# Analyzing user experience with a smart product-service system: Children-owned wearables

Isil Oygur[a*], Yunan Chen[b], Daniel A. Epstein[b]

[a]University of Cincinnati

[b]University of California, Irvine

*Corresponding author e-mail: oyguriil@uc.edu

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**Abstract**: Contemporary smart product-service systems increasingly enable multiple users to interact with multiple touchpoints of the same system simultaneously. We looked deeper into the use practice of one such smart product-service system, children-owned wearables. Our data comes from a short-term auto-ethnography and a user review analysis of 9 children-owned wearables. Experiences designed for children assume they have limited agency, leading parents to switch roles between being the end and mediating users. As mediating users, parents become service providers for their children. These user dynamics can hinder children's experience with wearables and their interaction with other wearable users. Our findings extend the theoretical understanding of human-centered design and service design by depicting the significance of multiple and shifting user roles and users as service providers during the use practice of children-owned wearables.

**Keywords**: wearables; smart product-service systems; service design; designing for children

## 1. Introduction

21st-century design culture is increasingly built around "networks of interactive artifacts" (Jung et al., 2008, p. 201) that are connected via information and communication technology (ICT). Some of these artifacts also have ICT-enabled e-services. Valencia et al. (2015) coined the term "smart product-service system" (smart PSS) to emphasize the significance of such smart interactions in contemporary systems. Smart PSSs such as smartwatches and smart speakers include at least one smart device and an e-service targeting end-users. Some smart PSSs expand Battarbee and Koskinen's (2005) "co-experience" concept. They enable multiple users to interact with the same smart PSS through different touchpoints simultaneously. Children-owned wearables are a recent example of such smart PSS solutions.

Children-owned wearables (e.g., activity trackers and smartwatches) involve relatively complex use practices compared to wearables for adults (Gram-Hansen, 2019; Mackintosh

et al., 2019). Adult-oriented wearables are designed around self-tracking and individual use. In contrast, children-owned wearables combine digital (i.e., app) and physical (i.e., wristband) touchpoints that require both child's and parent's interaction for the most effective use. While children wear wristbands, the associated apps of the wristbands are primarily available on parents' smartphones as children might not own a smart device to install the app, and the Children's Online Privacy Protection Act (*COPPA*, 2013) prohibits companies from directly addressing children under 13 with their apps. This brings a unique dynamic to the use practice of these wearables and impacts the users' experience with this smart PSS.

In this study, using children-owned wearables as a case, we aimed to understand users' experience with smart PSSs that have multiple touchpoints for different users to enable simultaneous interaction with the system. In contrast to the ubiquity of smart PSSs in everyday life, the user experience with smart PSSs is less studied (Valencia et al., 2015). While addressing this literature gap, we targeted 1) developing an ecological understanding of children-owned wearables to utilize in future studies and 2) enhancing human-centered design and service design literature to incorporate knowledge from smart PSSs.

## 2. User experience with smart product-service systems

Smart PSSs combine digital and physical solutions "targeted to individual users" (Valencia et al., 2015, p. 13). Use practices of smart PSSs are not always limited to networks of artifacts. They can also involve networks of users. For example, multiple family members can use the thermostat control and the thermostat app of a smart thermostat (Garg & Moreno, 2019). Consequently, smart PSSs define new challenges for designers as the system can involve networks of artifacts and networks of users that must be considered during the design phase.

The perspective of smart PSS is built upon the existing literature on product-service systems (PSSs). The interaction between the user and the service provider plays a significant role in users' experiences with a service (Meroni & Sangiorgi, 2011; Prahalad & Ramaswamy, 2004; Sandström et al., 2008). Technology acts as a mediator between the user and the service provider during the utilization of services (Secomandi, 2012). Users participate in the production of services through their input to the system. This role of a user in the "service-dominant logic" (Vargo & Lusch, 2018) renders the service production process a "customer-intensive process" (Pinhanez, 2009).

Valencia Cardona (2017) builds upon this centrality of users while defining smart PSSs. She explains that designing smart PSSs is further complicated as multiple touchpoints need to be designed coherently. Coherence impacts the user experience, but it is not the only determinant. Intrinsic aspects, situational aspects, and characteristics of a smart PSS simultaneously play a role in user experience (Valencia Cardona, 2017). These aspects unfold as the user interacts with a smart PSS over time, thus making it necessary to consider temporality while studying users' experiences (Karapanos, 2013). Karapanos's study (2013)

explains that interactive technologies take a role in social interaction. Technologies impact the social self (Secomandi, 2012) and help individuals with self-expression, which can eventually make them associated with a community of people using the technology (Karapanos, 2013).

While these studies address the social aspects, they are mostly built upon the idea of "self" (Karapanos, 2013; Secomandi, 2012) and a single type of user "interacting with a solution to achieve a goal" (Rexfelt & Hiort af Ornäs, 2009, p. 692). Battarbee and Koskinen (2005) criticize this approach. They call for moving beyond treating experiences as individualistic and considering the creation of experiences among people. They coined the term "co-experience" to highlight the significance of social interaction for experiences: "… people create, elaborate and evaluate experiences together with other people, and products may be involved as the subject, object or means of these interactions" (Battarbee & Koskinen, 2005, p. 15). This perspective is significant in understanding the experience with children-owned wearables.

Within the field of human-computer interaction, Gram-Hansen (2019), Jørgensen et al. (2016), Mackintosh et al. (2019), Masteller, Sirard, and Freedson (2017), and Müller et al. (2018) are among the few to study wearables for children. Tracking children's data and using children-owned wearables is a collaborative process (Kaziunas et al., 2017; Oygür et al., 2020; Pina et al., 2017; Saksono et al., 2020). Parents mostly take the role of "gatekeepers" of their children's data (Mackintosh et al., 2019, p. 2) or practice mediation or co-use (Oygür et al., 2021) when their children own a wearable. The dynamics of mediation practiced via these technologies do not fully overlap with the practices defined by the "parental mediation theory" (Clark, 2011). Most of the parental mediation theory literature explores the parent-child interaction taking place around a single touchpoint of technologies, such as parents helping their children use video games (Jiow et al., 2017), coding kits (Yu et al., 2020), and Internet (Livingstone & Helsper, 2008). However, children-owned wearables involve two touchpoints: an app and a wristband. The use practice of children-owned wearables via multiple touchpoints and multiple categories of users makes them an interesting case to explore as a smart PSS. This will help us better understand how human-centered design can be further developed to incorporate the product culture of the 21st century.

## 3. Method

We designed a study combining two data collection methods: short-term autoethnography and user review analysis. These two methods complement each other to understand emic (through autoethnography) and etic (through user review analysis) perspectives of user experience with children-owned wearables.

Wearables designed for children are a growing market with various technologies addressing safety (e.g., GPS trackers) and health-related concerns (e.g., smart thermometers). We limited our study to the two most prominent technologies in this product category: activity

trackers and smartwatches. For clarity purposes, in this paper, we use the term “product” for the wristband and “app” for the e-service of these smart PSSs.

## *3.1 Autoethnography*

Autoethnography has been encouraged to apply as a self-study research method in design to build empathy and better address user experience issues that can be overlooked otherwise (O’Kane et al., 2013; Xue and Desmet, 2019). While there are criticisms around introspective observation as a research method, previous studies (e.g., Cunningham and Jones, 2005; O’Kane et al., 2013) communicate the value of autoethnography for systems design. Similarly, we utilized autoethnography to better understand the ecological perspective of children-owned wearables.

The first author introduced a Fitbit Ace2 activity tracker for children into their family life. Her daughter, age 7, stopped using the wearable regularly after 29 days, which also naturally ended the autoethnography. The child participant was not encouraged to use the tracker either during the initial introduction or later. Both her parents had activity trackers and smartwatches.

To protect the privacy of the child participant, the researcher primarily focused on her experience with her child’s wearable. The researcher took observational notes and photographs of her child’s interaction with the wearable (e.g., which features was she using the most, did the child understood the data shared by the wearable, did the wearable use brought any behavior change) as well as her interaction (e.g., which information was most valuable, did the wearable use bring any impact to child-parent interaction). The researcher also used the field notes to self-reflect (e.g., how the researcher felt reviewing her child’s data).

Autoethnography helped us better understand the ecological aspect of children-owned wearables. Without this experience, it would have been impossible to understand some of the user reviews. From this perspective, autoethnography provided us with the basis to analyze user reviews.

## *3.2 User review analysis*

Scholars previously communicated the value of user reviews for learning from a wider user group (Caldeira et al., 2017; Epstein et al., 2017; Ghosh et al., 2018). Users share their positive and negative experiences that can lead to product improvements or new product ideas (Korfiatis et al., 2012). This research approach enabled us to learn from the experience of people who had already introduced these technologies into their lives.

For this user review analysis, we scraped data from consumer electronics retailers’ and mobile applications’ websites. We defined consumer electronics retailers from the top 10 lists for sales in North America for the consumer electronics (Shanhong, 2019) and online stores in the electronics and media (Montasell, 2019) in 2018. From this initial retailers’ list, we removed retailers that do not offer activity trackers or smartwatches or did not provide

original user reviews (some copied reviews from other sites). Our final dataset has user reviews from Amazon, BestBuy, Target, and Walmart.

We selected the specific wearables to study based on 1) their popularity, 2) being designed explicitly for children, 3) their ability to track activity, and 4) the wearable system's inclusion of a product and an associated app from the same brand.

We conducted keyword searches with "kid" or "child" combined with "activity tracker" or "smartwatch" on each retailer's website. From the results, we filtered the more popular wearables. We defined popularity similar to other studies (e.g., Caldeira et al., 2017; Epstein et al., 2017; Frie et al., 2017) and made a list of wearables with higher user ratings (≥ 3 stars) and a significant number of user comments (≥ 100 comments). This restriction helped us to exclude wearables that suffer from product malfunction. We reviewed each wearable that showed up after the filter and excluded ones that were not exclusively designed for children. In the final step, we reviewed the associated apps' details on the App Store and Google Play and excluded the wearables that do not have an associated app designed by the same brand.

Our final list included four activity trackers from two brands (Fitbit Ace (FA), Fitbit Ace 2 (FA2), Garmin Vivofit Jr. (GVJ), Garmin Vivofit Jr. 2 (GVJ2)), four smartwatches from three brands (Kurio (K), Kurio 2.0+ (K2), Ojoy (O), TickTalk3 (TT3)), and one design solution which could be classified as either (Joy Octopus Watch v2 (JO2)).

After an initial scan of scraped data, we decided to code the reviews that 1) are in English and 2) have >50 words on consumer electronics retailer websites and >25 words on application retail websites. The word limit difference was decided based on the knowledge that, in general, app reviews are shorter than other reviews (Fu et al., 2013). Filtering based on word counts allowed us to focus on reviews that discussed users' experiences more in-depth than short reactions indicating mere likes or dislikes. A total of 2,560 reviews (1,612 from consumer electronics retailers and 948 from mobile application retailers) were coded.

### *3.3 Data analysis*

The data from autoethnography (field notes and photographs) and user reviews were analyzed using Nvivo 12. One of the authors did all the coding, following Braun and Clarke's Field (2006) thematic analysis procedures. The research team discussed the codes and emergent themes during weekly meetings.

In our findings section, we focus on results from user reviews and introduce data from autoethnography whenever needed. This also reflects the nature of our data analysis. During the analysis, the data from autoethnography helped us better understand the children-owned wearables at the system level, develop an ecological perspective, and contextualize the user reviews. Thus, rather than comparing data from autoethnography and user reviews, we use autoethnography to complement our interpretation of the user reviews.

## 4. Findings

Our analysis indicates two trends for wearable ownership by children. Either the children want and ask for a wearable, or they receive these as gifts, mostly from parents or relatives, which was also how the child participant got introduced to a wearable in the autoethnographic study. On a few occasions, children save money to buy wearables.

Parents accept the eventual smart device ownership of their children as inevitable. They commented on children-owned wearables as introductory tools for their children to be independent and take care of technology:

> "It also serves as an introduction to wearable electronic gadgets, which are, after all, the way of the future… Bottom line, it's something to introduce young'uns to the idea of wearable technology." (K2, Amazon)

> "Overall, this is the perfect solution for those who want to encourage independence in their child but aren't ready for a phone and all the responsibility that entails." (TT3, Amazon)

With the children's wearable ownership, people also introduce different types of interactions into their lives. Our analysis indicates four types of interactions that define the user's experience with wearables (Figure 1). These are the interaction between touchpoints, children's interaction with wearables, parents' interaction with wearables, and users' interaction over wearables. We share our findings under these interaction types.

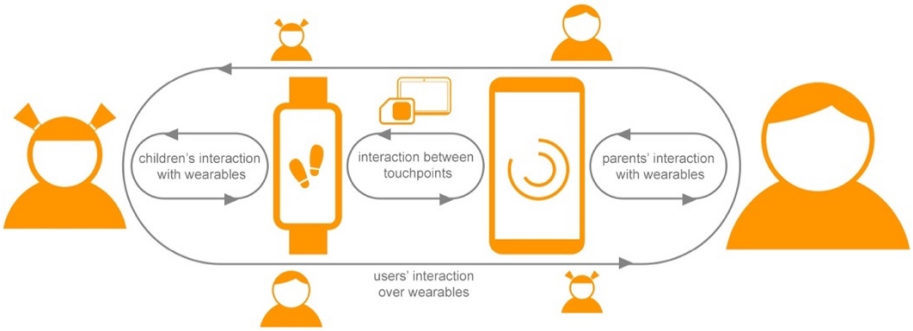


*Figure 1 Types of interactions that define user's experience with wearables.*

### *4.1 Interaction between main touchpoints*

User comments on retailer websites include feedback on the app, whereas the app reviews include comments on the products: "Device itself is fine. App is terrible" (GVJ, Amazon). Comments like this reinforce the understanding that users evaluate wearables as a system. A problem with one of the touchpoints negatively impacts the user experience with all the touchpoints, thus with the smart PSS.

One of the most described issues with children-owned wearables is the product's dependency on the app. Parents' comments indicate that the product is considered the primary touchpoint of this smart PSS and is expected to function fully without the app. However, the user comments show that without the app, the product cannot fulfill all the functions that they are advertised for: "The watches themselves are a great concept and

work well on their own; trouble is, I lose lots of functionality as they're near impossible to use with my phone" (VJ, Google Play).

The product needs to be regularly synced or connected with the app. This is especially valid for the activity trackers and is necessary for two reasons. First, some of the tracked metrics in some designs can only be available on the product after it is synced with the app. For example, the sleep data for FA2 does not appear on the product unless the product is synced with the app: "If I forget to sync hers one day, it doesn't keep up with her sleeping" (FB, Google Play). This was an issue during the autoethnography as well. The researcher needed to sync the wristband with the app so the child could see her sleep data, something she was interested in. Second, most products store tracked data for only a few days and can only show daily data. If users want to see data from previous days or store data history, they need to sync with the app. This historical information is only available from the app.

> "I have major issues with the app. You have to sync it EVERY DAY, or you don't get the information." (GVJ, Amazon)
>
> "… great to track the children's sleep and their activeness but sadly you have to sync this watch nearly every day, can be quite annoying but otherwise great product." (VJ, Google Play)

Furthermore, some functions of the smart PSS are only available through the app, whereas others are only through the product. For example, GVJ and GVJ2 have a game feature that can be activated by achieving a 60-minute daily activity goal tracked by the product. But the game can only be played with the app. The same wearables include a chore feature. The completion of each daily chore can only be marked via the app. The timer feature of all wearables is only on the product, whereas the contact settings for smartwatches can only be managed with the app.

Although the co-dependence of touchpoints is common in smart PSSs in general and wearables in particular, the users' comments indicate that it becomes a challenge when using children-owned wearables. This results from the multi-user nature of these smart PSSs. While the product is worn on the child's wrist, parents' comments show that, in most cases, the app is downloaded on parents' smartphones. Thus, while the child is the product's main user, the app's main user is considered the parent. Because of this main user difference, the co-dependence between the touchpoints can negatively impact users' experience, especially parents.

> "Not a fan of the chore list/rewards. It is more trouble than it is worth. The kids get "coins" when they do chores if I remember to login to the app and mark them as done. Would prefer this function to be redone." (VJ, Google Play)
>
> "If your kid doesn't have their own phone or tablet, don't buy this … we had to constantly open up the FitBit app on my phone so my daughter's FitBit would have the correct time and date." (FA, Amazon)

User reviews also show that the ecosystems for most of the studied wearables are more diverse than the two touchpoints. For example, some smartwatches need a SIM card for the

phone function to work. Others need to be connected to a computer for photographs to be transferred.

### *4.2 Children's interaction with the wearable*

According to parents, children like their wearables. They were reported to enjoy tracking activity, feeling independent, playing games, earning rewards, and competing with parents, siblings, and friends. Children feel like a "grown-up" with owning a wearable: "My son was excited to get this watch because now he can be 'just like dad' with his Apple Watch" (K2, Amazon). This was also apparent in the results of autoethnography. The child participant expressed excitement because of having a gadget like her parents.

In their comments, parents also described occasions when they needed to support their children, especially younger children. Some parents commented on their children, who could not yet read or make sense of large numbers, having trouble getting value from the data reported through the wearable. They questioned the possibility of communicating this information using a strategy other than numbers or percentages. Similarly, during the autoethnography, the researcher observed her child's struggle with making sense of the numbers (e.g., step count). At one point, the child started ignoring numbers and only focused on graphic representations (e.g., closing the ring for step count).

### *4.3 Parents' interaction with the wearable*

Parents reported having a positive experience with tracking their child's data. In the case of smartwatches, parents commented on having "peace of mind" with access to their child's whereabouts through location tracking and being able to contact their child whenever needed. For activity trackers, parents track their child's metrics, such as active minutes and sleep, to make sure they are "maintaining a healthy lifestyle" (VJ, Amazon). Her child's health was also the researcher's primary concern during the autoethnography. She found herself looking at her child's data mostly for times when she could not directly observe her daughter. For example, she checked her child's step counts more for the times she was at school.

In addition to engaging with children's data as app users, some parents are happy about their access to parental controls. Some also like that children have limited access to some settings and even appreciate having more restrictions on specific functions.

> "I have the firewall on the phone switched on so only I can call them and they can call each other but unknown numbers can't get through to them. I don't want strangers calling my kids. No boyfriends or girlfriends yet too till they are out of college (lol!)." (TT3, Amazon)

> "There needs to be a way to lock your child out of getting to the app settings. Within a couple minutes, my son added 12 coins to his profile because he could on his tablet. I don't want to restrict his access to the app because he enjoys looking at his history of activity." (VJ, Google Play)

While parents' reviews indicate that they enjoy having access to their child's data and parental controls, they also commented that the technology could not support multiple users simultaneously. This challenge arose in two cases. Because of some of the apps' designs, tracking more than one child's data could be cumbersome. In other cases, the app does not allow more than one parent to access the same child's data.

> "The app is also annoying to use with two kids. When you want to view each child's steps etc. for the day you have to log out, then log back in with your password to see the other child's stats. Not sure why you cannot just easily go back and forth." (FA, Amazon)

> "First of all, only 1 parent can be the "administrator" on the watch, so only 1 parent can use all the functions. This was a huge problem for our family, because both parents are actively involved with the kids and need to be able to access the full features on any smart watch." (O, Amazon)

## *4.4 Users' interaction over wearables*

Most user reviews explain that wearable ownership is a family trend. Children who ask for a wearable mostly have at least one other family member (parents or siblings) using a wearable. As these technologies are considered for private use, they are bought for every child in a family. Thus, in general, there are multiple people using wearables in each household.

> "This year my daughter is getting one and joining the wearable step tracker club!" (GVJ, Amazon)

> "Watch looks great and the kids have fun using it and inevitable fight over it sometimes. Did have to buy a second one as it was a huge success." (K2, Amazon)

Wearable ownership being a family trend seems to enable new types of family interactions. In the case of activity trackers, one of the most described interactions takes place in the form of family challenges. Family members compare their daily step counts or active minutes. This was also introduced during the autoethnographic study. Family members competed and compared their step counts. A few times, the child participant ran inside the house to beat her parents. Some users considered this "healthy competition" (GVJ, BestBuy) and encouraged it.

> "… my oldest (8) loved it so much we got one for my 3-year-old and now every night it's a contest on who got the most coins for chores done and who has the most steps!" (GVJ, Amazon)

> "The whole family is on the Garmin ecosystem and we have so much fun competing with each other." (VJ, Google Play)

The type of family interaction via smartwatches is different from activity trackers. Children and parents use smartwatches more for calling, texting, and sending voice and video messages to each other. This interaction can occur between child-parent, child-friend, child-sibling, and child-relative dyads: "The more kids that have the same watch, the more interactive they can be with their friends" (K, Walmart).

Either for family challenges or communication, interaction via wearables is desired. Being connected via wearables is considered fun and motivates the continuous use of these technologies. However, users' reviews include several comments about these smart PSSs' inability to support the desired multi-user interaction: "… you can only be connected to one person at a time for texts and calls and it is difficult for my 7-year-old son to figure out how to disconnect from one person and connect to another" (K2, Amazon).

The interaction via wearables is further interrupted in three of the studied smartwatches (i.e., K, K2, TT3). These wearables require the interacting parties to be in the Bluetooth range. This restriction negatively impacts the interaction between multiple users, which is one of the main motivations for owning a smartwatch.

Another repeatably explained concern affecting the interaction via wearables is the wearables' inability to interact with different ecosystems. Manufacturers purposefully limit the interaction among wearables to the options that they have in their portfolio. The inability of a child's wearable to connect with a wearable from another brand limits the interaction between wearable users: "I just wish my Fitbit could be synced to do some challenges with her" (VJ, AppStore).

## 5. Discussion

Our findings support previous studies (Gram-Hansen, 2019; Jørgensen et al., 2016; Mackintosh et al., 2019; Müller et al., 2018) by further communicating the use practice of children-owned wearables. Adult wearables are structured around individual use and self-tracking, where a single person interacts with multiple touchpoints in a system. In the case of children-owned wearables, while one touchpoint (i.e., wristband) is used by children only, the second touchpoint (i.e., app) is frequently installed on parents' smartphones. Thus, both children and parents can be active end-users of these technologies, each having a different point of interaction with the system. Children find wearables fun. They review their activities via their wristbands. Parents, as the primary end-user of the app, enjoy tracking their children's data and monitoring their children's safety and whereabouts. From this perspective, each touchpoint can be interpreted to address a different end-user category (i.e., child and parent), as illustrated in Figure 2.

*Figure 2 Parent as end-user.*

However, our findings also indicate more intricate interactions among users and with touchpoints. Some of these interactions result from the children's pain points using the wearables, whereas others result from parents' needs and wants.

Because of the wearables' design as a system, children either require their parents' help or the app to use the wearables effectively. The wristbands depend on apps for various reasons, including storing historical data and marking completed chores. This requires the wristband to be regularly synced with the app, which parents typically do for their children (except when the app is available on a child's smart device). On other occasions, children want to use their parents' smartphones to access features unavailable on the wristband, such as the games in GVJ and GVJ2. It is expected that the touchpoints of a smart PSS complement each other rather than being redundant. However, this complimentary nature does not reflect the multi-user practice of these smart PSSs, as some parents explicitly commented that they did not like to share their smartphones with their children.

Beyond the children's needs from their parents or their parents' smartphones for a better wearable experience, our findings also indicate some parents' desire to control their children's interaction with the wearable. For example, some parents like parental control features, such as managing children's contact lists. This aligns with parents being "gatekeepers to" (Mackintosh et al., 2019, p. 2) their child's data and wearable experience.

These interactions among users and with touchpoints can be interpreted differently based on each user category. From children's perspective, these smart PSSs are structured around their limited agency. The product's dependency on the app results in children's dependency on parents. This causes parents to gain two distinct roles in the use practice of this smart PSS. While they are end-users from one perspective, as illustrated in Figure 2, they are mediators between the app and the children from the other perspective (Figure 3). The role of a mediator here differs from the parental mediation practiced with technologies, such as video games (Jiow et al., 2017) or the Internet (Livingstone & Helsper, 2008), in which parents and children mostly interact with a single touchpoint (e.g., video game). For children-owned wearables, parents mediate the wristband-app or children-app interactions to help children better use the wearables.

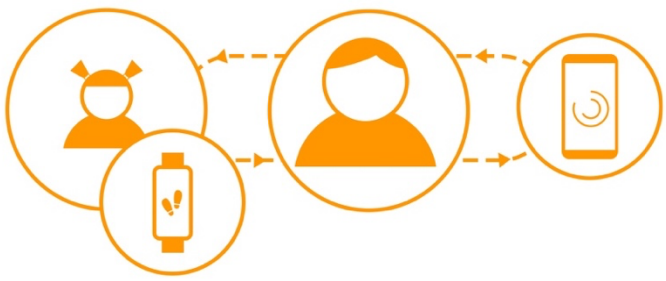

*Figure 3 Parent as mediator during the use of children-owned wearables.*

While technology's role as a mediator in systems is known (Secomandi, 2012), the user's role as a mediator is less explored from the design perspective. Studies looking into user experience mainly consider people as the end-user (Karapanos, 2013; Valencia Cardona,

2017), ignoring the additional roles possibly taken by users. Findings from our study indicate that parents shift between end-users and mediating users during the use practice of children-owned wearables. Their role as the mediator mainly results from the "customer-intensive process" (Pinhanez, 2009) nature of services. Parents support the delivery of e-services to their children. However, the nature of the customer-intensive process is different for children-owned wearables. With this technology, parents do not take part in producing a service that is necessarily for themselves but for their children. They support the e-service delivery for their children. Thus, they become service providers for other users.

This parental involvement process also results in a different type of co-experience than what Battarbee and Koskinen (2005) explained. In this case, experiences are not defined based on togetherness and the interaction of multiple people over multiple interactive devices/systems. The experience of children-owned wearables is structured around the direct involvement of parents and children over a single system. Therefore, one's negative experience with the system can affect other user's experience more directly. For example, when the wristband is not synced with the app, it can still be used by a child but with limited functionality.

Our findings also indicate that the co-experience via children-owned wearables is not limited to parent-child interaction. User reviews show that children were introduced to wearables by seeing those used by their parents. Thus, parents' product milieu has a direct impact on children. Some parents described or contemplated buying a children-owned wearable for each child in a family. The ownership of wearables as a family provides opportunities for social interaction via these technologies. Parents commented on having family challenges. Family members contact each other via smartwatches for fun. This interaction over children-owned wearables even extends beyond family. Children want to contact their friends and extended family via wearables. These findings support Karapanos's (2013) comment on the mediating role of interactive technologies for increased social interaction.

Even though users' comments show the potential benefit of social interaction via children-owned wearables, they also highlight users' struggle to facilitate this interaction digitally. Ownership of wearables from different brands in a family restrains the possibility of setting daily family challenges digitally over the wearables. Instead, users manually compare their step counts through physical data exchange at the end of the day. This limited the proposed value-in-use with wearables.

## 6. Conclusion

Our study on the user's experience with children-owned wearables extends the theoretical understanding of human-centered design and service design. We depict the significance of considering multiple and shifting user roles and users as service providers during the use practice of smart PSSs. Human-centered design and service design literature mostly approach technology as the mediator in a system (Secomandi, 2012) with users serving single roles (e.g., end-users, stakeholders). Service design literature differentiates between

end-users and service providers (Prahalad & Ramaswamy, 2004; Sandström et al., 2008). However, our study shows that, during the use practice of children-owned wearables, parents do not only take the role of end-users. Parents take on multiple roles. They shift between being end-users and mediating users in the system. As mediating users, parents become service providers for their children. Parents' roles as service providers bring a unique dynamic to the use practice of these smart PSSs. Users' experience with children-owned wearables indicates the need to consider multiple and shifting user roles as well as users in mediating roles while designing smart PSSs. These insights communicate opportunities for designing children-owned wearables and ways to expand human-centered design and service design literature further.

While user reviews provide detailed information on user experience, they also present some challenges. There is a tendency for users to share extreme viewpoints more on user reviews (Hu et al., 2009). This might have an impact on studies that analyze user reviews. To overcome this, we aimed to learn from users' experiences rather than their likes and dislikes. We focused on their stories and tried to uncover aspects of use practice.

The user reviews available through retailer websites are primarily written by the people who purchased the product or downloaded the app, in this case, mostly parents. For this reason, our findings are limited to parents' comments regarding their child's experience. While the parents are the gatekeepers of their child's digital interactions (Mackintosh et al., 2019), their perspective might differ from their child's. Even though we tried to balance this shortcoming with autoethnography, we see the representativeness of children's exact experience with the wearables as a limitation of our study.

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## About the Authors:

**Isil Oygur** is an Assistant Professor of Industrial Design at the University of Cincinnati. She holds a Ph.D. from Washington State University and has experience learning with and from people and developing physical and digital interactions for health and wellbeing.

**Yunan Chen** is a professor of Informatics at the University of California, Irvine. Her research interests lie at the intersection of human–computer interaction (HCI), computer supported cooperative work (CSCW), and health informatics.

**Daniel A. Epstein** is an Assistant Professor in Informatics at UC Irvine. He examines how personal tracking technology can acknowledge and account for the realities of everyday life, designing new technology and studying people's use of current technology.