Cuddling Up With a Print-Braille Book: How Intimacy and Access Shape Parents' Reading Practices with Children

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(a) Print-Braille Reading (b) Tandem Reading (c) Audio Reading

Figure 1: Illustrations of reading modalities visually impaired parents use to read with their children. See Section 5.2.

ABSTRACT

Like many parents, visually impaired parents (VIPs) read books with their children. However, research on accessible reading technologies predominantly focuses on blind adults reading alone or sighted adults reading with blind children, such that the motivations, strategies, and needs of *blind parents reading with their sighted children* are still largely undocumented. To address this gap, we interviewed 13 VIPs with young children. We found that VIPs (1) sought familial intimacy through reading with their child, often prioritizing intimacy over their own access needs, (2) took on many types of access labor to read with their children, and (3) desired novel assistive technologies (ATs) for reading that prioritize intimacy while reducing access labor. We contribute the notion of *Intimate AT*, along with a demonstrative design space, which together constitute a new design paradigm that draws attention to intimacy as a facet of both independently and collaboratively accessible ATs.

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CCS CONCEPTS

• **Social and professional topics** → **People with disabilities**; **Children**; • **Human-centered computing** → *Empirical studies in accessibility*; Accessibility technologies.

KEYWORDS

co-reading, books, blind, low vision, accessibility, eBooks, voice assistants

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1 INTRODUCTION

Reading books with children is important for fostering long-term literacy and emotional and interpersonal development [36]. Yet, for the approximately 7 million people who are blind or visually impaired[1] in the USA [43], equitable reading access is far from

[1]In this paper, we use a mixture of person-first and identity-first language. When we refer to parents, we use the term "visually impaired parent" (VIP), and when we refer to the larger population, we use the widely-used term "people with vision impairments" (PWVI). We do so in order to acknowledge that there are pluralistic preferences within the community. Similarly, we intermix the terms "visually impaired" with "blind" and/or "low vision." The lead author identifies as a "visually impaired person."

reality. Only a very small percentage of books are available in accessible formats (e.g., braille, large print, audio). Consider that, in the USA, while there are 36 million books and other print materials in the collection of the Library of Congress, only 80,000 titles are offered by the Library of Congress's National Library Service for the Blind and Print Disabled (NLS) [60], representing only 0.22% of the total collection. Moreover, only a small portion (between 10% and 30%) of people with vision impairments (PWVI) are braille literate, compounding limited access [84]. Thus, exploration of alternative ways for VIPs to access books that they can then read with children is both important and rife with systemic challenges.

In HCI, there has been steady interest in digital adult-child reading technologies such as enhanced e-books [29], conversational reading agents [61, 98], and robot reading companions [66]. However, rarely do these include people with visual impairments (PWVI) as readers. Even when PWVI are considered, studies of reading are predominantly centered about user experiences of blind adults reading independently (e.g., [40, 85, 88]). In fact, documentation of how blind parents read with their sighted children was completely absent in the literature, until Storer and Branham [89] published the first account in 2019 based on extant posts about reading found in a blind parenting forum. Their study revealed snapshots of the varied motivations, values, reading formats, and collaborative accessibility practices surrounding parent-child reading. However, their method precluded eliciting in-depth accounts of how VIPs choose among the many reading modalities and strategies available to them, as well as ideation of future technological supports for VIPs while reading. To fill these gaps, we seek to answer the following research questions:

- **RQ1**: How and why do VIPs read with their sighted children?
- **RQ2**: How do VIPs envision technology supporting their existing reading strategies?

To address these questions, we conducted semi-structured interviews with 13 blind parents who read with young children (ages 18 months to 9 years), focusing on their reading motivations and practices. Our analysis yielded three principal themes. First, VIPs were driven to read with their children to nurture familial intimacy and closeness, often valuing this intimacy more than their own access when selecting book formats and reading technologies. Second, VIPs undertook various forms of access labor to read with their children. Third, VIPs envisioned specialized assistive technologies (ATs) for reading, such as scanners and voice assistants (VAs), to foster greater intimacy while minimizing the access labor of reading with their children.

We contribute the notion of Intimate AT along with an accompanying Intimate AT Design Space (Figure 2). We demonstrate the utility of these concepts by applying them to our domain of assistive reading technologies. The design space invites researchers and designers of AT more generally to ponder how these technologies may hinder or engender intimate connection in individual and collaborative settings and to imagine novel directions for future work. We additionally propose two novel technologies for assistive reading–unobtrusive book scanners and interactive reading VAs–which constitute two examples of Intimate AT.

2 BACKGROUND

PWVI read using a number of book formats and assistive technologies. Below, we provide a brief introduction to these tools.

2.1 Common Book Formats for PWVI

There are several physical book formats that are designed to be accessible for PWVI. Chief among them are **braille** books, which are printed books that have the words transcribed into braille (raised dots) cells for touch reading [21]. Braille comes in two grades. Grade-1, or uncontracted braille, requires a single cell for every letter of the written word and is far more commonly used for young children or novice braille learners [6]. Grade-2, or contracted braille, is a more advanced form of braille which abbreviates words and letter combinations [6] and is typically used in more advanced children's books containing primarily text (i.e., chapter books) [81]. Braille books are often much larger and heavier than print books, due to the size of braille cells in comparison with printed typefaces [22]. For example, a braille copy of *Harry Potter and the Sorcerer's Stone*, weighs nearly 8 lbs [92], even when using Grade-2 braille. Braille books do not include printed text, as they are intended for independent reading by a blind person.

Braille books for adults and older children stand in contrast to accessible picture books, which often take the form of **print-braille** books[2], which have both printed text and braille embossing on the same page [81]. While print-braille books were originally created to help blind adults read with their children [31], today, they are primarily considered tools for children who are learning braille [91]. VIPs in previous research have cited this change as the reason behind publishers not including image descriptions in modern print-braille books [89].

Digital reading formats commonly used by blind people include e-books and audiobooks. **E-books** are a mainstream digital book format, which can be read on electronic devices such as computer screens and e-readers. Some e-books are particularly designed to work with a variety of accessible technologies such as screen readers and refreshable braille displays [20]. **Audiobooks**, which were invented by and for blind people [33] and have now made their way into mainstream reading technologies, are also commonly used by visually impaired readers. Audiobook is "a general term for books that you listen to, generally narrated by a real person" [33], although some kinds of audiobooks are read by a synthesized voice.

2.2 Assistive Reading Technologies: Digital Text

PWVI use various commercially available ATs to independently read digital texts. A **screen reader** is a computer program that allows users to read the text displayed on a digital screen with a speech synthesizer or braille display [45]. Screen readers can also access images on a display as long as *alternative text*–automated or human-written text which describes images–is present. The most common desktop computer screen readers are JAWS [45] and NVDA [72], which are controlled with a large set of keyboard shortcuts. Popular mobile screen readers include VoiceOver on iOS[3]

[2]Print-braille books may have alternative names, including print-braille-and-picture-books, dual vision books, and twin-vision books. Throughout this article, we refer to them simply as "print-braille" books.
[3]https://www.apple.com/accessibility/vision/

and TalkBack on Android[4], which are controlled by specialized touchscreen gestures.

Speech synthesizers convert digital text to audio, while **braille displays** are peripheral devices that dynamically display braille. Braille displays produce tactile braille output that users feel with their fingers, often using both hands for efficient reading [37]. Braille displays can be the length of a computer keyboard or small enough to be portable [51]. However, only a small percentage of adults with vision impairments are braille literate [75], making speech output by far the most common modality. PWVI often use headphones to access synthesized speech while around others, for both privacy and courteousness.

2.3 Assistive Reading Technologies: Images of Text

While screen readers support reading digital text, optical character recognition (OCR) apps, remote sighted assistants, and automated sighted assistance aid reading images of text.

OCR technologies recognize, structure, and read text captured as an image. Example apps include OpenBook [46], Voice Dream Scanner [96], and KNFB Reader [74]. On desktop platforms with a peripheral scanner, OCR apps can read scanned documents, but the resulting digital text may lack appropriate document structure metadata, making it difficult to navigate with a screen reader. On mobile platforms, these reading apps tend to make use of the camera for collecting still images or live video in which to detect text.

Remote sighted assistants and automated sighted assistants are options for accessing graphics, printed materials, or digital text. Remote sighted assistants provide real-time, human-generated audio-based descriptions of images and video *in situ*. Some examples of commercial remote sighted assistance are Aira [5] and Be My Eyes [13], through which the user connects to a remote person via video chat or other communication channels to get sighted assistance. Automated sighted assistants provide AI-generated audio- and text-based descriptions of images and video. Some examples include Microsoft SeeingAI [67], VoiceOver Image Descriptions by Apple [9], Lookout by Google [48], and Be My AI by Be My Eyes [14]. However, the accuracy and quality of automated sighted assistants vary widely based on internet bandwidth, lighting environment, and AI training data.

3 RELATED WORK

Our research builds on prior work on collaboration between people with mixed-abilities, along with mixed-ability and non-disabled parent-child reading. We address the need for in-depth accounts of how VIPs read with their children and what they desire from future reading technologies.

3.1 Designing for Ability-Diverse Collaborations

There is increasing interest in assistive and accessible technology design for collaborative, ability-diverse[5] settings. One of the key characteristics of such settings is that the access needs of participants may vary, sometimes existing in tension with one another [24]. As a result, assistive technologies (ATs) that work for one collaborator may not be accessible, usable, or desirable when used collaboratively [24]. Particularly in the home, when collaborators may be close friends or family, Branham and Kane [24] contend there is a connection between accessibility and *relational intimacy*, noting that "technologies that fail to support mixed-ability, collaborative use can create missed opportunities for shared experiences and spontaneous acts of kindness, both of which are important intimacy-building activities." When we consider the *interdependence* [15] of the people, technologies, and environment in ability-diverse collaborations, the negotiated, multi-relational, non-hierarchical nature of accessibility co-creation becomes apparent.

Several technical solutions have been developed to support collaborative accessibility, with a particular focus on blind-sighted interactions. In the context of synchronous collaborative text editing and review, one approach is to augment traditional visual editing tools with non-speech audio, speech output, or both, which have been shown to enhance feedback and coordination [35, 77]. Another approach is to use physical components in addition to visual and audio cues, the efficacy of which has been demonstrated in studies of block-based programming languages like StoryBlocks [54] and Torino [93], and the BrailleBlocks tangible braille learning system [47]. Most studies in this vein have involved collaborations between peers–whether adults or children. Very few studies target collaborations between adults and children, with the work on StoryBlocks and BrailleBlocks being notable exceptions–and none have addressed blind adults interacting with sighted children.

3.2 Parents Reading with Children: Benefits, Challenges, and Interventions

Education research shows that by the time American children from mid-to-low-income families enter the formal education system through kindergarten at age five or six, they already exhibit substantial deficits in reading readiness [49]. Much research has therefore focused on understanding early literacy skills gained in informal settings like the home (e.g., [42], particularly on the benefits of parents reading picture books with their children [25, 69]). When parents engage children in "extratextual" conversation while reading (as when a parent points to a picture on the page and asks *"how do you think the dinosaur is feeling right now?"*), children's vocabularies and storytelling capabilities expand [25, 69]. However, VIPs do not access picture books in the same way as sighted parents. While researchers have begun to explore how low-income parents read books with their children [63, 65], only one study documents how blind parents read with their children [89], which we discuss further below.

A focus on literacy gains may suggest a formal education setting, but reading for pleasure at home is important, if not essential, to learning [30]. When parents read to and with their children for pleasure, children's reading attainment, writing ability [73], breadth of vocabulary [8], text comprehension, and grammar [32] are improved. Moreover, parent-child reading for pleasure is also associated with many social and emotional benefits, including facilitating joint attention, spurring discussion around novel topics,

[4]https://blog.google/products/android/all-new-talkback/

[5]Related terms include mixed-ability and cross-ability. In the remainder of this paper, we use the term ability-diverse to signify the multiple facets of ability (e.g., visual ability, textual literacy, visual literacy) that each collaborator brings to the interaction.

fostering shared meaning construction, and generally creating opportunities for familial intimacy [58].

To encourage parent-child reading, including all the benefits that come with it, many researchers have been exploring digital literacy and digital interventions. Exploratory user experience studies on parent-child reading practices suggest that parents perceive shared reading as a time for bonding and physical closeness [95] and that traditional print books may encourage more "extratextual" dialogue as compared to e-books [66]. Interventions for sighted (grand)parent-child reading is largely focused on generating extratextual dialogue, as well, often with the use of interactive conversational agents, either through screen-based voice AI (e.g., [61, 78, 98, 99]) or robot interfaces [66]. Most of these systems augment or replace both the voice of the parent and the role of physical books during reading and discussion. Importantly, none of these are designed to support people with vision impairments.

Reading technologies for PWVI that have been studied tend to target solitary reading by blind adults. For example, among those reading systems developed for blind readers are enriched e-books [12, 57] and wearable computer-vision-based technologies [88]. While the former require screen-based devices, like a tablet, and work with screen reader software, the latter is compatible with a physical print book. Stangl et al. [86] developed 3-D printed tactile graphics of picture books for blind children, presumably to read with a sighted parent or teacher.Yet, the only study to consider how a blind parent reads with a sighted child to date is the work of Storer and Branham [89]. Storer and Branham's study of posts in a blind parenting forum revealed a wide range of reading formats utilized by blind parents, including braille-print books, audiobooks, watching YouTube videos of story narration, and creatively making up stories. Parents' motivations for co-reading included bonding experiences and their child's literacy development. Finally, external social support, such as a spouse or friends, along with the availability of accessible reading materials, impacted reading methods. While their paper provides a foundation for this domain, one of its limitations is the lack of direct interaction with VIPs, leaving a gap in understanding the rationales behind motivations and practices, as well as opportunities to address unmet access needs via future technologies for reading with their children.

4 METHODS

To answer our research questions, we took a constructivist and interpretivist qualitative approach, leveraging semi-structured interviews and inductive thematic analysis.

4.1 Participants

We recruited 13 parents who identify as blind screen reader users and read with their child(ren) (Table 1). Participants were recruited through the existing social networks of the authors, snowball sampling, and forums for VIPs. All parents were between the ages of 18 and 49 (reported in ranges to preserve anonymity). All children were sighted and were between the ages of 18 months and 9 years old. Notably, all but one participant were braille readers. In the remainder of the paper, we refer to parents via pseudonyms, and all children are referred to by reference to their parent.

4.2 Procedure

We conducted semi-structured, audio-recorded interviews with 13 VIPs over a teleconferencing platform of their choice, such as Zoom. Interviews were conducted between January 2023 and April 2023. The interviews lasted between 37 and 91 minutes, with an average of 60 minutes. Participants were compensated for their time at a rate of $40 per hour in the form of a gift card. The study was approved by the authors' institutional review board (IRB).

Interviews were conducted in two phases. Phase 1 focused on the motivations VIPs had for reading with their children, including discussing benefits, technologies used while reading, the role of image descriptions (data omitted from this paper)[6], media preferences, and technology ideation. Phase 2 focused on the accessibility of digital reading technologies for blind parents and their children. Those interviews discussed digital children's books and probed about other materials used by VIPs while reading with their sighted children.

4.3 Analysis

Nine interviews were automatically transcribed by teleconferencing software and manually edited for accuracy, while four were transcribed by a professional transcription service. All interviews were then inductively coded by the first two authors to understand the experiences of blind parents reading with their sighted children, with a particular focus on understanding the processes, motivations, and values in and around VIP-child reading.

We adopted the philosophical lens and practical activities outlined in Kathy Charmaz's book *Constructing Grounded Theory* [28]. Though neither the data we collected nor the level of abstraction we reached through analysis are rich enough to constitute grounded theory, the thematic coding and meaning making steps outlined in this book guided our qualitative analysis. The first and second authors conducted incident-by-incident coding (p. 53), leveraged in vivo codes (p. 55) where appropriate (e.g., "tandem reading"), engaged in constant comparison (p. 54), conducted focused coding to merge similar codes (p. 57), and conducted axial coding to develop thematic groupings of codes (p. 61). However, authors stopped short of theoretical coding and moved on to collaborative memo writing to synthesize and expand upon the interrelationships of codes grouped under the same theme (p. 72). Authors met once or twice weekly for five months to explore emerging themes and finalize memos. After receiving feedback from peer reviewers, the authors engaged in additional top-level axial coding to better convey the prioritization of intimacy expressed by VIPs throughout the interviews. These new axial codes map to the headings of each subsection in our Findings. Each sub-subsection of the Findings corresponds to a memo, and includes a sample of representative quotes for each phenomenon.

[6]Parents offered many additional details about how they access images while reading, in picture books as well as other media like graphic novels, activity books, and coloring books; however, to appropriately scope our paper, we have limited our reporting here to VIPs' experiences with images within picture books.

ID	Ages of Children	Self-Disclosed Vision Status	Braille Reader	Age	Gender	Race/Ethnicity
Alex	4 years	Legally blind	No	40 to 49	Man	ME, WE
Bell	2.5 years	Totally blind, no light perception	Yes	30 to 39	Woman	H
Cara	3 / 1 years	Legally blind	Yes	30 to 39	Woman	B
Dana	3 years 8 months	Only light perception	Yes	40 to 49	Woman	WE
Erin	3.5 / 6 years	Totally blind, no light perception	Yes	40 to 49	Woman	WE
Fran	9 / 7 / 3 years	Totally blind, no light perception	Yes	18 to 29	Woman	SA
Grace	7 years	Only light perception	Yes	30 to 39	Woman	WE
Henry	3 years 9 months	Only light perception	Yes	40 to 49	Man	WE
Ivy	2.5 years	Totally blind no light perception	Yes	40 to 49	Woman	WE, H
Jack	1.5 years	Totally blind	Yes	30 to 39	Man	WE
Kate	9 / 2 / 2 years	Blind	Yes	30 to 39	Woman	n/a
Lisa	21 months / 4.5 years	Blind	Yes	30 to 39	Woman	n/a
Mia	2 / 6 years	Legally blind, light/shape perception	Yes	30 to 39	Woman	WE

Table 1: Demographics of participants and their child(ren). If a participant has more than one child, the children's ages are separated by the back slash (/) symbol. Race/Ethnicity Key: B - Black or of African descent, H - Hispanic or Latinx, ME - Middle Eastern, SA - Southeast Asian, WE - White or of European descent.

5 FINDINGS

In the course of our data analysis, a recurring emphasis on intimacy in parent-child reading experiences emerged, a focus which was not initially anticipated in our research design.

5.1 Reading as Parent-Child Intimacy

All VIPs in our study read with their children as a way to foster an intimate bond and fill their role as an involved parent to their children.

5.1.1 Physical and Emotional Bonding. VIPs in our interview study read with their children as a means of becoming physically and emotionally connected to their child. When parents read books with their children, they did so in an intimate setting in which they had physical contact and could share reading materials. Parents would often find a *"cozy"* spot, like the child's bed or the family room couch, and lay down or sit the child in their lap so they could *"snuggle"* or *"cuddle"* as they read, especially at bedtime.

Beyond physical presence, VIPs described reading as a way to build emotional connection, often achieved through reading to their child in their "*own voice*" (Cara). Reading aloud, as Bell described, made VIPs "*feel like it's a connection because I'm reading to her*" (Bell). VIPs described the importance of inflection, cadence, and varied expression while they read:

> "*I want her to listen to my own emotions when I'm reading sentences from a book to her. I want her to feel how I express different words or how fast I read, how slow I read. ... This is important that she feels, 'Daddy himself is reading a book to me.'*" (Alex)

Emotional intimacy was also supported by creative theatrics, such as acting out character voices: *"I always read in my own voice with the kids because I'm reading Braille. So I have a little cast of characters at that point"* (Cara). Through their own voices and storytelling, VIPs used reading as more than just a shared activity; it became a way of sharing intimacy with their children. Interestingly, being in physical contact with the child and reading a book in one's own voice was not simply about establishing connection. As Alex hinted, these acts are tied up in feeling like a caring parent, which we explore further below (5.1.3).

5.1.2 Creating Shared Experiences and Understanding. Reading together was a means of developing shared media experiences and understandings that could transcend the context of reading. So, reading was about creating new memories together: "*I think it's also a good bonding time. And it's just a nice shared experience*" (Henry). And, for some VIPs (n=4), it was about revisiting old memories; reading with their child tapped into nostalgic feelings around reading books when *they* were children. Parents wanted to instill in their children the same love that they had for reading. For example, Mia said, "*I love reading, and I just really want my kids to like it too.*" They also wanted their children to experience reading in its original, *"actual"* (Grace, Erin) form, particularly before they became immersed in digital media: "*For kids, it's nice to have that physical book. ... It's a whole experience that I want them to have before they enter that digital world... to touch a book and know what that's like*" (Kate).

Parents also read with their children to build shared understanding connected to moments outside the reading session. Ivy shared how books transmitted moral lessons, such as not jumping on furniture or being patient, which VIPs referred back to outside of the reading context:"*One of her favorite books is The Three Little Monkeys Jumping on The Bed... I'm like, 'Oh don't jump on the couch, what did the book say? What happened to the monkey?'*" (Ivy). Similarly, Grace stated: "*I like sharing books that I've read as a kid that she is interested in.*" This practice of passing down beloved books created a bridge between her own childhood memories and her child's reading experience, enriching their shared reading sessions.

5.1.3 Being a Caring, Equal Parent. VIPs expressed a strong desire to be a caring, equal parent who can participate in teaching their child visual literacy skills. By reading with their children, VIPs demonstrated their capabilities as comparable to those of sighted parents. Alex emphasized that reading was a key component of his

family's broader parenting approach, wherein both parents *"decided that no, both parents have the same ability,"* with no activity being exclusive or *"unique to her (sighted) mommy."*

VIPs also prioritized typical childhood experiences over their own access. VIPs wanted their children to have parity between their experiences and those of their sighted peers. This included wanting their children to read books that their peers are also reading:

> "*They're sighted children, they're in a sighted world. I think they should be able to experience all that. Because their peers are. So I want them to be able to have the same experience as much as I can.*" (Kate)

Parents were willing to sacrifice their own access to visual content to provide their children with the *"full experience"* (Kate) of childhood, ensuring that they were socialized for a visual world. These common experiences revealed that VIPs desired to instill a sense of normalcy and independence in their parent-child relationships: "*Sometimes you feel inadequate as a blind parent… there are things that you don't do or can't do equally compared to other sighted parents. And … reading books makes you feel self-sufficient and equal to everybody else*" (Henry). As we will see in future sections, this desire to care for one's child through reading, just as sighted parents do, drives reading modality choices and the trade-offs they are (un)willing to make when weighing access and intimacy.

5.2 Reading Modalities and Intimacy

Different reading modalities (i.e., print-braille books, tandem reading, audiobooks, braille-only or print-only books, and e-books with screens and screen readers) had tradeoffs in intimacy, engagement, accessibility, usability, and convenience for both the VIP and child. We found that while print-braille books and tandem reading enhanced intimacy during shared reading sessions, the other modalities tended to decrease this sense of closeness.

5.2.1 Print-braille Reading. Print-braille books were preferred for both intimacy and literacy-building reasons by 12 of the 13 interviewees, with the exception being Alex who was not fluent in braille. For VIPs, this format enhanced physical intimacy, because reading a print-braille book together required close proximity to simultaneously access the text, images, and braille, along with physically manipulating the book. Print-braille books were also considered more conducive to learning both visual and textual literacy, such as interpreting illustrations and learning vocabulary. VIPs also enjoyed brailled touch-and-feel[7] books since the illustrations were more intuitively accessible than text-based image descriptions:

> "*We've had some given to us that were like touch and see [sic]. So it has 3D pictures with felt or different tactile [sic]. So you can see the animals. And then it has the Braille underneath. So it's very visual too for them.*" (Erin)

However, many print-braille books had usability issues regarding braille presentation. First, creative formatting for the braille that mimics visual word or letter spacing, such as *"text [that] is spread out for effect, if the text is at a slant, or if there's like a couple words at the top and a couple words at the bottom"* (Dana), made it difficult for VIPs to read the words on the page. Second, the placement of the braille both obstructed visual reading and disrupted the reading flow, and also made it difficult to focus the child's vision on specific words due to the misalignment with the printed text. Third, braille placed on a separate plastic page after each page of printed text as opposed to being overlaid on the same page as printed text changed readability. VIPs disliked the plastic texture, twice the page-flipping to progress through the book, and lack of simultaneous access inherent to the double-page format: *"They have these plastic pages and a print page in between. I don't like those… It's too much to deal with and turning the pages"* (Bell). Braille placed on the same page was therefore preferred.

In addition, participants were frustrated with print-braille books for young children because the image accessibility seemed to not be designed for blind parents. Several VIPs (n=4) felt that print-braille books were "*basically designed for sighted parents reading with blind children. ... there's no picture description*" (Bell). Interestingly, VIPs did not generally consider access to images to be important to their own understanding of the book. Instead, they believed access would enhance their ability to engage with their children in discussions of the visual elements[8]:

> *"Images generally don't really matter to me. They matter to my kids… I'd say it's moderately important so that I can actually engage with them about what's on the page, so that I can make commentary with them and try to help them learn… It enhances interaction and learning."* (Mia)

Alex found this lack of access frustrating, since young children "*learn a lot from those illustrations,*" yet he was often left wondering "*How should I explain it to my kid?... What are the descriptions?*" (Alex). Similarly, interactive elements, such as flip ups, are commonly not brailled, leading Erin to "*not try with those.*"

VIPs also reported that print-braille books tended to be written in grade-1 braille, which impacted their ability to read seamlessly and confidently. Many of our participants, being experienced braille readers, use grade-2 braille (n=5). The syntax of grade-1 braille was seen as too verbose and distracting. Dana, who prided herself on being a proficient grade-2 braille reader, felt self-conscious reading to her child due to her loss of familiarity with grade-1 braille: *"I don't want her to think I can't read... I'm slow... they should've combined those [words into a contracted format]."*

5.2.2 Tandem Reading. *Tandem reading*, a term coined by Grace, is where each reader uses a book modality which best aligns with their abilities to read the same book together, or in tandem. Participants exclusively described tandem reading when reading chapter books. The most common version of this strategy (n=3) was pairing a print book for the child and an e-book accessed via braille display or speech synthesizer for the VIP. An alternative used by one VIP was to pair a print book with an audiobook. Tandem readers described choosing to read with a braille display rather than a braille book, since *"it's just a lot easier to find the book on the Braille display and read it"* (Grace). Cara used tandem reading to retain the intimacy of *"still using [her] voice"* in the absence of an accessible print-braille book; she used a screen reader to listen to an e-book with a headphone in, echoed the text aloud, and coached her child to turn the page as she followed along with a "not-brailled" version.

[7] Touch-and-feel books [27] are children's picture books with tactile content.

[8] Parents offered many additional details about features of image descriptions which can be improved; however, to appropriately scope our paper, we have limited our findings to reporting on how images influence the reading experience.

However, VIPs found that aligning the physical and digital formats in tandem reading was challenging. Sometimes in the digital edition, the page counts were misaligned or page turns were not clearly indicated, so turning pages synchronously was difficult. Further, the VIP and child were sometimes reading editions from different countries, which introduced vocabulary or phrasing variability: *"Like Harry Potter sometimes the wording is different based on if you get like the UK version or the US version"* (Grace). Relatedly, in-person shopping was complicated by the difficulty in confirming whether an accessible digital version that accurately mapped onto the printed edition could be purchased online: *"When you buy a [print] book, you run the risk of not being able to find an accessible version of it"* (Grace). The alignment challenge was recurring, since braille books were often several editions behind those available to sighted children via school or a library.

5.2.3 Audiobook Reading. VIPs tended to use audiobooks to read with their children in a passive manner, often as a supplement to the more active reading strategies described above. Audiobooks were most commonly accessed by VIP's children through VAs (n=7) and mobile devices (n=4), and were acquired through services such as Bookshare, BARD, Audible, Prime Reading, YouTube, and Amazon Storytime.

Though most of our participants (n=9) used audiobooks as their primary format for individual reading, when it came to reading with their children, audiobooks were considered supplemental and particularly useful when they were tired, unavailable, or helping their child fall asleep. Sometimes, parents considered audiobooks an individual reading experience for their child: *"In some cases, it's kind of her quiet time alone. But at bed time I lay in bed and I listen with her. I'm just with her in that space"* (Mia). Similarly, Grace sometimes did not listen to the story the whole way through with her child, instead using it as a means of winding her child down before she left for the night: *"I'll sit there and listen to one story with her and then I'll leave and she'll listen to the rest on her own"* (Grace).

Audiobooks were found to be less intimate than both print-braille reading and tandem reading, with parents citing the introduction of a third party into an intimate space. For example, Alex would ask his daughter if she wanted *"another daddy to read to you"* before playing a narrated book on YouTube. While VIPs appreciated that audiobooks could take over reading duties when they could not read to their children, they also hesitated to switch from print-braille books to audiobooks, fearing listening to an audiobook might diminish their *"connection"* in the reading experience: *"If you were to incorporate technology and let technology do all the work, read the book to your child, you would lose that connection"* (Bell).

5.2.4 Modalities VIPs Avoided. Several modalities commonly used for independent reading were identified by parents as being unsuitable for reading with their children, often because these failed to provide the intimacy of other formats. These unsuitable formats were: print books; braille books; and e-books accessed on braille displays, phones, and computers with screens and screen readers. In the case of print or braille books, the major issue was accessibility; print was only accessible to the child, and braille, while accessible to the parent, lacked visual interest and failed to hold the child's attention: "*I have books that are just braille, but obviously, he likes those [print-braille] better*" (Henry).

E-books were also found to be less favorable among VIPs due to not being a *"tangible item"* (Lisa). Braille displays paired with e-books were considered more accessible to the VIP but less engaging for their children, citing limited physical interaction with the modality and less visual stimulation: *"Unless there was something to capture her attention when reading digital books, she just doesn't care"* (Ivy). Additionally, Lisa felt that children were unable to *"see how stories are physically put together, so they understand there's a cover, there's a beginning, a middle, and an end"* with e-books as compared to print-braille alternatives.

VIPs also tended to avoid e-books due to the intrusive nature of e-book reading technologies in intimate settings. The presence of screens—and, with them, screen readers–was of utmost concern when accessing e-books, so much so that several VIPs even disallowed screens in the child's bedroom at any time of day. Screens were considered "*weird*" (Alex), "*distracting*" (Lisa), and "*intrusive*" (Alex), and they made parents feel "*guilty*" (Mia) about added screen time, especially when the child was supposed to be winding down for the day: "*I find it to be a little bit weird, I go to her room with my earphones in my ears, having my cellphone in my hand, trying to scroll with my phone, you know?*" (Alex). Interestingly, VIPs found the intrusiveness of a device to be related to its screen size. The screens found on braille displays, such as the BrailleNote [51], were considered too small to view illustrations, and these devices were still used for tandem reading (5.2.2). With respect to larger screens, Alex concluded that: "*[Reading together] is a natural, intimate setting. A laptop is much more intrusive compared to a mobile device, right? Laptop… with headphones you know?...it is very intrusive. And mobile device is a little bit better*" (Alex). E-books and the hardware they entail–laptops, phones, headphones–as well as the added sensory aspects, like the synthesized voice of a screen reader, were perceived as detracting from the *"intimate setting"* of reading together.

The use of e-books was seen as a last resort by those who tried them, chosen only when the book was highly desired but no other formats were available. In such cases, the willingness to adapt to e-books was out of necessity rather than preference:

> "*There was a book that she really wanted to read and I couldn't find it with Braille so I pulled it up on my phone and it had images. I just didn't find it super useful or user friendly… it was a very limited [single] time that I read actual digital print with her.*" (Mia)

Overall, VIPs preferred book formats that supported physical and emotional intimacy, even if that meant sacrificing accessibility. This meant that book formats which worked for individual reading by either parent (e.g., braille book) or child (e.g., print book) simply did not suffice for parent-child reading.

5.3 Access Labor of Reading with Children

VIPs engaged in a wide range of access labor at all stages of the reading experience–from acquiring books, through preparing to read, to a near constant adaptation of reading strategies as children develop.

5.3.1 Acquiring (Desired) Books. VIPs were often unsure of where to source print-braille books. Discovering these resources was a gradual process for them, pieced together over time and largely

through word of mouth, requiring the use of various vendors, non-profits, and government organizations. Navigating this decentralized market of accessible books was challenging, with them *"always buying from random places"* (Erin).

VIPs and other household members sometimes used brick-and-mortar bookstores and libraries, although online services were the most popular way of acquiring books. This is partly because bookstores and libraries rarely provided print-braille books. Even when VIPs desired to acquire print books, the entire experience–from navigating to books on shelves to reading the book jacket information and other metadata––was highly inaccessible. VIPs reported engaging co-located assistance from employees, spouses, and their older children to access books, but they largely felt sidelined in the process. Alex, who often browsed with his spouse and child, explained, *"The reason why I don't get involved is that I don't have that very first common knowledge about that book,"* leading to his feeling excluded from the browsing experience.

Even when they drew from multiple online sources of print-braille or braille books (aggregated in Table 2), VIPs felt frustrated and marginalized by the limited book selection. They reported being restricted to classic children's books, rather than having their pick of trendy books or those teaching more modern values, such as diversity, emotional intelligence, or anti-bullying: *"I'm usually looking for ones that are diversity-based ... and I often struggle finding those. So I will get the book and get [it] brailled"* (Mia). VIPs who wanted to purchase braille books for use in tandem reading with older children were met with the same challenge; newer, popular chapter books were hard to acquire in braille:

> *"If I choose to get these bulky [braille] volumes… I still won't have access to the newest and the best stuff. And that's the sad part; I'm reading all these older books, and all these brand new nice ones are coming out."* (Cara)

Specialized books, like those for fostering literacy development, were often also unavailable: "*One issue that I found with some of the reading programs that you can buy for kids... like the Bob Books*[9] *...it was very difficult to find those in accessible formats*" (Grace).

5.3.2 Preparing to Read Together. Before reading books with their children, many VIPs prepared by becoming familiar with, screening, and sometimes even memorizing the book content. These strategies, though time consuming, made their reading sessions more fluid and improved their confidence.

Most VIPs (n=7) familiarized themselves with the contents of print-braille books before reading with their children, concentrating on the words, narrative, interactive elements such as flaps, timing of page turns, and potential discussion topics.

> "*I sit down [with] the book and I read it to myself… for instance, this heart shaped one that had different flaps, and I had to figure out… I wanted to make sure I knew what I was doing before I introduced it. I'm just trying to get an idea of the story so I'm not stumbling when I'm trying to read it.*" (Erin)

Some VIPs (n=3) also pre-read books to screen them for age-appropriateness with regard to literary complexity, relevance to particular topics, or sensitive content; this was necessary because this information was rarely available in an accessible format prior to acquisition. Alex, pre-read to ensure that children's books, such as *The Big Bad Wolf*, were not too intense for his child. Grace, who valued open communication regarding sexual education and anatomy, found it especially challenging to gauge the information found in illustrations of anatomy books for children; she needed to pre-read books with her sighted spouse to better understand the information being presented to their daughter.

VIPs mentioned they had memorized certain children's books–often unintentionally–as a byproduct of very frequent reading or listening to books. Cara considered braille books easier to memorize than *"a screen reader reading it to me or someone else,"* concluding that *"reading the braille for a lot of these books, it's like I'm physically reading it. So my brain can catch on a lot faster."* In contrast, Alex, who does not read braille, intentionally memorized poems and stories to share with his child:

> *"I tried to memorize some of the good stories that I knew she likes... I would sit down next to her crib, would definitely hold her little hand in mine, and would ask her to read with, to sing with me."* (Alex)

5.3.3 Adapting Reading Strategies as Children Grow. VIPs faced shifting access needs as their child's literacy skills developed and constantly adapted their strategies to continue reading with their children.

With younger children who read image-heavy books, VIPs preferred print-braille formats. Access labor in this case often revolved around inaccessibility of pictures to the parent. One access strategy was *"getting curious"* about what their children were observing by prompting them for descriptions. However, this strategy had limitations. There was no way for VIPs to verify what their children were observing, impeding their ability to scaffold dialogue for developing their child's visual literacy skills; they were instead limited to questions that children were likely already capable of answering at their stage of development:

> "*The strategies that I use now are just getting curious with my kids and saying, 'What do you see in this picture?' Not because I want them to tell me what's in the picture, but because I want them at least to engage. I just can't confirm or deny whether they're right or not. So I'll ask my son 'what color is that dozer?' He's probably going to say 'it's yellow.' And likely he's right. But if I don't have image description, which I usually don't, it's just a guess.*" (Mia)

As previously mentioned, the formatting of print-braille books was not conducive to letter-by-letter and word-by-word synchronization between the readers. This led VIPs to develop strategies to aid their children in the early stages of literacy development. For example, Grace used a BrailleNote with a screen as a means of teaching her child to pronounce words encountered in print-braille books:

> *"When she was learning how to read, I would ask her to read certain words... or have her spell them out and help her sound them out. ... We would use the braille display, and I would write words on it, and she would view them on the little LCD screen that's on the braille display."* (Grace)

[9]Bob Books [19] are structured series of books designed to help children learn to read through gradual progression in difficulty and complexity.

Source	PB Cost	Formats	PB Catalog Size	Free Book Limits and Eligibility
Seedlings Braille Books for Children [82]	Free, Paid	PB, digital	100+	5 free per year
Beola Rhymer Legacy [16]	Paid	Braille, PB, games	50	None
National Braille Press [70]	Free, Paid	Braille, PB	98	12 free per year (parents eligible until child reaches age 10)
Dolly Parton's Imagination Library [38]	Free	PB, audio	5 free per year	5 free per year (parents eligible until child reaches age 5)
American Printing House [7]	Free	PB	6 free PB books, other material available	6 free PB per year through Braille Tales program (Parents eligible)
National Library for the Blind [71]	Free	uncontracted PB, digital	115+	3 free copies once (parents and teachers also eligible)
Braille Bookstore [18]	Paid	PB, braille	Large offering	None

Table 2: Sources of accessible children's books identified by our participants. Print-braille is abbreviated to PB.

As VIP's children got older, they transitioned from picture books to chapter books. Chapter books, despite having fewer pictures, presented new challenges for VIPs to solve in order to continue reading with their children. Parents were concerned with their own braille proficiency and the ability to keep pace with the reading level of chapter books. This led Mia to proactively contemplate new strategies, namely switching to audiobooks: "*I think we're getting closer to where we might start doing more chapter books that I read to her. Due to my very limited proficiency in braille, we'll likely shift over to audio*" (Mia). Other parents shifted strategies from print-braille reading to tandem reading with e-books. This brought with it new types of labor and burden. First, there was the increased cost and time checking book editions during acquisition. Second, during reading sessions, VIPs needed to do real-time management of an additional device and coordination with their child to synch between the print book and e-book (5.2.2).

5.4 Imagining More Intimate Reading ATs

In our interviews, VIPs were asked about the technologies they used for personal reading tasks and how these could enhance reading with their children, identifying scanners and VAs as the most promising options.

5.4.1 Book Scanners. Parents experimented with a variety of what we refer to as "scanning" technologies to access the text and image contents of inaccessible books during book acquisition (5.3.1), preparation (5.3.2), and reading (5.2). One preparatory strategy was to use a document scanner, specifically a desktop peripheral device or PEARL Scanner [44], and then use OCR (n=3) built into a screen reader such as JAWS [45] to digitize the text. Brailling with remote sighted assistance, utilizing services like Aira [5] and Be My Eyes [13] (n=2), was another preparatory method employed by VIPs. During preparation and reading, some participants (n=7) took pictures of pages with a mobile phone and used OCR and AI apps, such as KNFB Reader [74] or Microsoft SeeingAI [67], to generate image descriptions.

However, scanning technologies were ultimately abandoned for accessing children's books after initial experimentation. Peripheral scanners were tedious, due to inaccurate and unstructured returned digitized text. Participants reported that mobile apps *"should be able to describe the picture to me. But those apps aren't very reliable...and totally disrupt the flow of our reading"* (Fran), while requiring the user to *"take a picture every single time"* (Fran). Further, none of the scanners provided convenient access to both text and image descriptions; tools like SeeingAI were capable of providing access to both, but "*if the book has too many pictures in it... SeeingAI or Envision will really not be able to get a lot of the text out of the picture*" (Grace). Furthermore, VIPs' attention was divided when they were engaged with their children, making it even more challenging to use scanners: *"By the time I scan the page, then go read it to her, go on to the next page, and scan the next page, she's just gonna lose interest"* (Bell). VIPs also found that scanning tools did not structure book jacket information in a way that was easily to skim, which posed challenges to efficient browsing during acquisition: *"[Scanners] would be no benefit to me. It would take forever for me to use a KNFB Reader or something like that"* (Cara).

In addition to these usability issues, the scanning technologies VIPs experimented with failed to align with the desired intimacy in parent-child reading. These devices were disruptive and cumbersome, and introduced screens that detracted from the natural flow of storytelling and nighttime routines. By disrupting the immersive experience of reading, they diminished the personal connection that motivates VIPs to engage in reading sessions with their children. Instead, VIPs preferred the more intimate and human-centered reading and preparatory experiences offered by assistance from friends and family over the mechanical and solitary nature of existing scanning technologies.

Despite these shortcomings, some participants (n=3) expressed openness to using scanners during reading, provided these devices enabled VIPs to access print books that are normally inaccessible but easily obtainable: *"I wish that there's more [book titles], and that's why a device would be great… And all I would have to do is throw a quick Braille label on the inside cover… I could access it some other way"* (Cara). For Cara and Fran, the interest in an alternative solution was motivated by it taking *"forever for me to scan all the pages and read"* (Cara), suggesting an effective multi-page scanner could improve her reading practices.

All three VIPs expressed interest in optical and imaging technologies that identify print books and pair them with accessible, digital assistive materials–ideally at no extra cost to the VIP. Erin, who

tandem reads with her older son using a braille display, lamented how tedious it would be to scan for digital text on each page of the book. She proposed:

> *"If you only had to scan a [single] barcode and then the file would be already on there and then you could just read. It would be just like reading a book then because you wouldn't have to hold the book just to scan [every page]."* (Erin)

We observed that VIPs would be open to using scanning ATs in the intimate setting of reading if they minimized intrusiveness, especially by reducing reliance on screens and the number of image captures required, while providing access to higher-quality accessible materials than those currently offered by OCR and AI applications.

5.4.2 Voice Assistants. VIPs were optimistic about the potential of VAs to support reading together, because VAs were already ubiquitous and considered more intimate than other digital reading technologies. VAs, particularly Amazon Alexa, were regularly used by all VIPs in our study. They placed VAs *"everywhere,"* including private spaces such as bedrooms (n=9) and bathrooms (n=2). VIPs anthropomorphized VAs by using gendered pronouns and the brand as a name. For example, their children *"just like to talk to him [Google Assistant]"* (Cara), which suggested that they view VAs as a familiar entity distinct from screen readers and other utilitarian digital interfaces. VAs also sounded *"more natural"* (Cara) instead of *"robotic"* (Erin) compared to screen readers. VIPs expressed differing preferences for speed of speech output between collaborative versus individual reading scenarios: a natural pace when played through a speaker for leisurely reading alone or with children and fast-paced speech from screen readers for tasks done alone. Nevertheless, VIPs emphasized the importance of minimizing the intrusiveness of reading technologies throughout our study, and this extended to VAs while reading: "*It would be great to know what images are on each page [via the VA], but I don't know how to do that in a way that doesn't take away from the experience*" (Cara).

VIPs imagined features for VAs, such as image descriptions, bookmarking and annotating, and learning tools, aiming to improve the efficacy of their reading time while reducing the cognitive load across reading sessions. Fran imagined a VA which paired "*very clear*" (Fran) image descriptions with discussion questions which rely on the images to be answered, so that she can discuss visual content while also being aware of what the answer is from the image descriptions. Participants imagined pairing voice-based interactively through VA with print books, such as smart navigation, storing bookmarks, and annotating notes to the stories in order to return to parts of the story to discuss further:

> *"And set bookmark. So you can go back and find information that you thought, 'Oh, maybe I should go back and explain this a little further next time. Or we had a couple of difficult words on this page. Maybe we should go back and read it again."* (Grace)

Erin imagined a feature for VA-assisted tandem reading via audiobooks for readers to *"hear a word again or get the spelling of that word,"* which could support VIPs in cultivating their children's literacy skills while adhering to their values around screen use (5.1.1).

Overall, VIPs suggested that any reading technology, including VAs, should not disrupt interpersonal family connection. From above, two design features emerged as potentially making or breaking this rule. First, VIPs expressed that the persona and likeness of VAs would play a crucial role in creating an intimate and engaging storytelling experience. Similarly, VIPs indicated the inappropriateness of synthesized voice for reading with their child; Cara indicated that, while *"the most generic robotic NVDA sound"* is tolerable for her while reading, *"it's got to be in a natural voice."* when reading to her child. Alex proposed a potential solution, which we then presented to other participants, to create a virtual reading assistant that used either their own or another parent's voice through synthesized speech: *"AI takes my voice sample and generates the voice based... Then even that speaker is me, and [my child] is listening to Daddy through another medium, which is good"* (Alex). Five VIPs felt that personalizing a VA's voice to mirror that of the parent, as opposed to a generic voice, could improve the bonding experience between the storyteller and listener. Erin and Fran, however, felt that a synthesized version of their voices would feel unnatural: *"I don't want to hear my own voice. ... There's just something about it that feels icky to me. Just doesn't feel as organic"* (Fran).

Second, VIPs identified that the degree of interactivity would need to be carefully fine-tuned as to not disrupt the shared reading experience. The VA would need to foreground the readers' voices, ensuring that the VA supports rather than dominate the reading experience. A very talkative VA which requires too many inputs, as expressed by four VIPs, could fracture the interpersonal connection that family reading sessions are meant to nurture. This concern is further specified by the apprehension of Cara and Grace regarding the potential for notification fatigue from the VA, such as unnecessary interruptions for page numbers or image descriptions. In contrast, a well-calibrated level of interactivity was perceived to complement the reading experience; Fran, for example, found it challenging to discern appropriate moments for discussion based on the book's structure and proposed that the VA notify her of these opportunities for discussion without disrupting the flow of reading. Supporting this, Cara proposed using subtle auditory cues to communicate the presence of stopping points or image descriptions:

> *"There should be a page turning sound… a different type of chimey [sic] sound that lets you know that there is an image that could be described. And you could either choose to go to the next page by clicking next page, or you just let it be and it will then describe the image instead of having just the page turning sound."* (Cara)

We observed that VIPs were already comfortable with VAs in their private spaces and were enthusiastic about the potential of these systems to support their intimate reading practices. However, such a VA would need to integrate an appropriate voice and frequency of notifications, while enhancing usability by balancing assistance against the frequency of inputs and interruptions.

6 DISCUSSION

After interviewing 13 VIPs who read with their children, we were surprised to uncover how much the ATs and modalities chosen by

VIPs influenced the intimacy of their reading experience, yet there is so little research on how intimacy influences technology design, much less AT design. While there is a substantial body of work on ATs for teaching literacy to blind children [3, 4, 47, 53, 76] and reading technologies for blind adults [26, 39, 55, 56, 59], studies specifically examining the mixed-ability reading dynamics between PWVI and sighted people are scarce [11, 89].

Our study contributes a novel perspective of the reading practices of VIPs and their children by documenting the intimate aspects of reading experiences. Storer and Branham [89] found that VIPs desired to teach literacy and foster bonding experiences through reading. While we also found that parents are motivated to read with their children for these reasons, we expand on these motivations, as we found that intimacy encompasses physical and emotional closeness, shared experiences, and a desire to be actively involved as parents, particularly in relation to their disability; we document how intimacy is integral to why parents are motivated to read, what reading technologies they choose, and their desires for improved technologies. Additionally, our study elaborates on the reading preparation activities of VIPs as well as conceptualizing this reading preparation as access labor. For instance, we found that our VIP participants did not tend to actively memorize books to prepare for reading, which contextualizes the prevalence of the practice reported by Storer and Branham [89]. We also uncover access labor undertaken by VIPs to keep pace with their children's literacy development. Finally, to conceptualize the relation of technology to intimacy and access, in the sections below, we present a design space that maps intimacy and access as dimensions in the design of assistive technology and explore future AT designs for reading.

6.1 Intimate Assistive Technology

6.1.1 Defining Intimate AT. We propose Intimate AT as a concept that can both explain our findings as regards reading technologies and guide future technology design in this and other domains. Intimate AT is distinct from notions of intimacy that have been explored in HCI broadly for the past two decades, just as it is distinct from the notion of "access intimacy" that has recently been taken up within the Accessible Computing research community. In this section, we position Intimate AT in relation to these two parallel adoptions of "intimacy," explore its dimensions through a novel design space representation, and gesture to how this concept can be taken up in service of developing more intimate assistive technologies going forward.

In HCI, intimacy has recurrently found its way into the literature. Intimacy has predominantly surfaced in the context of digital technologies for mediating romantic partner and platonic family relationships [23, 52, 94], with recent calls for inclusion of friendship and kinship [83]. Though the term intimacy is rarely defined [83], the emphasis is on "mediated intimacy" [94], or technology's role in creating intimate physical and emotional connection. Predominantly, this has taken the form of fostering abstracted presence, or presence-in-absence–a sense of closeness that transcends time and space for romantic partners separated by distance [52, 94]–though there have been efforts to re-center the conversation on everyday intimacies between those who are co-located [23, 41]. A notable outlier among these is Dalsgaard et al.'s 2006 grounded theory of intimacy [34], which not only provides a nuanced conceptual model of intimacy, but also does so for the particular intimacies of parent-child relationships. Their model articulates five constituents of intimate parent-child acts: emotional, physical, expressive, play, and care.

In Accessible Computing, intimacy has recently become a point of interest as relates the notion of "access intimacy" [15, 64, 90]. Access intimacy, originating from disabled activist Mia Mingus, is the connection that arises when someone deeply understands and meets another individual's access needs [68]. While HCI literature centers about the role of technology in brokering intimacy, it has as of yet not addressed the intimate experiences of people with disabilities. Access intimacy, on the other hand, de-centers the role of technology and foregrounds interpersonal relationships among people with varying abilities. To our knowledge, there has yet to be an exploration of intimacy as relates to assistive technology–what we call Intimate AT.

Intimate AT is assistive technology that enables individual or collaborative access and fosters interpersonal connection-building within oneself or between the self and other(s). The relationship may encompass love, friendship, or kinship in general. The interaction may or may not be mixed-ability. Access intimacy, though not necessary, may be a precursor to or an outcome of the interaction.

6.1.2 Intimate AT as a Design Space. We have developed a design space to chart the intersections of intimacy and access (Figure 2). Our two dimensional space sets disconnected technologies in opposition to intimate technologies, and independent accessibility in opposition to collaborative accessibility. At a fundamental level, this conceptualization of intimate AT invites the viewer to imagine how two alternative assistive technologies can be admirably accessible, yet completely unusable depending on whether the situation calls for disconnected or intimate interactivity. To demonstrate the more nuanced application and utility of this representation, we have populated the design space with the alternate assistive reading technology formats used by our participants.

When we plot assistive reading technologies on our design space, two insights are immediately at hand: (1) ATs that fall on the left of the vertical divide–those that parents perceived as hindering intimacy, regardless of the level of access–were avoided, and (2) ATs that parents embraced for parent-child reading fall in the upper right quadrant. In other words, intimacy was essential, a non-negotiable factor in selecting ATs for reading together. Interestingly, those ATs that offered the most collaborative access (tandem reading) and the most intimacy (print-braille books) were the most preferred formats. Beyond this sort of reflective pattern recognition across exiting ATs, the design space has utility for driving future inquiry. Every white space on the diagram is a subtle prompt: what would an AT that occupies this space look like? For example, what would it mean to have an intimate, yet independently accessible AT (bottom right quadrant, currently empty): perhaps an accessible diary which recites entries in a synthesized voice, one that mimics the author's voice at the various eras of their life? In this way, a design space can reflect imbalances in existing digital ecosystems while creatively eliciting novel digital futures.

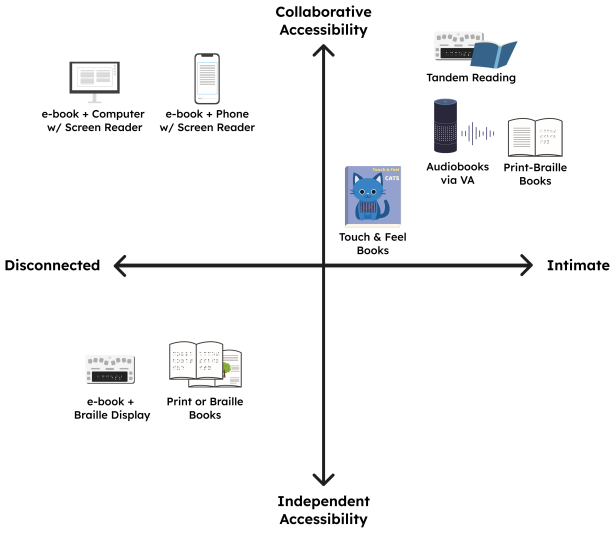

Figure 2: Intimate AT Design Space, Applied to Assistive Reading Technologies. A quadrant chart that represents different reading approaches based on the level of intimacy and accessibility

For a human-centered research field that has tended to neglect the disabled experience, and an accessibility-centered field that has tended to neglect intimate relationships, we believe this notion of Intimate AT can help. This design space is not to be used solely in the context of reading technologies; rather, this design space is also useful for taking stock of assumptions that existing ATs in any domain make about intimacy and access, and thinking through new possibilities. The fact is, people with disabilities desire intimacy *and* access, but digital technologies do not often provide it.

6.2 Implications for Design

Our participants helped us identify two promising technical directions for more intimate reading experiences: less intrusive scanners and more active voice assistants. Both of these would occupy the right side of our design space (the former in the lower right and the latter in the upper right quadrant), adding to the range of intimate reading technologies currently available. In this section, we consider how these ideas map to existing technologies and propose next steps for AT designers.

6.2.1 AI and Unobtrusive Scanners for Reading. Participants expressed a desire for digital book scanners that enable them to access the text and images of otherwise inaccessible print books, so that they could make use of bookstores, libraries, and the massive variety of print books available to sighted parents. However, current scanners are not usable. They tend to capture either text or images, not both. They require laborious page-by-page processing, making them impractical for live reading sessions. They often necessitate the use of smartphones, conflicting with VIPs' preferences to limit screen exposure for their children. More importantly, current scanners fail to support intimacy by interrupting the flow of reading and breaking the connection that arises from joint attention to the story.

Existing research on scanning technologies regarding human-generated and automated image descriptions tend to focus on the accuracy (e.g., [17, 50, 80] and ideal design of the image descriptions (e.g., [87, 97]), but do not investigate the holistic user experience of the process of physically capturing scans *in situ*, much less the specific demands of the parent-child reading use case.

We therefore propose new lines of inquiry into **AI systems capable of proficiently scanning both images and text in a single capture.** An existing example of a hands-free scanner is the commercially available ARxVision [10], which is an automated sighted assistant that uses a head-mounted camera combined with computer vision and AI to scan documents, read text, describe scenes, and search for objects while a VA provides voice feedback to the user. Automated sighted assistants in the form of hands-free scanners or mobile apps such as SeeingAI [67] or Be My AI [14] could be paired with reading books to increase access while reducing intrusion of technology, as VIPs reported prioritizing.

Further, we propose simpler technologies like **barcodes or QR codes, which can augment inaccessible print books with accurate digital representations**. Beyond improved access to image descriptions, a barcode-based system would allow VIPs to access a broader catalog of titles than those currently available via specialty websites. The supported output device, such as a braille display with a camera imagined by Grace, must also aim to minimize intrusiveness, screen interaction, and user inputs, as these elements increase technology engagement but detract from the intimate and engaging nature of reading with children.

6.2.2 VAs for Tandem Reading. VIPs conveyed a desire to better integrate VAs into the intimate reading experience with their children. VIPs suggested that VAs might be a promising digital technology for facilitating reading since they are usable hands-free by both the parent and the child, and they were described as a more intimate technology that integrates into every room of the house and that even becomes part of the family.

We know from prior work that VAs are relatively accessible to both children [62] and PWVIs [1], and that PWVIs are generally eager for more functionality from these mainstream, low-cost, non-visual interfaces [2]. Though several explorations of VAs as reading aids for sighted children already exist (e.g., [61, 78, 98, 99]), there has yet to be work on voice-based reading assistants for PWVIs.

We therefore recommend that **future research explore VAs which allow VIPs to tandem read print books with their children**, with features such as access to book metadata, indications of page turns and presence of images, smart bookmarks, image descriptions, as well as prompts and answers to discussion questions on visual content. Such a VA would allow them to maintain their preference for reading in their own voice while their child holds a physical book. Perhaps the biggest gain would be access to countless more children's book titles, as this device could retrofit otherwise inaccessible print books.

We provide this recommendation with a sober awareness of the vital tension surfaced by participants: the potential of such a VA to impede intimate connection by supplanting the parent's voice or interrupting the natural flow of reading. Prior work documents

how intimacy is established, in part, through the parents' performative reading of the book [95], and that some technologies, like e-book readers, can reduce parents' dialogic interaction [79] and expressivity in reading [29]. In a rare study of parent-child reading with VAs, Zhang et al. [99] forewent complete AI automation since it restricted parents' role in reading and adopted a human-AI collaboration approach in the design of an interactive storytelling system for parents and children to use together. Parents in the study reported that storytelling was important for building bonds with their children. Any VA-based solution would therefore need to toe the line of providing meaningful access while making space for the parent's voice. Otherwise, the device might well be relegated to the left side of our design space.

7 LIMITATIONS

Our work had a few limitations worth noting. Firstly, 12 out of 13 of our participants were braille readers. Our sample does not reflect the population of people who are blind, with estimates of braille literacy being somewhere between 10% and 30% [84]. Secondly, all of our participants resided in the United States of America, meaning that our findings may not apply to other cultures or geographic areas outside of the USA. Lastly, 10 out of 13 participants identified as women, and as such, our findings may not be reflective of VIPs with other gender identities.

8 CONCLUSION

Through 13 interviews with VIPs who read with their children, we found that VIPs highly value and prioritize the intimate experiences facilitated by reading, have a strong preference for physical books since they support intimate reading experiences with their children, and face increased access labor in acquiring accessible books and preparing to read. This work uncovered findings on intimacy and AT design, a factor which has largely been ignored by AT researchers. In the context of reading, we found that access and intimacy were important, but distinct, factors which influence choice of reading technology. From these dimensions, we defined the concept of Intimate AT and mapped them onto a design space to visualize this relationship. These points lead us to consider opportunities for future designs of AT for reading, along with needs of broader changes to both the production and acquisition of media for reading.

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