our university's Institutional Review Board. All names and data reported here have been

anonymized; we have made small edits in some presented quotes for clarity.

FINDINGS

The foundation of KidKeeper's design as a means to capture unprompted and unscripted audio recordings is that children would relate to our device as a toy rather than as a capture device. On this point, KidKeeper appeared to work. In Table 1 we see that the children in each family recorded a number of audio clips. We also heard from parents that KidKeeper was an artifact that their children could use comfortably and naturally. To examine this, we asked parents to describe how their children interacted with KidKeeper's tangible interface. Parents noted that their children's interactions with KidKeeper were "*like most toys*".

As we expected, KidKeeper was used more heavily at first. Children played with the toy, were "*super psyched*" at first, and over time became less interested:

I could definitely tell, initially, like any toy, when it's new and they're excited about it, they're playing on it and they're very interested, and they're spending a lot of time with it. Then, like most toys, it gets dismissed at some point. (M5)

However, in all but one family (Family 3), we saw continued, intermittent use in the days that followed. As the above parent explained, "*That's how my kids are about toys.*" When we took the toy away at the conclusion of the study, most of the children (if they were present at the time) asked whether they could keep it longer, suggesting that while their use had fallen off, they were still interested and attached to the toy. While we did not quantitatively track usage by age, in post-study interviews, parents with older children (8 years and older) reported that their older children were less interested in the toy, only using it once or twice throughout the week while their younger siblings used it much more extensively. In Family 3, both children in the family were older than our envisioned pre-school aged child, and while they did engage with the toy, it could not compete against their other more sophisticated games.

In the following sections, we report and discuss the findings drawn from interviews about what parents want to capture about their children, and what we learned about designing to support parents in capturing authentic memories of their children. Below, quotes from interviews are in quotes and italicized.

Getting an authentic glimpse of their children

In our pre-study interviews, our parents described employing many forms of keeping memories, from taking photos of their kids, to filming videos, to saving artwork sent home from school. Parents primarily kept artifacts that represented some aspect of their child's personality, and wanted to be able to capture a candid, "*authentic*" view of their child at that time in their life. The children's recordings were captured during playtime, an ideal setting

to capture candid audio, because children were “just being themselves.” This perspective, which KidKeeper enabled, was difficult for parents to catch, or even be aware of otherwise, because it was often imperceptible or occurred when no adults were present.

It was cool to hear them recording themselves when we weren't around...You know, the things that they would say, because you don't really get to hear that when kids are playing. (M1)

Hearing audio snippets that were created independently by their kids, our parents felt like they gained a glimpse into their children's everyday interactions and conversations they had been missing.

Getting memories of shy children

The low-key nature of the recording also helped parents capture children that could not normally be caught on camera or video. Parents recounted that some children enjoyed performing more than others, while others would only show their true personality only when they were in familiar company or unobserved. One mother was excited to be able capture her daughter singing, because, while her daughter sang all the time, she was too shy to do so for an audience or a camera.

I love when she sings, but she won't do it for a lot of people, so I love capturing that, getting that either audio or video. I only have one other video of her singing, and it was at least a year ago, because she won't do it. That, she was cool with it, because she wasn't even looking at me, she was just holding his hand and looking at [the toy], singing to [the toy]. She totally had no fear, it was awesome. (M4)

Since some children were less self-conscious when playing with a toy than being asked to perform for the camera, they acted as they normally would, enabling parents to capture elusive candid moments.

“Putting on a show” for themselves

Parents felt that their children's apparent ease and lack of fear did not come from being unaware they were being recorded. Instead, parents reported that the toy-like form let children perform on their own terms. One mother mentioned that her children at times were “kind of putting on a show,” not according to the expectations of their adult parents, but in this setting, for themselves.

I mean I'm sure they had to intentionally press the thing to make it happen, so they knew they were being recorded. Although they will sing songs and stuff in front of us... I think honestly they were recording to hear themselves playback.” (M1)

With an integrated capture device that afforded control, her children could now perform whenever and however they wanted. In another example, the mother quoted earlier who was able to capture her daughter singing, recounted that her daughter set her own criteria for that performance: “I had

the music playing on my phone for her, and she was like, ‘You don't have to sing with me.’” (M4) Independently interacting with KidKeeper let children create and share what they liked, whether making silly noises or putting on a show.

We note that not all children's staged recordings were interesting to parents. For example, in Family 3, an older child recorded herself and a friend taking turns reading a book aloud. Her mother didn't think much of this recording as a memento. Yet there were numerous clips of her reading the book, indicating it was something she had spent significant time recording. For most of our parents, their own interest drove what they viewed as worth saving.

In summary, while parents had many different capture devices, putting this embodied audio recorder in their children's hands allowed them to glimpse more of the elusive, uncontrived and unprompted moments where their children's full personalities came through.

“Capturing the stage they're at”

Parents hoped their kids would create more “meaningful” content on KidKeeper that would “capture that stage that they're at.” Two families had audio-based games their children played, and recalled, “they love to record their own voice and then play it back and laugh at whatever silly things they say.”(M1) While these other games encouraged silly play, parents wanted to capture conversations, storytelling, or self-reflection from their children as well: “[I want] to see if they do record more meaningful thoughts rather than just things that are funny words to them...like...talk to it or share feelings.”(M5) All the parents expressed a desire to hear their children's innermost thoughts, to gain “insight into how their little brains work,” especially since many of the children were pre-school or early elementary age and just beginning to express themselves using speech.

Discovering More About Their Child's Personality

One example of meaningful use that emerged was when parents discovered unknown aspects of their children's personalities that only came up as their children recorded things they themselves wanted to hear. For example, in describing the differences in what her three children liked to record and playback, one mother shared that her more introverted son would talk to the toy when he was alone.

I would say that one of the boys, Billy, would play by himself with it. He would tell it affirmations about himself. Like, “I like you Billy.” Then the other two would always play together with it, they would always just gargle, make noises. (M2)

This mother confirmed that her son normally talked to his stuffed animals, and it was not new behavior. But now she was able to hear that while his siblings made silly noises with the toy, he would say encouraging words so the toy would repeat it back to him. The independent recording

combined with the playback feature caused an informative reaction in her son, which she could now observe:

It was interesting that Billy did the self-affirmation. Compared to a story or music, Billy just kind of told himself things that he wanted to hear. That was very intriguing because we didn't know words were important to him until we heard him say things he wanted to hear. (M2)

This unintended use of KidKeeper's features created a new dynamic for this parent. Listening in became useful beyond its amusement value as children created "meaningful" content. In this case, the parent was able to learn directly from her son what was important to him.

"It's who they are"

While there were notable exceptions, the majority of the recordings that children created were silly sounds and sayings that they thought were funny. Yet, in addition to capturing developmental milestones, some parents also found that these simple snippets of their children playing around, for example "making fart noises," also captured aspects of their children's personality that they wanted to preserve. Although the clips were not of meaningful content per se, "They were cool, because they're not something we have." (M2) The random noises recorded by her children reflected the banality of everyday life. While not worth pulling out a camera to record (and perhaps impossible to record with a camera as [11] found), they represented an "authentic" slice of life. "I saved all of them... It's them and everyday life. It's who they are and what they do. They make these boy noises all the time." (M2)

Parents valued everyday audio content when the content was "meaningful", and also when it served as an iconic representation of their child's personality at that stage in life. We note here that although most parents thought some bit of idiosyncratic playful noises were entertaining and even nostalgic to have, only two parents (including M2) elected to "save them all." Most saved only one or two of these from each of their children.

Enjoying the accessibility and surprise

KidKeeper also elicited curiosity and surprise from parents. Parents described the daily experience of anticipating and listening to their children's audio snippets "as exciting for us as it would be for them getting a new toy." (D4) In looking more deeply into parents' experiences, we discovered that the enjoyment of KidKeeper for parents came from two factors: the accessibility of the clips and the unpredictability of the audio content.

Accessibility: "It has to be easy"

Parents primarily listened to the clips they received daily via email. The alternative—the random playback feature enabled by squeezing the toy's tongue—was entertaining and accessible for the children, and, as parents reported, a primary reason the children kept returning to it. However only one parent reported going to the toy to listen to the

recordings. Initially, parents were enthusiastic about the potential of having a physical marker of memories present in their home, thinking, "at the end of the day, you walk by and you'll be like, "Oh, what's the kid caught today?" (D4) However, email turned out to be more accessible for parents. As one mother recounted, she preferred email:

Probably because I'm addicted to my phone, and it's constantly in my hand, so...I'll see if something pops up, or I'll get a notification if there's an email. That's pretty immediate. It doesn't matter where I'm at or what I'm doing. (M4)

Although the idea of a leisurely evening at home browsing through the day's clips appealed to parents, in reality, they had busy schedules and could more easily listen to the audio pushed to their phone. The feature of KidKeeper to select and deliver audio content directly to parents made the content more accessible and more likely to be listened to.

Surprising Content: "A fresh sense"

Being able to access everyday moments remotely provided a further benefit to the parents who had to work long hours outside the home or while traveling, and who cherished hearing their children's voices when they were missed. In one example, a parent who worked long hours recalled listening to the emails of his two sons' recordings every day at work on his phone.

I got some email every day, that was so interesting. It was a fresh sense for me, I just listen, like a phone, I just listen to their voice. And I think if I'm very, very busy, then it's very nice. Like for instance, if I'm very busy for work and I cannot go back until they are asleep or I am at business somewhere in another country, in that case it is more helpful to listen to their voices every day. (D7)

The experience of being able to listen to his children's voices made it difficult for him to discard even the "stupid" recordings of his sons screaming into the microphone. Although some days the clips he received were non-ideal from an aesthetic perspective and far from "meaningful", his total experience throughout the week was enhanced because of that variable quality. Although he did not like receiving just noise, especially given that he only got one "voice" a day, the fact that he had no idea what to expect when he listened to the recordings created a more engaging emotional experience for him that was "maybe better than a picture." In comparing the unpredictable content of the recordings with the weekly school emails of pictures that he received of his oldest son, he mused that while the delivery method was the same, he found the audio more interesting as a snapshot of his children: "[With sound], I had more of a feeling, of up and down, surprising and disappointing. For pictures, [the school] catches his best picture, so I can see how he works well. But with sound, the difference in quality, the gap, is interesting... I think a picture from school will not surprise me. Maybe satisfy me, but not surprise me." (D7)

The delivery feature also served as a digest for parents, sending only a few of the best clips their children had recorded. However, two families were dissatisfied with their digest, one where the majority of the high quality clips delivered by our algorithm were different takes from a single child's self-staged recording session (Family 2), and another where all the clips featured music and ambient sounds the children had recorded rather than themselves talking (Family 3). These parents described these recordings as "boring" although they thought their children had fun making them. These cases of mismatched interests are important to consider, both as breakdowns of our mediation and inevitabilities in these types of systems, and we return to this in our discussion.

Parent's interactions with KidKeeper and reactions to the content that was recorded by their children illuminated some of their unarticulated desires: accessibility was a primary driver in listening, and variability created interest through surprise and novelty.

Comfortable with privacy features

Although other cloud-connected recording devices have caused concern about children's privacy (e.g., *Hello Barbie* [29]), KidKeeper was perceived as secure by our parents. Our participants reported that a combination of three main features made them feel comfortable: manual capture ("they had to intentionally press the thing to make it happen" (M1)), secure storage ("it's just contained" (M6)), and innocuous recordings ("It would surprise me if they said something that I wouldn't want anybody else to hear" (M4)). Though parents were aware of privacy concerns, they perceived little risk of a privacy breach with KidKeeper. Privacy had two aspects for our parents: the privacy of the family with respect to the outside world, and the privacy of children from parents.

Privacy from the Outside World

A feature of KidKeeper was that all the content was kept on a private, secure server, but individual clips could be shared with others outside the family via email or another media messaging service. When parents were presented in interviews with plausible scenarios of accidental disclosure of content, such as an audio clip being sent to an unintended audience, our parents felt that the content that their child was capable of generating was not sensitive enough to cause alarm.

However, there were several instances in which parents realized that their children were actually recording *them*. While there were no privacy breaches in this study, this did cause consternation as parents realized their children might intentionally or by happenstance record them without them noticing. For example, one dad only realized that his daughters were recording him playing the guitar in a different room after receiving several emails of himself playing. In this instance, we see that children's creative use of the toy could catch activities in the background, leaving the recorded party unaware. Although the unknown

recordings largely contained innocuous content, one could imagine private phone conversations recorded inadvertently and emailed out, a concern reported by families in [2]. All the parents rejected the idea of adding continuous capture into KidKeeper without a host of controls to regulate how and when the stream could operate.

Privacy between Children and Parents

In addition to parents' privacy concerns, children could have privacy concerns as well, particularly in wanting to keep some things they said hidden from their parents. In our study, our parents did not think their children cared about what happened to these voice recordings: "Cause they're so little, I think they don't really give a cr-p. Cause we're parents right? They think we can see and hear and know everything." (M1) As this mother expressed, our parents thought their children at this young age were indifferent about disclosure through these recordings, because they already associated a certain omniscience to their parents. "They're too little to know that we don't really see and hear every single thing." Whether this is a good view or not, many of our parents echoed this sentiment regarding their children in our target age group. They also pointed out that this would certainly change as their children got older.

As well, privacy between children and parents may have been less of a concern because most parents set up KidKeeper in a public, common area of their home where their children usually played together, and where there was generally little expectation of privacy. Thus the toy was situated as an observable plaything, shared among all the children in the home and easily accessed by parents. Even so, some children did record things that they were normally forbidden by their parents to say, such as "language we discourage" (M7), rude words, and insults to their siblings. When our parents observed this behavior, they said they responded as they usually would when they heard such language during playtime.

In summary, none of our parents appeared to be concerned about KidKeeper and the privacy of their children. This was due to both the features of the system, their own views about the sensitivity of the content of the recordings, and their relationship to their children. As privacy is a recurring issue in new capture technologies, we discuss the implications of these findings for integrated capture technologies in our discussion.

Summary

In our study, we proposed and demonstrated KidKeeper as a means for embedding capture technologies into an everyday environment to record hard-to-capture moments without disruption. We successfully integrated a toy-like capture device into children's everyday activities, and children generated hundreds of audio clips during play. As parents reflected on their memory practices and on what they wished to capture about their children during the study, they shared that they wanted to capture and save token moments that exemplified their child's personality, gain

insight into how their children were thinking and feeling, and hear snippets of life that they missed. KidKeeper helped some families achieve this goal, while others were less enamored with their children's playful recordings. In the next section we discuss the implications of these findings in designing technologies to support families in capturing memories of everyday life.

DISCUSSION

KidKeeper demonstrates “integrated capture,” an innovative approach to capturing family memories in the home by embedding capture technologies into the artifacts that are normally used in everyday activities. This approach addresses the current limitations of capture and access technologies, while incorporating the benefits of unobtrusive and candid total capture, the purposefulness of situation-specific capture, and the ethos of unremarkable computing. KidKeeper is toy-like to capture authentic, everyday moments of young children's playtime, a time valued by parents but difficult to capture otherwise.

KidKeeper addresses the current limitations of capture and access technologies for family memory that create tensions between privacy and disruption. In this regard, KidKeeper worked. Families used it and obtained what they considered significant mementos hard to obtain otherwise. Its features appeared to also reduce barriers to access recordings by providing content delivery mechanisms, reduce overload through automatically prioritizing delivery of recordings, albeit simply, and mitigate privacy concerns using private secure cloud storage and ceding all sharing control to parents. Further, in deploying KidKeeper, we came to understand what parents seek to capture when documenting the everyday lives of their children. These insights, we believe, will help designers create more directed and purposeful systems that support families in capturing and creating mementos of this important period in their children's lives.

We learned that integration was not only about building a unremarkable device, but also about aligning different interests of family members towards a family goal of capturing memories. KidKeeper shows a valuable approach to designing memory technologies for the home, and we discuss some of the tradeoffs of integrated capture (capturing meaningful content, too much content vs privacy, aligning interests) and how they might be addressed in future work.

Too Much Content

The children generated hundreds of recordings in only a few days, with diverse content and variable value to parents. Over time, the accumulation of digital artifacts could very well become overwhelming, especially if there were multiple capture devices in a home. While the strategy of automatically delivering content to parents reduced the effort in listening to the audio clips, this will not lend itself to easily accessing large numbers of recordings. Winning down the number of clips, such as in creating

an audio album, would be tedious, and there is evidence that users just will not do it manually [13]. As with many CSCW systems, too much use brings its own problems (e.g., [8]).

Because KidKeeper is a situated device, it could also help to organize the content it records for future reference. Its recorded content is embedded with event (playtime), subject/owner (the children), and location (home) information, in addition to some higher level context that might be important at a family level, such as the approximate age of the child. The added context that can be inferred from an integrated capture system could help to better inform accompanying systems that automatically structure and organize a family's collections of digital mementos, further lessening the burden of overload to the users. Having additional context automatically included in the metadata of saved clips could help parents revisit the content later, whether in accessing the database manually or using a delivery system like KidKeeper's to select content for them to enjoy.

Robust organization schemes are critical for digitally captured moments to become useful for family memory. In related work, we are building a semi-automated curation system to help parents find the “treasures” in a large collection worth revisiting as digital mementos.

Tradeoffs in Capturing Meaningful Content

From our interviews with parents about what they save, and in their reflections on the audio clips their children recorded with KidKeeper, we drew out key goals of parents when trying to capture the everyday lives of their children. We found that parents valued most highly audio clips that portrayed the authentic and unfeigned personality of their children just being themselves at their current stage of life. These token moments had been difficult for parents to anticipate and capture with existing technologies, and thus were new and fun to hear as they were recorded through KidKeeper. These new glimpses also helped parents gain insight into how their child was thinking and feeling.

However, our children (and likely most children in our age range) were not attempting to capture audio for memory sake, as their parents were, but just amusing themselves. Our rudimentary content filter ensured that there was a minimum audio quality to the clips sent to parents, however, not all parents got as much highly precious and meaningful content as they hoped. As children made recordings that they found amusing, their parents sometimes had different reactions—at times similarly amused, and at times bored and uninterested.

Fortunately, in our study, the variability in content which manifested from this imperfect alignment of interests was generally accepted as status quo by our parents. It was even a positive point for some parents. Although parents expressed a preference for more valuable meaningful content, getting an occasional dud was not necessarily a bad

thing for them. Hsieh et al [9] and Odom et al [16], among others, have intentionally employed randomness and spontaneity in their timing of delivering sentimental content to users to positive effect—the anticipation induced more joy in users when they eventually received their memento. Our findings suggest that variable quality might also create a similar interest in our parents.

However, finding the right balance between meaningful content and randomness is a challenge. Even if parents become more discerning, there remains an open question about how they might get only the content they want from an integrated capture system. One strategy, such as the one currently employed by KidKeeper, might implement better filters that take into account sophisticated knowledge of parent's desires to select the most interesting content for them, without affecting the capture process. To change what content is captured would require cooperation from both parents and children, as KidKeeper's full functionality cannot be realized by only one group of users. It would be difficult for parents to co-opt their children's playful use of the system without disrupting its fit as a toy. Thus, in order for parents to capture more meaningful content with the toy, whether it be their children's thoughts, singing, or just more content from a particular child, they may have to engage in their children's play and actively change the way their child is playing.

Capturing meaningful content with an integrated capture system requires careful attention to the interaction dynamics between all the users in the system. For KidKeeper, we chose to prioritize the playfulness of the system as it is most integrated into children's lives, and because the meaningfulness of much of the content could only be determined in retrospect. Systems which emulate an integrated capture approach in a different context will have to take their users' practices into account and the different tradeoffs each group might experience.

Aligning Different Interests of Family Members

When designing memory technologies for families, viewing the "family" as a like-minded unit has proven in the past to be problematic. In the Family Archive [10], for example, involving children in the memory artifact preservation process, while democratic, resulted in a breakdown in the parents' careful organization scheme, eventually resulting in abandonment of the system all together. Systems designed for close-knit groups such as families must be careful not to assume that a common activity is undertaken for a common purpose. Rather than taking a persuasive approach, where users are encouraged to adopt a similar model of the system, in our system, we attempt to align the cross-purposes of parents and their children towards a family goal of capturing memories difficult to achieve otherwise. Similar strategies of aligning incentives have been adopted in to create useful organizational memory (e.g. AnswerGarden [1]). Yet in balancing these interests, a significant area of uncertainty remains regarding privacy.

The issue of privacy between children and parents is a complex and dynamic issue [27], especially in the context of capture and access [10]. Technologies which mediate social interactions, such as family memory capture systems, engage with existing power and agency dynamics. Yardi and Bruckman, referring to these dynamics as the "politics of technoparenting," note that most conflicts between parents and children occur with respect to personal values [27]. Yet, as we noted in our findings, due to the age range of children in our study, the parents in our study were primarily concerned about privacy in relation to the outside world, rather than within their home. Some of our parents assumed the perspective that anything their children did was subject to their scrutiny, and that their children were young enough that eavesdropping on their playtime was unproblematic. On the other hand, children's rights advocates have argued that children deserve the right to privacy and agency [6]. Our system brings up a further question about the age at which "privacy" is truly possible for children in a home where capture technologies and their databases are chosen and managed by parents.

To address immediate issues of negotiated privacy and control, two features of KidKeeper might be useful for consideration in this and other capture scenarios for parents and children. First, KidKeeper can only be used "up close." While its physicality was originally intended to facilitate play and ensure that children could easily use the recording capability, it turned out to also make it almost impossible to appropriate KidKeeper for clandestine recording. This means children have primary control over what is recorded. Parents can of course step in to intentionally record something, but then their presence is known to the child.

Second, clips were intentionally short and neither parents nor children could intentionally access a specific recorded clip. Access was either random (through the toy) or automatically selected by the system (email). The database was completely restricted to access by one of these two means. This too was not intended to be a privacy feature, but it disrupted the kind of purposeful search and retrieval affordances that characterize effective surveillance systems.

Nonetheless, neither of these features are perfect solutions, and it remains an open challenge to create shared capture and access systems that respond to competing disclosure preferences of multiple users. Technologies that mediate family interactions around memory will need to negotiate the immediate and long-term privacy concerns of family members, especially with respect to how relationships and content might shift and change over time. The issue of negotiated control over content access is an intriguing area for future work to address.

Limitations

Several limitations in this study are important to note. The number of families in our field study was small, and these families no doubt self-selected into the study because of their interest in family memory. We might expect other

families to have less usage, although the study does show there are some families who would find KidKeeper valuable. Furthermore, the study was only a week long. We might expect parents to have to encourage children to use the system over a more extended period, although as we noted above, irregular but occasional use is common with toys. Even if use is sporadic over the long term, the family will still have gained a large number of mementos.

CONCLUSION

In this paper, we introduced our system, KidKeeper, a kid-driven, audio-based "integrated capture" system to help parents capture everyday moments in their children's lives at home. We described and qualitatively evaluated the design assumptions for integrated capture during children's playtime that we implemented in this context, namely,

- Encouraging spontaneous and authentic play,
- Reducing the effort for parents to enjoy content their kids created, and
- Mitigating privacy risks that might arise from using an embedded audio recording device.

In a deployment with seven families, we gained insight into our approach to designing for family memory and our design assumptions. Overall, there were a number of families that showed the kind of use that would successfully lead to a new kind of family memory artifact. Yet, although parents were able to capture the authentic personality of their children at a particular stage in their life, the integrated capture approach came with some issues to consider in future work: capturing too much content to be actively managed; negotiating the capture of meaningful content; and managing content access and control. We learned that integrated capture systems like KidKeeper must align the interests of different family members to effectively capture memories of the everyday life of children. Implementing this socio-technical alignment is an intriguing area of future work.

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