

# Parenting with Alexa: Exploring the Introduction of Smart Speakers on Family Dynamics

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## ABSTRACT

Smart speakers have become pervasive in family homes, creating the potential for these devices to influence parent-child dynamics and parenting behaviors. We investigate the impact of introducing a smart speaker to 10 families with children, over four weeks. We use pre- and post- deployment interviews with the whole family and in-home audio capture of parent-child interactions with the smart speaker for our analysis. Despite the smart speaker causing occasional conflict in the home, we observed that parents leveraged the smart speaker to further parenting goals. We found three forms of influence the smart speaker has on family dynamics: 1) fostering communication, 2) disrupting access, and 3) augmenting parenting. All of these influences arise from a communally accessible, stand-alone voice interface which democratizes family access to technology. We discuss design implications in furthering parenting practices and behaviors as the capabilities of the technology continue to improve.

## Author Keywords

Voice interfaces; Smart speakers; Parenting; Parental Mediation; Child development; Families

## CSS Concepts

• **Human-centered computing~Human computer interaction (HCI)**; ~Empirical studies in HCI

## INTRODUCTION

With the prolific adoption and marketing of smart speakers, many experts, parents, and the mainstream press have questioned the impact of the technology on children and their development e.g. [1,10,14,25,37,42]. Yet, empirical research on the effects of smart speakers on children's development and on child-parent dynamics is sparse. Initial research regarding family interactions with smart speakers in the home have

shown that families collaborate to use the smart speaker, particularly during communication breakdowns, and that existing social dynamics of the household are reflected in family interactions with the smart speaker [3,31].

However, little empirical research has investigated the impact of smart speakers on the parent-child dynamic in the home, particularly with children of a variety of ages. Even less attention has been given to how (and if) parents utilize, restrict, or collaborate with smart speakers to promote parenting goals. We seek to shed light on how parents actively use smart speakers in everyday life, over time. We provided 10 diverse families with an Amazon Echo Dot to use in their homes for one month. All families had children in their homes. We audio captured family interactions with the Echo Dot throughout the month and also conducted whole family interviews, both prior to the family obtaining the Echo Dot and after they had used the Echo Dot in their home for one month. Using an inductive analysis approach, we found that the Echo Dot was used by parents as a tool to complement and promote their parenting practices.

This paper provides data demonstrating how smart speakers in the family home can support parenting goals and behaviors. We find the communally accessible nature of smart speakers democratizes technology access in the home. As a result, smart speakers can foster family communication and augment parenting practices. However, we also find that smart speakers can be used by both children and parents to regulate and disrupt each other's communication and access to the device. We suggest that designers of home-based voice interfaces have the opportunity to support existing parenting practices and to expand the capabilities of voice interfaces to further complement parenting goals.

## RELATED WORK

There are two broad areas where we discuss related, prior literature and theoretical constructs: 1) voice user interfaces and families, and 2) technology and parenting.

## Voice User Interfaces and Families

A number of excellent studies have explored voice user interfaces in the home, using diary studies [26], history logs [4], and interviews [36]. While there are also a number of

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studies which explore children's interactions with a variety of voice interfaces [11,16,29,41,48], we are interested in the parent-child dynamics involved with voice-interfaces, and the impacts on child behaviors in the home. Our literature review discusses works related to those themes.

#### *Voice User Interfaces and Ease of Access*

One of the first studies to investigate the impact of voice user interfaces on family dynamics was Porcheron et al.'s study with five families using the Amazon Echo [31]. Despite family members having equal access to the device, the researchers found that the voice interface becomes embedded within the social order and communication interactions of the family, which in turn, regulates access. In earlier work involving adults interacting with a voice interface on a phone, Porcheron et al. refers to the nature of voice interfaces as having a democratizing effect in which any member of the group engages with the device without invitation [32]. While these two studies allude to possible effects on parent-child dynamics in the family home, we do not yet fully understand the ramifications of home-based voice interfaces on parenting practices, particularly with children of a variety of ages.

#### *Voice User Interfaces and Children*

Prior work has shown opportunities for voice interfaces to engage children in learning activities and social play (e.g. [16,27,30,43]). In participatory design sessions, Pantoja et al. found that children like incorporating voice interfaces in social play and that voice interfaces can keep children engaged by redirecting their attention and giving positive feedback [30]. Lovato et al. found that the ability of voice interfaces to interpret natural languages lowers the barriers that children might face when information-seeking on visual interfaces [27]. However, limitations of these voice interfaces can also create challenges for children. Children and voice interfaces sometimes struggle to interpret the other's comments, either because of complexity, grammar, interrupted turn taking, or manner of speech [27,30,33,43]. During these times, parents and children may need to collaborate to successfully interact with voice interfaces [3,31]. Yet, aside from parent-child collaboration to improve communication with voice interfaces, we do not yet understand how voice interfaces impact parenting practices or the parent-child dynamic.

#### **Technology and Parenting**

HCI has a long history of exploring the impacts technology has on family life and parent-child dynamics. We discuss two frameworks used to explore technology, parent-child dynamics, and parenting practices.

#### *Joint Media Engagement*

The way parents use technology together with their children can promote learning through joint engagement [40]. For example, by watching videos and discussing them together with their parents, preschoolers are more likely to extract social and emotional lessons from the content [35] and increase general understanding [17]. By watching television [5] or playing video games together [39], families bond and generate shared experiences that take on meaning which

transcends the interaction with the technology itself. The concept of Joint Media Engagement (JME) includes these broad types of collaboration with digital media, and does not restrict family technology interactions to specific educational technologies [18]. In fact, parents can take on a variety of learning roles when jointly exploring a variety of new media with their children [2]. We are inspired by JME as a mechanism by which technology can be used to enhance parent-child relationships, and we intend to explore how (and if) parent-child dynamics are enhanced through the relatively new media of voice interface technologies.

#### *Parental Mediation Theory*

Parental mediation refers to the strategies that parents utilize to mitigate the potential harms and take advantage of the benefits of media and technology on children [38,49]. Emerging from children's television viewing, parental mediation theory defines parental interventions around media and technology as restrictive, active, and co-usage [12,13].

In 2011, Clark called for an update to parental mediation theory to include participatory learning in which parents and children interact together through digital media [12]. Clark described how parental mediation of technology used by children can foster cognitive development, creativity, and strengthen relationships. Since then, parental mediation theory has been applied to a variety of technologies, including video games [24] and mobile games [39].

In 2016, Jiow and colleagues argued that the notion of restrictive, active, and co-usage are limited constructs for modern, interactive digital media such as video games [24]. Instead, the researchers assert that parental mediation theory of restrictive, active, and co-usage are a spectrum involving gatekeeping (regulating technology usage), discursive (discussions between parent-child), investigative (parental information seeking and skill acquisition), and diversionary (parental active effort to direct children away from technology) activities. The authors found parents use multiple mediation strategies concurrently and they also suggest that their revised framework of parental mediation theory be tested with other new and emerging media.

As digital platforms become more complex and interactive, we want to better understand how these technologies impact and fit into existing parent-child paradigms. In contrast to prior work, our study specifically seeks to understand how communally accessible voice interface technology effects the parent-child dynamic using an in-the-wild study in the home environment. We focus on the introduction of smart speaker technology to the whole-family and discuss parenting dynamics and how parental mediation theory fits within the paradigm of home based voice interfaces

#### **METHODS**

This paper deeply analyzes the collaborative parenting behaviors between parents, their children, and the Echo Dot. As part of a larger study, we recruited 10 families in an urban area of the United States who identified having a total

household income at or below the median household income for their geographic area. These families would not be considered “early adopters” of technology but were families who expressed interest in smart speaker technology. In recruiting these families, the research team sought to better understand diverse households with children and how families’ use of home-based voice interface technology impacted families. None of the participant families had owned a smart speaker prior to the study. Families were diverse in nature, including families of two (parent-child) up to families of five (grandparent(s)-parents-children). Two families were bilingual, speaking both Spanish and English in the home. Some families had stay at home parents or grandparents, some families had one parent who worked night shifts, and some families had both parents working. Specific participant demographics are listed in Table 1.

**Table 1. Demographics of Participant Families**

Fam. ID	N	Adult N	Adult ages	Child ages	Ethnicity
A	4	3	41-68+	13	Asian
B	4	3	18-55	12	White/Asian
C	2	1	41-55	9	White
D	4	2	26-55	3, 5	Hispanic
E	5	3	26-67	4, 8	White
F	5	3	18-55	<1, 5	Hispanic
G	3	1	26-40	10, 16	African American/ White
H	2	1	41-55	9	White
I	5	2	26-40	2, 4, 6	White
J	2	1	18-25	4	White

We used a website and fliers distributed to community centers, local colleges and universities, libraries, and workplaces to recruit families. The research study began with an in-home, whole family interview, in which children and adults were interviewed as a group. Using a semi-structured interview protocol, researchers asked families about their familiarity with smart speakers, how they learn about technology, and how they anticipated using the Amazon Echo Dot. Researchers directly encouraged children to respond to questions as well as adults. We encouraged families to setup the Echo Dot in an area of their home where all family members would be able to access the device.

We asked families to place a Samsung tablet computer next to their Echo Dot, which recorded a total of 4 minutes of audio when triggered by the word “Alexa,” using Anchored Audio Sampling [21]. Families had the option to delete the last 10 minutes of audio capture by utilizing a “delete” button. Families were also able to “record a thought” with another on-screen button, that provided the participant with an audio-diary format to record thoughts they wanted to share about their use of the Echo Dot.

Upon completion of the four-week audio capture, we interviewed families a second time in their homes, with both children and adults present as a group during the interview. Using a semi-structured interview protocol, we asked about their experiences using the Echo Dot in their home. Families were compensated with a total of \$100 in gift cards and with the Echo Dot. Our study was approved by our Institutional Review Board and family members provided consent or assent to participate in the study

### Analysis

Our analysis focused on the parent-child dynamic related to the Echo Dot. We began analysis with open coding of our audio capture data, during which three of the authors began coding and memoing any items related to parenting [7,9,19,20]. In the next phase of analysis, one researcher re-coded all 10 families’ audio capture excerpts, refining the coding structure through constant comparison of the data. A codebook was developed collaboratively between two researchers, reconciling, comparing, contrasting, and expanding codes found both in the audio capture and in the exit interview transcripts and notes. To strengthen the coding analysis, a fourth researcher independently coded and memoed a randomly selected 25% of the audio capture with the established codebook, with the intention of diversifying perspectives to broaden and strengthen the codes [8,9]. The final stage of analysis involved another review of audio capture data in constant comparison [9,20] with the interview data. We focused recurring codes using thematic analysis [6], which broadened into four themes: Fostering Communication, Disrupting Access, Augmenting Parenting, and Democratizing Technology Access (see supplemental material). As a non-purposive, exploratory study, we do not provide counts of incidence in our findings [8].

### FINDINGS

Our findings revealed broad themes on use of the Echo Dot in the parent-child dynamic at home: 1) Fostering Communication, 2) Disrupting Access, and 3) Augmenting Parenting. These themes are impacted by the dedicated, home-based voice interface technology modality, which results in a final theme: 4) Democratizing Technology Access.

#### Fostering Communication

The nature of voice user interfaces naturally promotes verbal communication. Our findings revealed that, within the parent-child dynamic, smart speakers promoted communication skills in a variety of ways. We break down the theme of “fostering communication” into two categories: 1) speech and language practice, and 2) expanding communication skills. Within these two categories we find that communication between parent and child is often fostered through the child’s interactions with the Echo Dot.

#### Speech and Language Practice

Speaking to the Echo Dot was a forcing function for children and parents to reflect on their communication skills. Both interview data and audio capture indicate that parents directly encouraged children to modify their speech and language

skills to be better understood by the Echo Dot. For example, audio capture from Family E highlights how the parent used the child's (age 8) interaction with the Echo Dot as an opportunity to explain how the child's use of language (in this case a double negative) was confusing:

(Child): Alexa, make sure not ... to remind me not to mop the floor at three o'clock PM

(Alexa): When should I remind you?

(Child): No.

(Adult): You're asking her to do a double negative.

Similarly, we see the parent in Family J explain to their child (age 4) why the Echo Dot did not respond, which encouraged the child to modify their speech production:

(Child): Alexa, tell me a joke [using a goofy tone]

(Parent): I don't think she understood you that time.

(Child): [enunciated clearly] Alexa, tell me a joke.

We see how parents are jointly engaged with their children in improving their children's ability to be understood by the Echo Dot. Not only do we find instances of speech and language practice with multiple families (Families J, E, D, G), parents also discussed the phenomenon during exit interviews. The parent in Family E described, "[child] *will be really vague...and I'm like, you need to be specific...we have to be specific with the information we're asking....this has been an ongoing conversation before Alexa.*" Having the Echo Dot as a communication partner in the home provides additional opportunities for parents to provide cues to their children on how to improve their speech and language skills, based on their observations of their children's interactions with Alexa.

#### *Expanding Communication Skills*

The Echo Dot also provided opportunities for children to expand and develop their communication skills. Specifically, we see interactions with the Echo Dot lead to learning new words, learning active listening skills, and expanding social niceties, often facilitated with parental support.

Children in three families attempted to learn and practice another language with the Echo Dot. Family A discussed how their child (age 13) was learning Mandarin in school, and they had hoped that their child could use the Echo Dot to practice and learn Mandarin. However, they were disappointed to discover that functionality was unavailable. Whereas Family A, Family J, and Family E discovered the Echo Dot could communicate basic words in other languages. For example, the child (age 8) in Family E asked:

(Child): Alexa, how do you say banana in French?

(Alexa): Banana in French is banane [spoken in French]

....

(Child): Alexa? How do you say Bonjour in French?

(Grandma): That is – 'bon jour' is French.

(Alexa): Bon jour in French is [with French accent] 'Bon Jour.'

In these examples, the child attempted to engage the Echo Dot in exploring another language. We see how the Grandma engaged in the discussion as well, increasing the child's understanding of language ("*bon jour is French*"). The parent of Family D also jointly engaged with their child in expanding their communication skills: "*Because we're raising them bilingual, we try to speak a little bit more Spanish when counting numbers. That was one thing that we did have fun with, we'd ask Alexa to count to thirty with [child].*" Here, the combination of children engaging with the Echo Dot while an adult or parent are present furthers learning about language and expands their skills.

Parents also used their children's interactions with the Echo Dot as a method of expanding their social communication. The parent of Family E describes how they used their child's engagement with the game, Panda Rescue (played on the Echo Dot), as a teachable moment to work on his active listening skills:

I had to explain to him [child], 'You have to listen to everything that it's telling you. It's teaching you. The answers that you're getting wrong it's because the information you didn't listen to it.' ... And so he's finding more success because he's already heard the information once but he's also trying to really focus on listening.

We see that the child's engagement with the Echo Dot, and the parent's encouragement to practice active listening skills within the context of the game provided the child with opportunities to expand their communication skills.

The parent in Family H also used their child's (age 9) interactions with the Echo Dot as teachable moments for social communication skills:

(Mom): So if you want to set a timer for 5 minutes, you can say

(Child): [interrupts] Alexa, set the timer for 5 minutes....Just wanna practice...

(Alexa): 5 minutes, starting now.

(Mom): You gotta use your manners... Hear me out, you have to use your manners, or she goes. OK? It is not OK to bark your communications like anybody. It's a bad habit to get into. OK? Yes? All right, so, say thank you.

(Child): Alexa, thank you. Alexa, please stop.

In contrast to previous examples, Family H's emphasis on using manners with the Echo Dot are not reinforced by the Echo Dot itself. In earlier examples in which children are unsuccessful with their communication with the Echo Dot, their parents' directions to focus on their communication skills result in increased success in using the Echo Dot. However, at the time of this study, adding "thank you" and "please" did not increase success with interactions with the Echo Dot. Using manners was a communication requirement created by the parent, rather than one directly influenced by the Echo Dot's capabilities.

Overall, we see that when parents heard their children interacting with the Echo Dot, they capitalized on opportunities to improve their children's communication skills, often through directly instructing their child, and occasionally using built-in features, such as games.

### Disrupting Access

In contrast to the previous theme of "Fostering Communication," we also found that families disrupted each other's communication with the Echo Dot, which ultimately led to disrupted access. We find two sub-themes: 1) Communication Interruptions, and 2) Regulating Use.

#### Communication Interruptions

Not all forms of communication between families and the Echo Dot took a positive form. Communication interruptions were found in both the audio capture and described by families during interviews. During these times, family members undermined and interrupted one another's use of the Echo Dot. These interruptions took two forms, which we call instrumental and subversive. Instrumental interruptions served to enable a family member to take control of the Echo Dot. In these instances, family members wrestled for control because they wanted access to the device as an end-goal in its own right. For example, the youngest child (age 4) and a parent in Family E engaged in the following interaction around the Echo Dot:

*(music playing)*

(Child): Alexa [*pause*] Alexa, stop the song.

*(music stops)*

(Dad) Why?

(Child): Because I don't want any music.

(Dad): Why?

(Child): Because I just—

(Dad): Alexa, resume music.

(Child): [*almost whispering*] She'll never give you the music, she'll never—

(Dad): Alexa [*pause*] resume music.

*(music resumes)*

(Dad): Boom! . . . No...stop!

(Child): Change to a different song!

In this interaction, the child interrupts the Echo Dot and the father interrupts the child's interruptions. These acts serve to shift control of the device from one family member to another. Consistent with prior work, our findings of instrumental disruptions reflect the existing social hierarchy of the home [31], with parents' interests dominating those of children.

In contrast, subversive interruptions served as a means of teasing, annoying, or controlling other family members, with changes to the behavior of the Echo Dot as a means rather than an end. For example, we see the following exchange in Family I (children ages 2, 4, and 6):

(Dad): Alexa, make volume 4.

(Child): (*giggling*) Alexa, make volume 50.

(Alexa): *Sorry, we can only set the volume between 0 and 10.*

In this excerpt, the child giggles while giving contradictory instructions to the Echo Dot, suggesting this act of defiance is playful. The interaction is brief, and qualitatively sounds like gentle teasing. The child's enjoyment of the interruption itself suggests he was less preoccupied with controlling the volume and more interested in provoking his Dad.

Yet, subversive interruptions were not always playful. In other instances, family members leveraged the Echo Dot as a tool to irritate or stymie one another, leading to tension or conflict, as in the example below from Family G (children 10, 16):

(Mom): Alexa, tell me a good story.

(Child): Alexa, stop (*child laughs*).

(Mom): [Child's name]! Why'd you do that? Hey, don't do that anymore.

(Child): Alexa, go die in a hole.

(Mom): Stop it.

(Child): Ok.

(Mom): Alexa, tell me a scary story.

In many ways, this interruption is similar to the instrumental one enacted by Family E. Yet, these two examples take different tones. In the first, the child explicitly says, "*I don't want any music*," justifying her interruption, given that she knows it goes against her father's interests. In the second family's interaction, the child makes no mention of his own desires with respect to the activity, laughs at his mother's frustration, and ultimately agrees to stop without stating one way or another whether he minds the story, appearing to take interest only in how he affects his mother.

During exit interviews, families discussed communication interruptions using the Echo Dot as part of typical family life. Family G explained, "*I mean, that's kind of the old argument between parent and child, you know? Not liking the music they play or whatever.*" Family E (children 4, 8) discussed an ongoing form of interruption during their month-long deployment, also over music:

(Child): And then when she's out of the house and she turns on Spotify to listen to music, I just randomly tell Alexa to play Ghostbusters in her room.

(Researcher): Wait, so you were interrupting her time listening to music?

(Parent): Oh, yeah.

(Child): Yes, I irritate my parents.

Family I also experienced communication interruptions, both between siblings and between parents and children. During their exit interview, one child (age 6) said "[sibling's name] *would interrupt the animal quiz* [their favorite Alexa skill] .... *I don't know, he [sibling] wanted to do something else.*" As described by Family G, communication interruptions involving family members and the Echo Dot appear to be an extension of typical family communication engagements. The use of the Echo Dot adds a new tool with which family

members can interrupt and disrupt other family members, either to purposefully annoy and irritate or to compete over control of the Echo Dot's functionality.

### *Regulating Use*

Parents and children regulated use of the Echo Dot in different forms. Parents occasionally limited children's use of the Echo Dot, either as an entire entity or specific regulation of certain functions. Children also regulated their own use by asking permission to use the Echo Dot. Perhaps the more expected form of regulating use was when adults curtailed their children's use of the Echo Dot, such as with Family E, "*Mom says no Alexa. [Child's name], no Alexa. At least for half an hour...*" In addition, Families G, I and J experienced instances when adults had to limit children's use of the Echo Dot because they were trying to watch TV in the same room: "*We don't need music playing while we are watching TV*" (Family I), "*We are watching the show. One joke, then we are done.*" (Family J), and "*No [child's name], I'm watching this!*" (Family G). In essence, this form of regulating use was essentially due to competing media or competing interests in a shared physical space.

In other cases of parents regulating use, parents focused on specific features or capabilities of the Echo Dot. In their exit interview, the parents in Family I described how they tried the Echo Dot's calling feature with their children, to call their Grandmother, who also owns an Echo. "*They [kids] loved it, and then they kept trying to do it. We had to say 'no.'*" In this case, the parents were concerned that the children would keep calling their Grandmother constantly, and as a result, the parents had to limit their children's use, despite one parent saying, "*I like them being able to do that [make calls], if they needed help.*"

For Family I, the feature they wanted for their children (the ability to make calls with the Echo), ultimately lead to problems with the children's ability to regulate their use of the feature. As a result, the parents had to discontinue the feature, despite wanting the feature as an option for the children to use for emergencies.

A less frequent, but interesting form of regulating use came from children asking adults for permission or assistance in using the Echo Dot. This occurred with both younger and older children. For example, the child in Family B (age 12) asked: "*Can I see if the Alexa will work with 'In the Heights'?*" and waited for a parent's permission before attempting to engage the Echo Dot. The same event happened with the child in Family J (age 4), "*Can I tell...Can I ask Alexa to tell me a joke?*" and we also found the same occurrence with the child in Family F (age 5), "*Can I mess with the Alexa?*" In all of these instances, audio capture indicated that the child asking for permission to engage with the Echo Dot occurred infrequently in comparison with the number of times children from these families engaged with the Echo Dot without permission. Yet we provide these examples to demonstrate that regulating use is not always instigated by

the parents, and that, at times, children regulate their own use by asking permission to engage with the Echo Dot.

Although we saw instances in which parents limited their child's use of the Echo Dot, the parents in Family E explained that they felt differently about regulating their child's use of the Echo Dot compared with regulating screen-based technologies:

And I thought it was really great for him, he's only done Panda Rescue...its really forcing him to auditorily learn, right? Because there's no screen...so we try to make sure they [children] don't have too much electronics time throughout the day... he wasn't sitting in front of a TV just staring at something. He was having to actually use his brain to listen and retain information.

The family goes on to think of how they might handle use of the Echo Dot in the future, as the family explores more skills and games:

I think if we start introducing more of those skills that we might have to say there are certain times you can use Alexa or you can earn times to use Alexa, but I didn't care as much with Panda Rescue because he was learning things. Sure, knowledge about Pandas is not going to necessarily help him in life, but it's still something versus just staring at a screen...it just doesn't seem as mindless.

We see that with Family E, there is a correlation between the modality of the media and their perception of the need to regulate use. The fact that the Panda Rescue skill is seen as fostering communication through expanding communication skills (as described in our earlier theme) influenced the parents' decisions regarding regulating use.

### **Augmenting Parenting**

During the month-long deployment, parents found opportunities to use the Echo Dot as a way to augment their parenting practices. We describe three ways of augmenting parenting with the Echo Dot: 1) leveraging the Echo Dot as a neutral third-party mediator, 2) utilizing the Echo Dot as a complement to parenting tasks, and 3) using the Echo Dot to increase their child's autonomy.

*Leveraging the Echo Dot as a Neutral Third-Party Mediator*  
Both parents and children used the Echo Dot as a neutral third-party mediator for managing behavior. We derived the name of this theme from an exit interview with Family I, when the parent said "*I would use my iPhone [for timers with the kids], but it was nice with Alexa. Seems more neutral.*" Our findings show how many parents and children viewed the Echo Dot as a neutral third-party mediator. For example, audio capture shows how the child in Family C (age 9) turned to the Echo Dot as a tool to help with decision making:

(Child): Alexa, how long would it take to get to [city name] from here?

(Alexa): Based on current traffic, it'll take about 44 minutes to drive to [city name].

...

(Child): Alexa, pick a number between 3 and 5.

(Alexa): Your random number between 3 and 5 is 5.

(Child): That's the time that we're leaving.

In this case, the child is treating the Echo Dot as a neutral third-party to help with a decision. Parents also used the Echo Dot as a neutral third-party, doing so to further their own parenting goals. During exit interviews, parents discussed how they used the Echo Dot as a tool for mediating choices and decisions, particularly during contentious times with children. For example, the parent in Family F said, "*Once I tricked [child] and I had the machine talk and you know tell him that in a couple minutes it was bedtime. So he had to pick up his toys...*" The parent clarified that they had surreptitiously set the timer with the app on their phone so the children would perceive the timer being generated by Alexa, rather than the parent. "*Yeah, I set it up on my phone. And so I was able to do it on my phone and then a couple minutes later it'd [Alexa] talk. And so he was like uh...He kind of just froze.*" During their exit interview, Family I discussed using the timer feature to signal when their children should trade toys because Alexa signaling time to trade toys seemed more neutral than using the timer on the parent's phone.

Unlike the earlier example from Family C, when the child purposefully engaged the Echo Dot as a neutral third-party mediator, parents' use of the Echo Dot as a third-party mediator had a different tone. Instances where parents and grandparents discussed using the Echo Dot as a neutral third-party mediator were intended as more surreptitious methods for establishing household rules and/or parenting goals. The grandparent in Family E explained:

It would be interesting if we programmed things on the calendar like...it's time to put your shoes on. Hearing it from Alexa, yes. Because I think it's [children] tone deaf with us and I think if the Alexa was giving him that instruction, he might pay more attention. It would be interesting to see.

When parents and grandparents discussed using the Echo Dot as a third-party mediator, we see that they are capitalizing on the apparent neutrality of the Echo Dot. Unlike using a kitchen timer or the timer on a phone, parents indicated that there was something about the use of the Echo Dot ("Alexa") as a third-party mediator which differentiated it from other technologies which might perform similar functions at a basic level.

#### *Utilizing the Echo Dot as a Complement to Parenting Tasks*

We also observed that parents utilized the Echo Dot as an extension of their parenting tasks. These tasks range from asking Alexa to play lullabies, sing songs, help with routines, set a timer for time outs, or tell stories to their children, rather than performing those tasks themselves.

The most apparent form of augmented parenting was when parents used the Echo Dot to perform a function to interact with their child. For example, the parent in Family H

specifically asked the Echo Dot to perform functions for her child (age 9):

(Mom): Alexa, can you sing [Son's name] a song?

(Alexa): Sorry, I don't know that.

(Mom): Alexa, will you tell [Son's name] a joke?

(Alexa): (no response)

(Mom): Alexa, please tell us a joke.

Here we see that when parents attempted to engage the Echo Dot in parenting tasks that are customized to their child, the Echo Dot was often unable to perform those tasks successfully. The parent in Family D reported a similar experience, when, after downloading the "happy birthday" song skill for their child's birthday, the Echo Dot could not understand how to pronounce their child's name. The parent in Family D also reported that they attempted to have the Echo Dot tell bedtime stories, but that the lack of visuals and familiar stories made the activity uninteresting to their children.

In some cases, using the Echo Dot as a complement to parenting tasks was successful. The parent in Family G explained how they were attempting to engage a visiting child in their home in a way that felt appropriate, and decided that the Echo Dot was an appropriate form of engagement. "*Yeah, something not technology, but technology, I mean...It's an actual interactive voice that she's doing, kind of like if she was doing a book with a speaker on it.*" Audio recordings also show how the parent in Family G asked the Echo Dot to play lullabies when a child was crying, demonstrating an extension of parenting behaviors, moderated through the Echo Dot. The child in Family J (age 4) described how their family also used the Echo Dot to complement parenting tasks: "*I'll tell you something calming that she [Alexa] does. The little scenery sounds, those little ones. We just used them for calming down when we're trying to go to bed.*" When successful, we see how complementary parenting tasks from the Echo Dot are positively perceived by both parents and children.

When discussing the ideal interaction between their child and the Echo Dot, the parent of Family H explained: "*But I also wanted her [to] feel more of a teacher... I wanted her to remember [son's name]'s favorite songs. And she can say 'Hey [son's name], want to play a song?' or if he said... 'tell me a joke' and she would tell a joke that's more appropriate for him. I want her to know us differently.*" This parent's ideal is for the Echo Dot to interact with her child in a way that shows the Echo Dot understands it is interacting with a child. Not only does the parent want the Echo Dot to know it is interacting with a child, but that it understands the child's preferences and needs. In this way, the Echo Dot truly would function as a complementary parenting tool, customized to the parent's own parenting style and the child's individual preferences and needs.

#### *Using the Echo Dot to Increase Children's Autonomy*

Parents explicitly modeled the use of the Echo Dot as a cognitive tool, to help with organization and reminders. Audio

capture shows how the parent in Family H attempts to demonstrate the need for setting timers and reminders to her child (age 9):

(Mom): Are you gonna remember it?

(Child): I remember everything. That's why yesterday I remember...

(Mom): No you didn't. I reminded you. I set a timer to Alexa. [She] told us.

(Child): Oh yeah.

Here we see the parent modeling how to use the timer as a reminder for her child. Throughout the one-month study, we also see the parent in Family H using multiple strategies for furthering her child's autonomy in self-organization and management: telling her child their tasks, asking her child to repeat the tasks, and also engaging Alexa to help her child remember his tasks "Alexa, will you make a to-do list?" We see that the parent is using the Echo Dot as one strategy among many for promoting their child's autonomy.

When incorporating the Echo Dot into daily routines, families are seeking ways the voice interface can be useful within the context of their daily environment. Family E (children 4, 8) also provided prompts to their child to incorporate the Echo Dot into helping manage cognitive tasks:

(Mother): Buddy, [Grandmother's name] is talking to you.

(Grandmother): Could you tell Alexa we need two percent milk?

(Child): Alexa, we need 2% milk on the shopping list.

(Alexa): I've added 2% milk on the shopping list.

(Grandmother): Thanks buddy!

Finally, parents expressed a desire for their children to use the Echo Dot independently not only to help with cognitive tasks and daily activities, but also to address safety concerns. The parent in Family G explains:

Sometimes when her and I would go out and he [child] would be here alone, we would do like the check in thing and we were able to call him. That was the most helpful thing. It just rings and he just comes up to it and he just talks and we can talk back... I hate leaving him alone with no means of contact. He's totally okay to be alone, but I need to be able to contact him if we go to the mall or something.

Family I also wanted their children to be able to use the Echo Dot to make calls (as described in Regulating Use). However, without any built-in regulations, Family I's children were unable to engage in this autonomous task.

With the examples described here, we see how parents purposefully viewed and used the Echo Dot as a means to an end: increasing their children's autonomy. However, parents were still actively involved when trying to use the Echo Dot as a tool to increase their child's autonomy.

## Democratizing Technology Access

We found multiple instances of children independently using the Echo Dot to play music, listen to jokes, and play games. In these cases, the child independently used the Echo Dot to perform certain tasks, primarily using the Echo Dot as a source of entertainment. In addition, we saw parents independently using the Echo Dot to perform a number of tasks. Therefore, we build on the concept of democratization, initially introduced in the context of adults using a voice interface built into a phone and we apply that concept to a dedicated voice interface located in the family home environment [32]. We find that the ease of access to the technology initially described by Porcheron [31], ultimately influences all of our prior themes.

We explore the effects of democratizing technology access within the parent-child dynamic. To do this, we compare and contrast two families experiencing similar phenomena, even though they have different family household compositions. Family E, a family of five with two children (ages 4, 8), had multiple examples of their children independently engaging with the Echo Dot for music and games. In particular, one child had a favorite song, Ghostbusters, which was played frequently throughout the month-long deployment and was prominent in our audio capture. We provide one example from our audio capture on how this impacted family dynamics.

(Child 1): Alexa... Alexa. Play Ghostbusters by various artists

(Alexa): Playing Ghostbusters, original motion picture soundtrack by various artists from Spotify.

[music begins playing]

(Dad): Yeah, yeah. We're actually gonna go to the park.

(Child 2): Alexa, quieter.

(Dad): No. Alexa, stop. [music continues] Go get your socks on please. Go get your socks on. Alexa, stop. [music stops]

(Child 2): You wanna have sandals?

Dad: Okay.

(Child 1) [far away]: Alexa, resume music.

[music resumes]

(Dad): Alexa, delete song.

(Alexa): Hmm, I don't know that one.

(Dad): [makes noise of frustration] Alexa, change song.

(Child 1) [far away]: It doesn't work that way.

At Family E's exit interview, the independent use of the Echo Dot by their child came up as an example of the perils of communal access to the device, particularly when integrated with other family member's technologies.

He just always wants Ghostbusters. Constantly. And well, what was frustrating is that sometimes I would be downstairs getting ready listening to Spotify...and he would tell Alexa, 'Alexa, open Ghostbusters.' And so it would stop playing my music downstairs and it would turn on Ghostbusters and it tells me on my phone,



‘Playing Ghostbusters’ on Amazon Echo. I’m like, ‘Stop playing Ghostbusters!’

As a result of the over-use of playing Ghostbusters (at least in the parents’ view), parents regulated use of their child’s ability to independently engage with the Echo Dot.

A similar phenomenon occurred with Family J, a family of two (child age 4), indicating that the democratization of access to the Echo Dot can cause parental frustration, no matter what the family household size. *“The most popular thing [child] said was ‘tell me a joke.’ For 15 minutes at a time just all the jokes.”* Audio capture from Family J reinforces that the child frequently used the Echo Dot to tell jokes, which at times, resulted in the parent regulating use (see Disrupting Access section for specific example).

Through these two case examples, we see how the democratization of communally shared technology influenced families’ engagement in other themes, in these cases: regulating use and communication interruptions. Our findings show how the modality of voice user interfaces, in a communal setting, impacts the parent-child dynamic in the home. Both children and adults are able to independently access a dedicated, home-based technology easily. Ultimately, this democratization of technology access provides a foundation in the family dynamic for fostering communication, disrupting access, and increasing autonomy.

## DISCUSSION

Our findings demonstrate how the development of voice-based interfaces, used in a communal home environment, is integrated in existing parent-child dynamics. A key element is that the device is a dedicated voice interface. Unlike voice interfaces incorporated into other technologies, such as phones or computers (which are also technologies with screens), our findings reveal how a dedicated voice interface in the home is communally accessible, thereby democratizing access to the technology.

### Parental Mediation and Augmented Parenting

While our findings support the notion that families applied multiple mediation strategies with voice interfaces and their children, such as speech and language practice (discursive) and regulating use (gatekeeping) [24], we find that parents used these devices as a means to enhance their parenting practices as well. For instance, the dedicated voice interface lends itself to the perception of it being a neutral third-party mediator, whereas families indicated that using technologies, such as their phone, would not be perceived in the same way. In this case, parental mediation theory only describes part of the story of how parents leverage voice interface technologies.

We suggest that augmented parenting be considered as an additional factor within the context of parental mediation theory when considering voice interface technologies. Prior work on parental mediation theory focused on the strategies and practices parents take to mitigate children’s usage of technology [12,24,38]. In comparison, augmented parenting

describes how parents use technology to complement their existing parenting practices and to extend their parenting goals in a number of ways. As technologies become more democratized in the home, opportunities now exist in how parents both mediate and augment technologies into their parenting practices. These practices are intertwined. By including augmented parenting and mediation together, designers can create holistic parenting tools.

### Designing for Augmented Parenting

Historically, parents have leveraged a wide variety of technologies to augment their parenting, such as using kitchen timers for time-outs [15] or using cassette tape recorders for leaving messages to their children [28]. Yet recent work has indicated that parents have concerns about the idea of using voice interfaces embedded in digital technologies in everyday family interactions [10] and the effects that voice interfaces may have on child development [42]. However, in contrast to these concerns, our findings show that parents are already leveraging home-based smart speakers to augment parenting practices, and our findings highlight ways designers might formalize and improve this experience.

Prior work has shown that maintaining rituals and routines can be challenging for divorced parents or parents working away from home [44]. For example, a parent working night shifts might want to participate in a bedtime routine. To augment this parenting behavior, designers of home-based voice interfaces could create functionality for a parent to record themselves reading one of their child’s favorite bedtime stories. The child could ask the voice interface to *“read [story] from Mom.”* In this way, parents are still able to engage with their children through the voice interface, even if they are not immediately present. Prior work has shown that technology which support children in connecting with remote loved ones through stories and eBooks open up new and meaningful opportunities for bonding [34]. As smart speakers and dedicated home voice interfaces become pervasive, designers have a direct line of access to deploy such experiences in the home.

Our findings also demonstrated how parents (and occasionally children) used the Echo Dot as a neutral third-party mediator. Building on prior work of creating neutral mediators in screen based systems [22], designers of voice interfaces can expand mediation applications to help with transitions. Parents could create messages to go along with existing functions they are already using to enforce parenting rules, such as timers. For example, a parent could choose for the voice interface to play the message *“it’s time to switch toys”* when the timer function is engaged. In this way, the parent is capitalizing on the modality of the voice interface itself as a mechanism for managing transitions, and prior research has shown that technology can make transitions significantly smoother than if they are mediated by the parent alone [23]. Finally, we recommend that designers expand the abilities of voice interfaces during routines. An example would be that a “bedtime routine” is pre-programmed for 7:00 pm, in

which the device automatically begins to play music indicating it is time to get ready for bed, rather than requiring a voice-activation prompt from an adult to begin the routine.

In these examples, designers targeting augmented parenting will want to consider the possible implications for family dynamics. We can imagine a scenario, as described below, in which the adult at home might need to regulate their child's communication.

(Alexa): [plays bedtime music] It's time to start getting ready for bed.

(Child): Alexa, stop. Alexa, tell me a joke.

(Parent): Alexa, stop. Alexa, restart bedtime routine. [child's name], come on, it's time to start getting ready for bed, you heard Alexa.

This example shows how designing for augmented parenting as a parenting complement (by incorporating the ability to customize a bedtime routine) also leads to the parent regulating their child's use of the device, because their child interrupted the routine and changed the device's functionality (all because of the democratization of access to the technology). We also see the parent reference the voice interface as a neutral third-party mediator, and the designer has another choice: do they incorporate additional functionality that capitalizes on that concept as well? An example might be incorporating phrases like, "*I know that it's bedtime, because it's 7:00 pm,*" which could perpetuate the impression the voice interface is not taking sides between parent and child in the conflict over getting ready for bed.

#### *Designing for Increasing Autonomy*

Our findings demonstrate how parents felt the need to regulate use when their children used specific functions to excess, such as the example with Family E when children played music or when the parents of Family I had to regulate their children's ability to call their grandparents with the Echo Dot. When parents regulated use, they did not entirely eliminate children's use, rather, they limited times for use or specific functions. These findings provide a design opportunity to incorporate parental controls that regulate use while increasing children's autonomy.

Prior work has shown that regulating use for family distance communication is a challenge and suggest that one option for limiting disruptions from children calling family members is to have a regular, set time for calls [45,47]. Our findings support this, for example, Family I had to abandon the calling feature when their children used it too frequently. Designers can build-in regulation of use as a setting for the call feature of voice interfaces. For example, a limit could be set to only allow one call per day to "Grandma" or to allow a call to "Grandma" on certain days of the week or at certain times of the day. Another option, suggested initially by Yarosh et al. [45] is to implement an asynchronous messaging feature, which children and adults could access when convenient.

#### **Designing for Fostering Communication**

Prior work has indicated that cross-cultural families anticipate the child's language spoken in the home as a potential area of conflict [46], and we see language as an exciting opportunity for designers of voice interfaces to support families. We had two bilingual families participate in our study, and having a voice interface that was also bilingual would most likely have contributed to more use of the technology in those households. Other families in our study (both children and adults) also attempted to use the Echo Dot for languages other than English, providing an opportunity to design for joint media engagement and participatory learning [12,40]. Increasing multilingual capabilities is an opportunity for voice interfaces to promote and expand family members' communication skills.

#### **Limitations**

We conducted this study during summer, when children were not attending school. A similar study during the school year would be an interesting follow-up. Our study focused on families who are not early adopters—a focused study on early adopters and their parenting practices involving voice interfaces would provide opportunities to expand this work. We also did not recruit families based on the ages of children, and we believe that future work that explicitly compares family dynamics based on children's ages would provide interesting insights our study cannot speak to. Finally, a study that explicitly explores ethical considerations from both children and adults' perspectives would provide important insights for designers of home-based voice interfaces.

#### **CONCLUSION**

We explored the impact of introducing the Echo Dot to 10 families for one month. Using an inductive approach to analyze recordings of in-home use and pre- and post-deployment interviews, we found that designers can build upon what families are already doing with their voice interfaces at home. Our contributions include: 1) providing empirical data showing how voice interfaces can support parenting practices, 2) expanding parental mediation theory constructs with voice interfaces, 3) providing design ideas to support parents' existing goals and behaviors. We also show that the communal nature of dedicated, home-based voice interfaces democratizes access to technology within the family, which at times, results in family disruptions to access the device. Although our findings suggest designers be mindful of these dynamics, they also show that designers have the opportunity to promote augmented parenting and foster communication skills. There is great potential for parents and children to expand their current use of voice interfaces in a way that is consistent with each individual family's parenting goals.

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