# Co-designing for the Co-Use of Child-Owned Wearables

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## ABSTRACT

Child-owned activity trackers are not only devices for self-tracking, but they are also co-used by children and parents for family-centered health and wellbeing. This presents a challenge for the design of this technology as children's and parents' wants and needs from this technology are not always aligned. To further understand children's and parents' ideas and expectations, we conducted a qualitative study utilizing co-design sessions and semantic differential scales. Data from five families show four trends: 1) representation of parental worries and values as tracking metrics, 2) wish to access the unknown, 3) the significance of smartphones and touchscreen imagery on children's visual language, and 4) concerns around child's privacy and autonomy. These trends can be interpreted as a potential for activity trackers to mediate family interaction and to structure family conversations around worries, values, and privacy during co-use.

## CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); HCI design and evaluation methods; User studies; Human computer interaction (HCI); Interaction paradigms; Collaborative interaction.

## KEYWORDS

Child-owned wearables, activity tracking, family informatics, co-design

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## 1 INTRODUCTION

A growing number of brands target children as users of activity trackers [11]. This change in the target users has required more than a modification in design and human factors aspects of existing wearables. While the activity trackers initially grew out of the need to self-track, child-owned wearables are not solely used by children [6]. Parents, especially with younger children, mediate their children's interaction with the wristband through the app available on their smart device [12]. They also become the co-users of this technology as they can access their children's tracked data [7, 10].

The co-use of child-owned wearables presents a different reality than other smart technologies available in the family context. Garg and Moreno [5] described how family members share technologies such as smart thermostats and speakers. In these cases, each co-user interacts with the same touchpoint. This situation differs for child-owned wearables that require regular connectivity between the wristband and the associated app for the most effective functioning. The Children's Online Privacy Protection Rule [4] prohibits manufacturers from targeting children under 13, and younger children do not always own a smart device to install the app. Consequently, the wristband and the app of these solutions target different people. Wristbands are used by children, and the associated apps of the wearables are mostly available on parents' smart devices [6, 7, 11, 12].

This co-use practice can have both positive and negative impacts. Co-using child-owned wearables allows family members to address family-centered health and well-being concerns [13–16]. At the same time, they can cause conflicts between children and parents. These conflicts typically result from excessive parental control, surveillance, and privacy invasion [7, 17]. This technology needs to support both self-tracking experiences and co-use without increasing child-parent conflicts. To understand children's and parents' wants and needs, scholars conducted studies on wearable use in families with neuro-typical children [12, 15] and children with chronic conditions [3, 8, 9]. Our paper builds upon this previous work, utilizing a co-design and semantic differential study on activity trackers with families. We aimed to uncover children's and parents' ideas and expectations around everyday tracking practices and activity trackers in a more profound manner using co-design. Our work contributes to research on family informatics and technology use in family life by 1) illustrating how child-owned activity trackers represent and structure family worries and values, and 2) highlighting design and research opportunities towards setting boundaries to balance individual use and co-use.

## 2 METHOD

We designed a qualitative study that utilized co-designing and semantic differential scale with families. In this study, we only target neurotypical children. We have conducted 5 sessions so far. The participants were recruited purposefully from our social circles. Children's ages ranged from 7 to 15 (Table 1). None of the children owned an activity tracker or smartwatch during the time of our study.

Co-design and semantic differential scale sessions were conducted by the first author. Children and the parents signed consent and assent forms before the start of sessions. Each session was conducted in a location that the participants preferred (4 in their homes and 1 in a community building) and lasted about an hour. An


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**Table 1: Participant overview**

| Family | Child | Child's age | Participating Parent | Participating parent's wearable ownership | Other parent's wearable ownership |
|---|---|---|---|---|---|
| Family 1 | Son | 9 y.o. | Mother | - | - |
| Family 2 | Daughter 1 | 8 y.o. | Mother | - | - |
| | Daughter 2 | 15 y.o. | | | |
| Family 3 | Son | 10 y.o. | Father | Smartwatch | - |
| Family 4 | Son | 10 y.o. | Mother | - | Used to have one |
| Family 5 | Son | 7 y.o. | Mother | Smartwatch | Smartwatch |

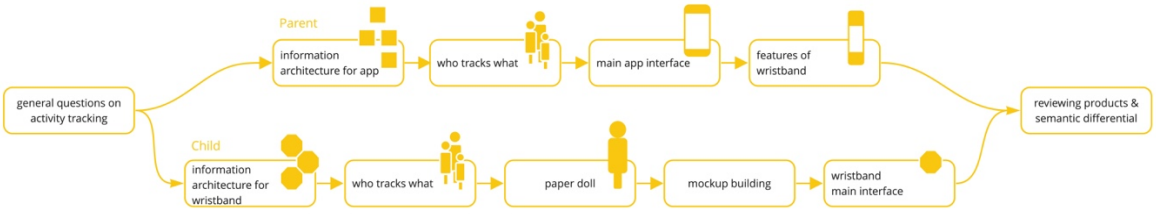


**Figure 1: Design of co-design and semantic differential scale sessions**

incentive of $25 was given to each child participant. Our research design had a different order than the one in Figure 1 for the first of five sessions. We conducted the semantic differential scale first and continued with the co-design exercise during our very first session. Reviewing commercially available activity trackers impacted participants' idea generation during the co-design exercise. Participants were not able to think beyond what they had seen. We swapped the order for the rest of the sessions, as seen in Figure 1.

In each session, we started by asking general questions on activity tracking and activity trackers to understand the child's and parent's existing knowledge and thoughts. Then, we wanted the child and the parent to work on different tasks. For children, we wanted them to 1) select metrics to track from a set of hexagon blocks (20 with a tracking metric and 4 without for the child to add whatever they want) and rank order them according to importance, 2) define whom they prefer having access to each tracking metric, 3) using a paper doll as a probe, think about what part of the body should the tracker be worn on, 4) design and build their activity tracker out of cardstock, play-dough, and stickers, and 5) draw what they want to have on the main screen of the wristband. In the meantime, parents 1) listed the metrics they want to track about their child on post-its and rank ordered them according to importance, 2) noted who will have access to each tracked metric, 3) designed the main interface of the tracker's app that they will have access to, and 4) defined the features that they expect the wristband (for their child) to have. Each session concluded with children and parents filling out a semantic differential scale for three commercially available activity trackers (i.e., Fitbit Ace 2, Garmin vivofit jr. 2, Xiaomi Mi Band 3). We specially selected two child-oriented and one adult-oriented products to evaluate whether the child-oriented ones are more attractive to users. Two child-oriented trackers were selected because of being the most popular ones during the time of the study. The adult version was selected purposefully because of resembling child-oriented trackers and having a colorless tap screen with a wider range of tracked metrics (e.g., heart rate) than the child-oriented versions. During the sessions, the participants were also presented with a product description card, which included information on each product (e.g., battery life, water resistance, band material) and the associated apps of each wristband. We asked the participants to reflect on the app and the wristband as a single product while evaluating. The 12 adjective dyads in the semantic differential scale were selected from previous studies (e.g., [1, 2]) according to their relevance to the product category under study and in consideration of the age range of the target children population.

The first author did a thematic analysis of the verbal data and photographs. For the rest of the paper, we use a combination of letters and numbers to indicate each participant. For example, F2C is the child participant from Family 2, whereas F3P is the parent participant from Family 3.

## 3 FINDINGS

It is not surprising that each family showed differences in the metrics they want to track and how they rank order them. Furthermore, parents also focus on different metrics to track for each child they have. For example, F3P explained how she would like to track her older son's exercise but not her younger daughter's. She believes that her son is more into reading, and she is more worried about his activity level. F1P had a similar comment on how parental worries can change from child to child: "It really depends on the child what you worry about as a parent. Like for him, I would worry about how much he eats or drinks, but I honestly do not care about how much activity he gets... I can see, if like he was an overweight


**Figure 2: The metrics that F3C, F3P, F4C, and F4P wanted to track and their order of significance for them, with some primary metrics being common across children and parents**

child and had some problems physically, I would worry about how much activity he gets."

Despite differences, we also observed four main trends in our data around family tracking practices and the design of activity trackers by children.

## 3.1 Representation of parental worries and values as tracking metrics

It is difficult to separate individual worries and values from everyday practices. This is also visible in parents' comments about what they want to track about their children: "I am constantly worried if he eats enough food" (F1P). Our data shows how parental worries and values can also become a concern for children and how the tracking metrics can communicate family worries and values. This trend is represented in our data in two different ways.

First, for some families, there is a similarity between what the child and the parent want to track and how they prioritize those metrics. In Figure 2, two photographs on the left show how F3C and F3P rank ordered the metrics. F3P had location as the most important metric. He wants to have access to the whereabouts of his son if needed. This parent also gave SOS alarm the same significance as the location. For him, the tracker is meaningful if it can help with his son's wellbeing by addressing safety concerns. Similarly, while explaining why he put the location on the top, F3C shared his concern about getting lost or being able to reach his parents in case of an emergency:

> "I think the location is important because, like if you got lost or something like and if the tracker is connected to like your parent's phone, the parent could just look on it . . . where you are . . . if there's like a GPS on your watch, you could just open it and see, like a map and say, 'Oh, I'm right here."'

Second, the parents' worries and concerns are represented by the data that the child prefers to share with the parents. While F4C did not want his mom to access much of his data (which we further explain in section 3.4), he preferred his parents to access his location (Figure 2, second photograph from right). Location was also the most important metric for his parent. F4P placed post-its in descending order of importance from left to right, put location first, and wanted both herself and her husband to have access to location data.

## 3.2 Wish to access the unknown

Children's and parents' comments and the metrics they selected for tracking illustrate that people want to utilize trackers to access information on aspects of life that they do not naturally know. For example, F2P explicitly commented on knowing what her children are up to most of the time. For this reason, she was not interested in learning about their steps or sleep. However, she preferred knowing where and who they were with when not with her. Similarly, F4P commented on wanting to access her children's emotions in general: "Emotion, I want to know whether you have a good day or not. Sometimes, as they get older, you know, they don't want to tell parents about things happen to them."

The preference to track location was the most common aspect across parents. Four out of five parents (except F1P) wanted access to their child's location. Three of these four parents placed the location at the top in their rank order and app screen.

Overall, children selected more metrics to track than their parents. Children, except F2C2, did not select metrics they could easily count (e.g., water intake) or already have quantitative data on (e.g., weight). They had more interest in what they could not easily quantify. While parents commented on not needing data from an activity tracker to know if their children were active, children had no such conception. Furthermore, the idea of having access to their step counts or active minutes was novel to them. Some children even described how they could use data from the activity tracker to evaluate their health and wellbeing further. For example, F3C wanted to use data from body temperature to make sure he was not sick:

> "If you're feeling a little bit uncomfortable, you could just look on your watch . . . your temperature is not high, you probably could just say, Oh, I probably have some sort of allergy ... But then if you're feeling uncomfortable . . . and you see it on the watch and your temperature is high, then you probably know you have a fever."

## 3.3 The significance of smartphone and touchscreen imagery on children's visual language

There were many similarities between children's activity tracker designs (Figure 3). Five children designed trackers similar to watches.

**Figure 3: Children's designs were largely inspired by smartphones, as illustrated by the activity tracker designs by F3C, F4C, F5C, and the wristband main screen design by F5C**

Only F2C1 designed a wearable that can be attached to a shoe, but even that design included a circular touchscreen like others.

Children's designs can also be interpreted based on the impact of current smartphone imagery on children. F3C had a smartphone screen on his activity tracker design. F5C combined a smartphone screen with an analog watch interface on the main screen of his design. These children did not own a smartphone during the time of the study. They might have conceptualized an activity tracker as a smart gadget equivalent to their parents' smartphones.

### 3.4 Concerns around child's privacy and autonomy

The conversations during sessions highlight two areas of concern. The first one is related to respecting children's privacy. Both children and parents brought this up. F2P said she would like to track everything but believed this would invade their children's privacy. When F4P shared her app interface design showing her son's location, her son reacted with a joke saying that if he could, he would move the pin for his location in the app to trick his mom about where he was. This conversation around privacy continued after F4P shared her concern about her son's sleep and explained how she would want to know more about his sleep cycle overnight:

> F4P: "... sleep follows because I want to make sure, especially when you are in higher grade, you know, just take enough sleep."
>
> F4C: "Hey, then I'll just take my watch off."

Similar to concerns around the child's privacy, F4P also shared her concern about the possible impact of task reminders in an activity tracker on her child: "... it's good and bad. It is good that he will be reminded about it, but it is bad that he really relies on it .... But I can save energy with it reminding him." Parents other than F2P all described how they could benefit from task reminders. None of the children shared concerns about task reminders as well. Even if F4P shared a concern, she included task reminders in her metric selection.

## 4 DISCUSSION AND CONCLUSION

While our data is limited to five families, its analysis provides new areas of exploration as we conduct more sessions. Furthermore, the analysis of our research design shows us possible areas of improvement in our current study.

### 4.1 Structuring co-use toward family interaction

Our findings indicate children's awareness of their parents' worries and values. These worries and values are not only defined by the family, but they also define the family and the family members' possible interaction through activity trackers. Activity trackers can potentially mediate family conversations around these worries and values. These conversations can occur while setting up the activity tracker for the first time and during everyday use with discussions around tracked data.

While activity trackers define design opportunities for family conversations around worries and values, they can also bring conflict between child and parent. This can become an issue, especially when children sense an invasion of privacy. Setting up boundaries up front and balancing individual use and co-use around pre-defined boundaries might help overcome this conflict. This indicates a need for designing activity trackers with children-controlled data-sharing options.

### 4.2 Reflection on the design of sessions

During co-design, we provided play-dough and cardstock for children to think out of the box. We specifically left the design options open-ended. Still, children's designs were conventional. Except for one child, they all designed a wristband similar to a watch. On the other hand, the more structured steps in our co-design sessions (e.g., tracking metric selection, wristband interface design) provided more insights for our study. In the future, we will use more structured generative tools during the design of the activity tracker to focus more on how children want to operate a wristband (e.g., control type, placement of controls) rather than designing it from scratch.

We preferred having the child and parent side by side during sessions to provide more comfort for the child. We were initially worried about the possible negative impact of this decision, as participants might prefer to avoid talking about certain topics in front of each other. While there might have been times when the child or the parent had concerns sharing thoughts openly, having them

together gave us a chance to observe their conversation around tracking as well. We find this very valuable as our data support previous studies [6, 7] and communicate the co-use practice of children-oriented activity trackers. Co-design exercises provide necessary tools for family members to discuss a topic that can be conceptually hard to address.

We expected to collect further verbal data while children and parents filled out the semantic differential scales. Based on the participant's feedback and our observation of children's attention spans, we decided to divide our study into two in the future. We redesigned our study as two separate research studies, one conducting co-design sessions and the other utilizing semantic differential scale.

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