“That comes with a huge career cost”: Understanding Collaborative Ideation Experiences of Disabled Professionals

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Collaborative ideation plays a vital role in driving creativity and innovation across various professional and educational contexts. This study investigates the experiences of disabled individuals within the collaborative ideation process, specifically examining their utilization of digital whiteboarding tools. Through interviews with 19 professionals and academics with disabilities, alongside a thematic analysis of online forum posts for two popular digital whiteboarding platforms (Miro and Figma), we delve into the access barriers encountered by disabled individuals and the strategies they employ to create access in collaborative ideation. Our findings illuminate the multifaceted nature of access barriers, encompassing issues such as inaccessible visual features, technology-induced discomfort, unstructured nature of freeform content, and complex communication setups. Furthermore, we uncover the intricate dynamics involved in negotiating diverse access needs and conflicts within teams involving people with different disabilities. Through this analysis, we highlight tensions around proficiency with inaccessible technologies stemming from ableist standards of professional success and discuss the implications of our findings for the design of accessible collaborative ideation systems.

CCS Concepts: • **Human-centered computing → Empirical studies in accessibility**; **Empirical studies in collaborative and social computing**.

Additional Key Words and Phrases: accessibility, mixed-ability collaboration, ideation, brainstorming, digital whiteboarding

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1 INTRODUCTION

Generating and discussing new ideas with others fuels creativity and innovation across various educational and workplace settings. The collaborative ideation process involves a range of group activities that start with an idea generation or storming phase—where the collaborators participate in divergent thinking to come up with as many ideas as possible, then followed by a norming phase—where they discuss, evaluate, categorize, and merge the generated ideas to converge towards the best possible solutions [18, 42, 60]. Researchers across business, organization, and HCI have extensively studied approaches to individual and group ideation [27, 48, 59], detailing how these

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approaches affect the quality of ideas and group dynamics [62, 68] and innovating new strategies and technologies to augment creativity and productivity in collaborative work [18, 39, 42, 51, 54, 75].

In recent times, computer-mediated ideation [27] i.e., using technology specifically designed to support collaborative idea generation, has become the standard practice at many organizations [13, 28, 40]. A number of commercial tools (e.g., Miro [5], Figma [2], Google Jamboard [3], Microsoft Whiteboard [4], Apple Freeform [1]) have emerged to support computer-mediated ideation by allowing team members to write or sketch together on digital whiteboards. These tools were introduced widely in remote education during the pandemic and are now an essential part of discussions and brainstorming in online classes [31, 40, 58, 67, 70], design sessions [46], workshops [78], and User Experience/User Interface (UX/UI) research practices [8, 28]. A recent survey [13] revealed that over 82% of UX practitioners use digital whiteboarding tools in their work, serving as an example of the near-ubiquity of these tools in several professions [28]. Given the extensive use of ideation tools in educational and professional settings, understanding how people with disabilities make use of these technologies and engage in ideation practices with other disabled and non-disabled collaborators is essential to reduce existing access gaps and enable opportunities for equitable participation of disabled people in learning and employment.

In a relevant thread of research, HCI and accessibility scholars are increasingly examining how disabled individuals collaborate with other disabled and non-disabled colleagues in contexts such as videoconferencing [9, 24, 49, 52, 53, 71], writing [20, 22], programming [61, 66], making [19, 21], and research methods [50]. These studies have not only documented a myriad of accessibility issues in widely adopted collaboration tools but also uncovered the significant labor that disabled people put in to create accessible work practices. While this body of work contributes important knowledge about accessible collaboration more broadly, we know considerably less about how access is created in the specific context of *collaborative ideation*—a complex practice that is mediated through new and constantly evolving technologies and shaped by unique group dynamics.

To address this gap, we investigate *how disabled people engage in collaborative ideation with others and how they work through challenges in both emerging technologies and collaboration practices*. We report findings from 19 interviews conducted with professionals and academics with different types of disabilities (e.g., blind and low-vision, d/Deaf and hard-of-hearing, neurodivergent, and chronically ill) as well as a thematic analysis of 97 conversation threads from online forums on Figma and Miro—two popular digital whiteboarding tools used by over 59% and 44% respondents (out of 4260) respectively according to a 2022 survey [13]. Our analysis reveals that disabled people must navigate multifaceted access barriers in digital whiteboards (including inaccessible visual features, technology-induced pain, unstructured freeform content, and complex communication setups) and configure alternative workflows for ideation, sometimes turning to traditional writing tools to generate and share ideas. In doing so, disabled people need to develop shared strategies with other collaborators and negotiate diverse—and at times conflicting—access needs, all the while braving ableist collaboration norms and professional standards at workplaces.

Our paper makes three primary contributions. First, we contribute to new empirical understandings of the access barriers people with different disabilities face in the context of collaborative ideation, complementing prior work that explored remote co-design using ideation tools in d/Deaf-hearing teams [71, 74]. Through this analysis, we revisit and problematize ableist norms and organizational practices that equate professional competency with the ability to navigate inaccessible technologies. Second, we unpack how disabled people grapple with and reason through tensions arising from competing access needs, building on and extending prior work that studied access conflicts in other contexts such as remote work [9, 24, 49] and human-centered research [50]. Taking the lens of "access as a process" [12, 25], we elucidate the interdependent [11] and fluid ways in which people move towards resolving access conflicts in ability-diverse teams. Finally, we discuss design considerations for future systems to support accessible collaborative ideation.

2 RELATED WORK

We situate the present study within research on collaborative ideation tools and practices, accessibility in collaborative work, as well as literature on disability, interdependence, and access.

2.1 Collaborative Ideation Tools and Practices

Collaborative ideation, also known as brainstorming, involves individuals or groups coming together to generate new ideas, solve problems, or explore creative possibilities [48]. Traditional tools like physical whiteboards and post-it notes have long been used to capture and organize thoughts, with whiteboards providing a large writing surface and post-it notes enabling flexibility to jot down and rearrange. Previous research has extensively explored users' preferences and patterns of usage with these physical tools (e.g., [32, 82]) and developed various strategies to boost productivity and quality of ideas generated in group sessions [27, 48, 59, 62, 68]. To further enhance collaborative ideation, researchers have innovated technologies such as digitized whiteboards [14, 51] and post-its [39, 64], tabletop systems [18, 35], wall displays [75], virtual reality applications [45], and AI assistants [42]. These digital tools augment the ideation process by incorporating interactive features for content manipulation [51], easier handling and transfer of ideas [39], awareness of collaborators' actions [18], and reflection on and expansion of ideas [42, 85].

With the onset of the COVID-19 pandemic, commercially available digital whiteboards (e.g., Miro, Figma, Google Jamboard) gained immense popularity in various domains, including remote education [31, 40, 58, 67, 70] and UX research and design [8, 28, 46, 78]. These tools have been found to promote students' collaborative learning [67], skill building [40, 70], social presence [58], and group cohesion [46, 58]. However, challenges with learning curves, technical requirements, and lack of structure in the open-ended canvas space commonly inhibit their use [31, 40]. We contribute to this literature by highlighting the experiences of disabled individuals in collaborative ideation and the challenges and opportunities digital whiteboards present in their work.

2.2 Accessibility in Collaborative Work

Within HCI, CSCW, and accessibility, researchers have explored diverse team compositions involving people with disabilities to enhance inclusivity in collaborative work. For instance, researchers have investigated how blind and sighted people form a shared understanding while writing [20, 22], programming [61, 66], making [19, 21], and performing navigation tasks [81, 83] together. In the context of remote collaboration, researchers found that videoconferencing platforms are rife with accessibility issues that require extensive advanced planning to address and yet may not be fully resolved [44, 80]. McDonnell et al. [52, 53] put forth the social, environmental, and technical factors that impact captioning practices and preferences of d/Deaf and hard-of-hearing (DHH) people while videoconferencing in small group settings with hearing collaborators. Others delved into remote [49] and hybrid [9] work practices of ability-diverse teams and neurodivergent professionals [24, 88], highlighting the importance of developing, teaching, and maintaining accommodation norms on a community level to co-create accessibility in collaborative work [49].

Compared to the extensive and growing research on accessibility in the broader context of collaborative work, limited studies have focused specifically on *collaborative ideation in ability-diverse teams*. Two recent studies [71, 74] explored remote co-design using digital whiteboarding tools (Miro and Figma) by teams with mixed hearing status and observed strategies that enabled a smoother collaboration between signing and hearing collaborators. For example, they found that a hearing person sketching for the signer mitigated the complexity of signing and working on the whiteboard simultaneously and that the integrated drawing and chat features of the whiteboarding interface reduced the group's reliance on ASL (American Sign Language) interpreters to exchange ideas. Our study corroborates findings from this work that focused only on d/Deaf-hearing teams but also contributes to new insights about the dynamics and challenges that emerge when individuals with various disabilities engage in ideation activities using digital whiteboarding tools.

2.3 Disability, Interdependence, and Access Conflicts

Our understanding of disability and access is shaped by Disability Studies scholarship [25, 26, 34, 41, 57, 65] that rejects a deficit narrative, locating disability solely within an individual. Instead, this literature views disability and access as enacted through the ongoing interplays between people, technologies, and their surroundings [41, 57]. Drawing on this scholarship and disability justice activism [37, 55, 65], Bennett et al. [11] introduced the notion of interdependence within HCI and assistive technology research. An interdependence framing emphasizes the collective work and continuous negotiations between people with and without disabilities to achieve and sustain access [11, 83]. This broader framing allows us to understand "access as a process, an effortful and moving assembly of actions" [12], departing from the instrumentalist view of accessibility as a technological configuration or a 'fixed' system state, as adopted in much of the earlier HCI research.

Related to this discourse, researchers have foregrounded "access synergies" i.e., when people with different disabilities draw on individual strengths to reduce each other's access barriers in collaborative work [36, 38]. At the same time, "access conflicts" also occur sometimes when accommodations for one collaborator hinder access for another [24, 36, 49]. Recently, Alharbi et al. [9] and Mack et al. [50] have discussed how disabled people work through contradictory access needs in hybrid meetings and human-centered research methods, highlighting the tensions that unfold when access conflicts are intertwined with power differentials. Our work builds on and extends this scholarship by focusing on emerging access conflicts in collaborative ideation and the continuous process in which ability-diverse teams move towards reconciling access conflicts.

3 METHODS

Our investigation of accessibility in collaborative ideation involved two approaches conducted in parallel: (1) interviews with disabled professionals and (2) a thematic analysis of online community forums of two digital whiteboarding tools. This work was done in line with our university's Institutional Review Board policies.

3.1 Interviews with Disabled Professionals

3.1.1 Participants. We recruited participants through an online survey circulated within our research networks, social media, and across several mailing lists and online groups at our university. We interviewed 19 participants, selected out of 45 respondents to optimize for a more representative sample across disability and collaborative ideation experience. All participants except one lived in the United States. Table 1 shows details of participants' self-reported disabilities, assistive technologies or services used, collaborative ideation frequency, and digital tools used for ideation. Table 2 shows participants' demographic information on an aggregate level to maintain anonymity.

All participants had experience of collaborative ideation in educational or professional settings both remotely and in-person. For remote brainstorming, all participants simultaneously used videoconferencing tools like Zoom while working on a separate digital tool. Some also used messaging services such as Slack, Discord, and WhatsApp for asynchronous communication and file sharing related to brainstorming activities.

3.1.2 Procedure. The first author conducted the interviews remotely over Zoom between February to May 2023. Interviews started with obtaining verbal consent from the participants. We adopted

Table 1. **Details of Interview Participants.** All names are pseudonyms. CI: Cochlear Implant, ADHD: Attention Deficit Hyperactivity Disorder, ADD: Attention Deficit Disorder, ASD: Autism Spectrum Disorder. Docs, Sheets, Slides, and Jamboard are Google products. Word, Excel, and PowerPoint are Microsoft products.

Name	Self-reported disability	Assistive tech or services used	Ideation Experience*	Digital tools used for ideation
Kai	Blind since birth	Screen reader (JAWS)	10-15 times*	Docs, Sheets, Slides
Mia	Totally blind, ADHD	Screen reader (JAWS, NVDA), braille display	At least once a month	Word, Excel, Miro
Saba	Blind	Screen reader (JAWS, VoiceOver)	At least once a month	Jamboard, Docs, Slides
Jason	Totally blind since birth	Screen reader (NVDA, JAWS, VoiceOver), braille display	5-6 times*	Docs, Word, Slides
Carla	Deaf-blind, no vision, some hearing loss	Braille display, screen reader, hearing aids	2-3 times*	Word, PowerPoint
Aaron	Some vision on right eye, no light perception on left eye, since birth	Digital magnification, screen reader (VoiceOver) for long-form reading	10-15 times*	Miro, Figma, Slides, Sketch
Julia	Chronic migraine, low vision, ADD	Digital magnification, dictation, text read-aloud	>15 times*	Miro, Prezi, Trello, Word
Zoya	deaf & hard of hearing with a CI	CART captions, live captions (Zoom, Otter.ai), CI	>15 times*	Miro, Mural, Figma, FigJam, Jamboard, Slides
Jordan	Hard-of-hearing	CART captions, live captions (Zoom, Google Meet), hearing aids, CI	Almost daily	Figma, FigJam
Chloe	Hard-of-hearing	Live captions (Zoom), high volume, hearing aids	Multiple times a week	Miro, Figma, FigJam
Lily	Hard-of-hearing	ASL interpreters, live captions, hearing aids	At least once a week	Figma, FigJam, Slides, Pages
Paula	Deaf (culturally)	ASL interpreters, CART captions, hearing aids, CI	About twice a month	Figma, FigJam
Giselle	Autism, ADHD, auditory processing issues	Live captions (Zoom)	At least once a month	Jamboard, Slides, Figma, Zoom annotation
Sofia	ASD, dyslexia, anxiety	Text read-aloud, dictation, screen magnification	Daily	Slides, Docs, Zoom annotation
Ella	ASD, ADHD, and auditory processing issues	None	10-15 times*	Docs, Slides, Zoom annotation
Gina	ADHD	None	2-3 times a week	Figma, FigJam, Miro, Slides
Sylvie	Limited use of dominant hand caused by nerve damage, nausea	Dictation, voice control, keyboard-based navigation	Daily	Miro, Mural, Figma, FigJam, Jamboard, Slides
Martha	Multiple Sclerosis	None	>15 times*	Figma, Miro, Slides, Sketchup, Discord
Avery	Anxiety, Irritable Bowel Syndrome	Live captions	10-15 times*	Miro, Jamboard, Figma

*Frequency of ideation (at the time of interviews) or an approximate count of ideation sessions joined in the last 12 months (in case participants' ideation activities were sporadic e.g., project-dependent).

a semi-structured interview format, where we asked participants to share how they set up their workspaces and what tools they used for collaborative ideation activities. With a particular focus on digital whiteboarding tools, we requested participants to walk us through their ideation process

Table 2. **Participants' demographic information on an aggregate level**

Gender	**Count**
Woman	13
Man	3
Non-binary	3

Age (years)	**Count**
18–24	9
25–34	7
35–44	2
45–58	1

Race	**Count**
White	6
Hispanic/Latine	2
Asian	7
Arab	1
Ugandan American	1
Mixed race	1
Not disclosed	1

Profession	**Count**
Undergrad	5
Grad student	4 (1 formerly UX designer at industry)
UX designer	2
Professor	2
Program manager	2
Others	Community organizer (1), disability inclusion consultant (1), health and wellness coach (1), and technology business systems associate (1)

Tools used for ideation	**Count**
Figma & FigJam	11
Miro	9
Google Jamboard	5
Mural	2
Other writing and presentation tools	Google Suite (Docs, Sheets, Slides) and Microsoft Office apps (Word, Excel, and PowerPoint)

via screen sharing on one of their previously worked-on documents or whiteboards. Kai and Jason who did not share their own documents for privacy reasons performed the demonstration using a sample board/document we pre-generated on their preferred platforms (e.g., Google Jamboard or Google Sheet). The sample whiteboard was seeded with a few sticky notes and shapes with text content arranged within two frames. Blind participants shared their screen reader speech while screen sharing through Zoom and DHH participants sent screenshots of their workspace setup for ideation using digital whiteboards. We prompted participants to reflect upon the accessibility of the tools and processes they were demonstrating, positive and negative instances of their past ideation experience, how they managed their access needs in group ideation activities, and their collaborators' reactions to their access needs. The sessions lasted 60-90 minutes and each participant received a $30 gift card per hour on a prorated basis.

To make our study procedure more accessible [50], we included an optional question about access needs on our recruitment survey. We arranged ASL interpreters for two participants, turned on Zoom live captions for all sessions unless participants requested to turn it off, and sent participants a list of guiding questions prior to the interviews so that they could review it at their own pace. Some sessions required in-the-moment adaptation, for example, supplementing spoken conversation and captions with text chat for a participant with a "deaf accent." For member-checking, we emailed all participants a full draft of the paper, a short summary, and their own quotes aggregated in a separate document. Several participants shared their positive feedback upon reviewing the draft and we made adjustments based on their requests (e.g., changing pseudonyms) when applicable.

3.2 Online Forum Analysis

To supplement and triangulate [86] our findings from the interviews, we analyzed accessibility-related posts on the community forums of two popular digital whiteboarding platforms: Miro (https://community.miro.com/) and Figma (https://forum.figma.com/; FigJam is a part of Figma). We collected data from these forums during the period of March 3–6, 2023. Using the built-in search option on these forums, we looked for posts using 20 keywords: accessibility, disabilit*, disabled, a11y, impair*, "special need", blind, "screen reader", vision, visual, deaf, "hard-of-hearing", "hard of hearing", DHH, neurodiver*, autis*, adhd, "learning disabilit*," dyslexi*, and motion. We also checked posts that appeared under 'suggested topics' or 'related topics' of our search results. Analyzing forum data allowed us to gain insights into experiences of people with particular disabilities or health conditions who were not represented in our interviews (e.g., colorblindness, dyspraxia, carpal tunnel neuropathy, and tendonitis).

Our search generated 200+ conversation threads on the Miro forum and 1000+ threads on the Figma forum. The first author read through the titles and first few sentences of the original post in each thread and discarded the threads that did not pertain to the experiences of people who have disabilities or use assistive technologies but instead included our search keywords in different contexts, e.g., 'access'-ing a whiteboard without creating an account or 'disabl'-ing a feature. Through this initial review process, the first author identified 47 and 50 threads respectively from Miro and Figma forums for detailed analysis. The threads collected from the Miro forum had conversation posted between March 2020–February 2023, while those collected from the Figma forum ranged between January 2021–February 2023. Each thread included one original post and 0–30 replies. To preserve anonymity of individuals, we paraphrased forum excerpts included in the paper following established practices [56].

3.3 Data Analysis

We analyzed the data collected from interviews and online forums in parallel following a reflexive thematic analysis method [16]. We took an inductive, bottom-up approach starting with an open coding of our entire corpus led by the first author. Our initial open codes captured instances such as accessibility issues in the ideation tools, workarounds developed by the participants individually or in cooperation with their colleagues, instances of competing access needs, and more. We also prepared analytic memos to draw connection between similar or contrasting instances across our two data sources. The coauthors met regularly to examine the data, codes, and memos together. Through iterative refinement of codes and memos, we developed three overarching themes that capture the core aspects of how disabled people build and negotiate access in collaborative ideation.

4 FINDINGS

Our analysis reveals that disabled individuals work through numerous access barriers on digital whiteboards and engage in collaborative efforts to create accessible configurations and practices for ideation, all while navigating ableist norms and standards within professional organizations. Figure 1 shows an overview of our findings.

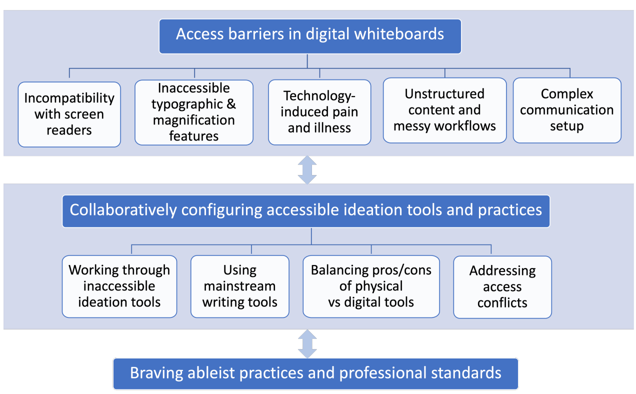

Fig. 1. Overview of findings. We identified five types of access barriers in digital whiteboards. To address these, disabled participants collaboratively configure accessible ideation tools and practices with team members. While doing so, participants must also brave ableist practices and professional standards within workplaces.

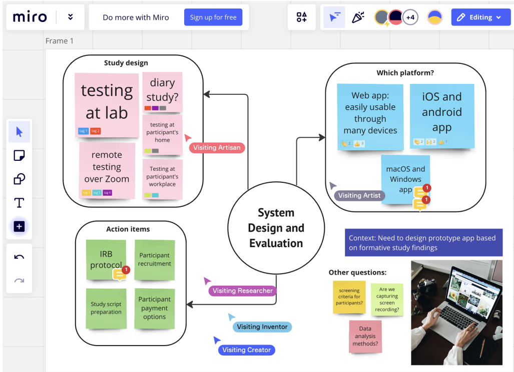

Fig. 2. Screenshot of a Miro board showing text on sticky notes of different colors (some with tags, comments, and emojis), text boxes, and an image. Some stickies are organized into three rounded-square shapes that are connected to a circle at the center with arrows. Five collaborators' cursors are spread around the board.

4.1 Managing Multi-faceted Access Barriers in Digital Whiteboards

Since the beginning of the pandemic, many organizations and educational institutes have adopted digital whiteboarding tools (e.g., Miro, Figma, Google Jamboard) to support collaborative ideation. The workplaces of participants in our study were no exception to this. Several participants detailed how they engaged in *"thinking out loud"* (Gina) with their collaborators on digital whiteboards. These tools offer a range of interactive visual features to enhance idea generation, sharing, presentation, iteration, categorization, and solution convergence among collaborators. Some frequently used features among the participants included: sticky notes or text boxes to jot down ideas, tags or colors to label idea categories, shapes or frames for separating different sections, voting icons (e.g., '+', dots, or thumbs up/down emojis) to mark preferred ideas, @mentions for task assignment, comment boxes to provide feedback on others' ideas, and cursor tracking to monitor others' real-time location on the board. Figure 2 shows a sample Miro board prepared by the researchers.

On the surface, these digital whiteboard features help foster engagement in remote ideation [58, 67, 70]. However, our analysis revealed a plethora of accessibility challenges that disabled people encounter on these tools, as we detail below.

4.1.1 Dealing with Screen Reader Incompatibility. Both forum data and interviews showed that digital whiteboards offered little to no compatibility with screen readers and braille displays. Mia, Kai, and Saba had tried using Miro, Figma, and Google Jamboard as recommended tools for their work but found those to be *"nonsensical"* with screen readers. One forum poster tested Figma and FigJam with JAWS screen reader and noticed *"an absence of alt text, regions, and headers to perform basic screen reader navigation"* within these tools. Even PDF documents exported from whiteboards were rendered *"as essentially images, which makes it very difficult to generate accessible PDFs,"* noted two posters on Figma forum and Mia who tried this on Miro.

During our session, Saba encountered challenges while navigating a Jamboard that had been created by her sighted collaborators. The post-it texts were read aloud by her screen reader (JAWS), but there was no clear way to differentiate between different post-its, if a post-it was associated with another, or determine the post-its' relative spatial positioning. When Saba tried to add a post-it note and write content on her own, the text she typed neither appeared on the board nor was announced by the screen reader. The underlying cause of this inconsistency is revealed in a forum post: *"Even if you are using keyboard shortcuts, like creating a new sticky note by pressing 's', you'll still have to click the mouse to place it on the board."* This design limitation significantly hinders screen reader users from performing essential actions on Jamboard and impedes effective ideation. Participants in our study expressed frustration over this issue, saying *"What probably looks very nice and neat for everyone else, looks like a garbled mess for a screen reader user"* (Jason). The incompatibility with screen readers also means that these tools are inaccessible for deaf-blind individuals who rely on braille displays. Mia explained, *"If it's (screen reader) just picking up graphics or nonsense coding, that's what the braille display will echo, just in braille."*

While some digital whiteboards have incorporated screen reader support at the time of our analysis, those were either limited to read-only access to a few basic features (e.g., signing up, opening a board, and navigating to elements) or available only in paid enterprise plans.[1] Consequently, screen reader users were effectively curtailed in their ability to directly create or edit content on digital whiteboards. One poster criticized an update on the Miro forum:

> *"As sighted folks share this new update as a success, I sit back and wonder how so? While it definitely is more accessible now, it still gets an 'F' grade accessibility-wise... Miro's essentially saying, 'This tool is read-only if you are a screen reader user,' and as someone who's blind, I can't actively participate in brainstorming."*

Overall, these findings highlight the glaring lack of screen reader compatibility in digital whiteboarding tools that place blind and deaf-blind people at a severe disadvantage.

4.1.2 Adapting to Inaccessible Typographic and Magnification Features. While our low-vision participants were able to use digital whiteboarding tools to some extent, they struggled with a myriad of inaccessible typographic features related to font types, size, spacing, and color. During our session, when Julia (low-vision, migraine, ADD) tried to make the text large enough for her to read by zooming in, it broke down letter and line spacing on the Miro board, and she could *"no longer actually make out any of the text."* Typographic styles on digital whiteboards were inaccessible to many dyslexic people as well, who expressed their frustration on the Figma forum about tight spacing on bullet lists making the content *"hard to read"* and the lack of *"dyslexia-friendly fonts"* and built-in spell checkers *"setting dyslexic users up for making mistakes in front of others."*

Lack of color contrast came up as another burning accessibility issue in our interviews and on both forums. Low-vision users were disappointed because digital whiteboards *"don't meet the WCAG AA contrast standards"* (Julia), and thus *"dramatically interfere with my activity"* (Figma forum). We found posts or replies from over 25 forum users discussing the challenges with inaccessible color palettes for colorblind people. One poster on the Miro forum wrote, *"As colorblind, I can't understand when folks mention elements by their color."* To avoid this problem, some people used tags instead of color for categorizing objects (e.g., sticky notes). However, the color contrast of text labels on tags were also poor, making them hard to read. Julia suggested that digital tools enable *"a limited accessible color palette hard-coded in"* instead of *"letting people without any sort of accessibility background choose color contrasts that are impossible."*

Besides low-vision and colorblind people, design choices around color can be distracting and *"harmful"* to neurodivergent users as well. One poster on the Miro forum mentioned someone with dyspraxia or developmental coordination disorder *"struggling with the colorful mess"* created on the whiteboards. Another poster with ADHD wrote that they were not able to focus because of *"the very highlighted color and giant size"* of an alert on Figma and that they could not find an option to close the alert or change how frequently these notifications would come up.

Additionally, issues around screen magnification features like zooming and resizing elements were challenging for one-handed users. One Figma user who could not use their right hand

[1]For recent accessibility updates in Miro and Figma, please visit https://miro.com/accessibility-statement/improvements/ and https://www.figma.com/blog/accessibility/.

explained: *"I can't press CTRL while also simultaneously scrolling the mouse wheel for zooming, so I have to use the pinch gesture. But even the smallest pinch causes the zoom level to change dramatically, which makes zooming in/out not only impractical but also unusable."* Another one-handed user described facing similar challenges while resizing elements on a Miro board with a trackball mouse.

4.1.3 Minimizing Technology-Induced Pain and Illness. The lack of accessibility considerations becomes particularly difficult to manage for people with multiple disabilities, where the workaround to address one issue often causes another challenge. For instance, Julia's low vision required her to dynamically adjust content size on digital whiteboards, which subsequently triggered migraine for her. She explained, *"A lot of the solution to low vision is zooming in and out... And that basically makes me too nauseous to use the computer... The combination of being low vision and that sensitivity to movement just kills me with these tools."* Similarly, forum data showed that people with vestibular disorders experienced an *"extremely uncomfortable form of motion sickness"* triggered by continuously moving content on digital whiteboards that are designed to illustrate a dynamic flow in brainstorming. One Miro user said navigating the board by scrolling induced a *"whirling around feeling"* and that *"the gestalt of doing this hurts my brain and feels viscerally uncomfortable."* Others pointed out various sources of extraneous motion and animation on Miro: *"When there are too many sticky notes on a board, their drop shadows create a wavy line effect. I also need to remind myself to look away from the bouncing motion of the timer when it's done."*

Tracking collaborators' real-time activity, although beneficial for developing collaboration awareness [20, 61], is another key source of motion sickness for disabled people. Forum posters wrote that they *"dread collaboration on Miro because it's quite tiresome to see the screen being dragged around"* in different directions and to follow *"the live updates on the board by other users."* To minimize nausea, Sylvie preferred doing *"asynchronous work when other people are off,"* and in cases when synchronous work is necessary, she resorted to *"just look[ing] away from the screen or to really zoom[ing] in on just the section I'm working on."* Julia, in contrast, had to ask her collaborators to avoid using *"nausea-inducing"* digital whiteboards and presentation tools (e.g., Prezi) altogether, since she felt *"violently ill"* by observing others' movement on the board.

Additionally, forum posters described *"enduring headache and eye strain"* due to bright backgrounds on digital whiteboards, which they termed as *"retina-destroying"* and equated with *"looking directly into the headlights of a car."* Although posters shared *"fixes"* (e.g., third-party solutions) to simulate a dark mode, those were not viable in the context of collaborative ideation. For instance, browser extensions like Dark Reader *"invert all colors and images which makes collaboration impossible,"* since others often referred to whiteboard elements or images by their specific colors.

Furthermore, the *"mouse intensive"* features on digital whiteboards are significant sources of pain and illness for disabled individuals. Forum posters lamented that working on digital whiteboards required too many mouse clicks, which is *"literally a physical pain point"* for people with carpal tunnel neuropathy or tendonitis and ergonomic mouse users. Sylvie, who had a limited use of her dominant hand due to a nerve damage, tried to *"reduce the amount of mouse dragging"* on whiteboards and created new content reusing previous materials as much as possible by copy-pasting with keyboard shortcuts. However, limiting mouse interactions restricted her from exploring the full functionalities of digital whiteboards and resulted in her boards being *"very simple"* and *"not beautiful."* She (and also forum posters) strongly advocated for keyboard-only navigation options and dictation/voice commands on digital whiteboards to better support people with upper limb motor impairments as well as blind screen reader users.

4.1.4 Navigating Unstructured Content and Messy Workflows. Digital whiteboards present access barriers that extend beyond their built-in inaccessible features, as they are also influenced by how collaborators utilize these tools to create content and structure ideation workflows. Despite offering an *"infinite canvas"* for users to place their thoughts, these tools often lack a navigable hierarchical structure. This lack of structure poses challenges for our disabled participants, making them feel *"very lost in space"* (Sylvie). The problem with unstructured content is particularly salient for low-vision users like Aaron. While sighted people are *"able to just at a glance get an understanding of what's on the screen,"* Aaron needs to adopt *"a depth-first way"* to orient himself within information-rich whiteboards, which *"necessitates going through each element one by one."*

To make his exploration process easier, Aaron had developed various strategies that involved tracking *"distinguishable landmarks"* and making *"educated guesses"* based on the context of the prompt. For instance, when tasked with typing answers on a whiteboard, he tried to identify the element that *"looked the most white"* (i.e., resembling an empty text box) as a likely place to leave answers. Another strategy for locating elements of interest was to consider the level of completion of the ideation activity (e.g., if the activity was at an early stage and involved row-wise content, then looking at the topmost rows for clues). However, these strategies failed if there was a *"chaos of directionality,"* for example in cases of radially organized content that moved away from the center in all directions. In such cases, Aaron looked for *"informal"* landmarks implying high-activity zones (e.g., *"cursor flurry"* from collaborators' movement). At other times, he tried to *"memorize where everything was"* on the board if he got sufficient upfront time to do that. Despite these extensive *"hacks"* to guess or memorize content organization within a board, Aaron lamented that these were not accessible solutions per se, instead, *"it's like strategies to feign being able to navigate these tools... But ultimately, it's sort of just pretending I can see it."*

Beyond the lack of organization in content, the task of brainstorming itself presents access barriers due to the lack of structure in the interactions. An inaccessible but fairly common brainstorming exercise involves sorting randomly-placed elements (e.g., sticky notes) into *"vague categories."*

> *"Sorting sticky notes or making any rich comparison between things asks you to- for every element, look at every other element in a collection. And because I have to physically pan, zoom, presently un-zoom, zoom, pan - just the sheer time it would take for me to operate that kind of thing is just pretty inordinate."* - Aaron (low-vision)

The complexity of unstructured brainstorming activities coupled with the limited amount of time [36, 41] assigned during sessions made it extremely challenging for blind and low-vision people to engage seamlessly in collaborative ideation. Saba (blind) recalled an in-person workshop where the organizers neither structured the activities well in advance nor allocated enough time for her to get on board. She explained, *"They gave a 15-minute crash course on what's going on... But I needed way more than 15 minutes to understand what my part is...They're like, 'Oh, it's easy, it's easy.' Honestly it was almost so intricate that by the time you figured out how to do it, it was time to be done."*

The lack of structure in workflows constitutes a cognitive access issue for neurodivergent individuals as well. Mia explained, *"Because I have ADHD, if you don't give me structure, I am all over the place. Somebody who is autistic may need to just know where we're going. So, when you put in a structure... it helps leverage all of our strengths rather than adding confusion and anxiety to a process."* Collaborators' inconsistent real-time actions added to the lack of structure, which resulted in our neurodivergent participants feeling *"zoned out."* Gina (ADHD) said, *"When the coordinator is jumping across different frames, I find it hard to keep track of what they're saying... Somehow my brain just goes somewhere else."* In sum, access barriers in digital whiteboards can be exacerbated by collaborators' actions including unstructured content, messy workflows, and inconsistent real-time actions, particularly for low-vision and neurodivergent individuals.

4.1.5 Maintaining Complex Communication Setups. To maintain synchronous communication during remote ideation, some digital whiteboarding tools have recently incorporated built-in audio/video calling features. While these new features aim to enable more seamless communication

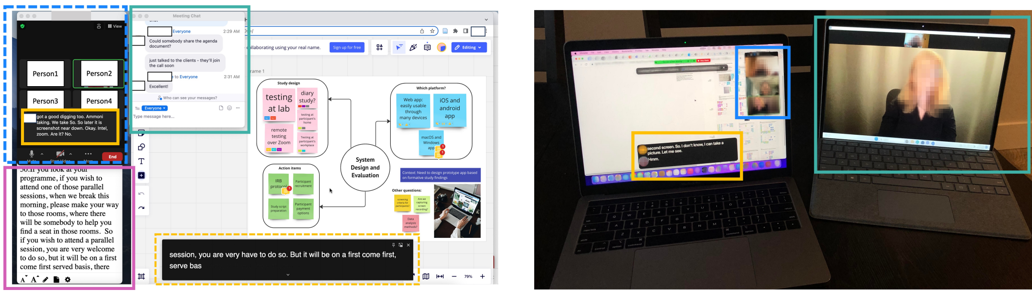

Fig. 3. **Left image:** Researcher-made representation of Jordan's (hard-of-hearing) typical setup. A digital whiteboard takes up most of the screen. A video call (blue dashed line) partially covers the CART window (pink outline) and both are shrunk to a column on the left part of the screen. The video call has live captions inside (yellow outline). A chat window is placed to the right of the video call (green outline). Google captions (yellow dashed line) is placed at the bottom of the whiteboard but movable anywhere. **Right image:** Paula's (Deaf signer) setup during the interview. Left monitor shows a digital whiteboard with captions at the bottom (yellow outline) and attendees' video feed (blue outline) when Paula is screen sharing. An interpreter is on the interview call and a separate one-on-one call with Paula (right monitor, full screened for better sign access).

opportunities for non-disabled people, considerations for DHH users have remained largely overlooked. For example, Figma's audio-only call does not support DHH users who rely on lip reading or need to *"see each other on video to sign."* Many digital whiteboards do not provide automated captions for their audio/video calling features (e.g., Miro), while the ones that do (e.g., Figma) fall short in the design of captions in terms of font size, delay, caption area (*"takes up a lot of space on your whiteboard"*), and positioning flexibility (*"it's static—you can't really move it around"*).

Instead of relying on built-in captions on digital whiteboards, our DHH participants commonly turned to videoconferencing platforms that provided more flexibility with caption area and positioning. While this workaround improved access for DHH individuals, they must still consider the trade-offs between various automated captions and CART[2] services to find the optimal setup for their work. No single captioning service fulfilled all the requirements in terms of caption accuracy, lag, speaker identification, flexible positioning of captions on-screen, customizability of caption size, color and style, availability of full transcripts, and access to captions/transcripts through braille displays (for deaf-blind people) [63, 73, 74]. Hence, DHH participants had to maintain a complex setup comprising multiple caption sources (in case one failed), video feeds of ASL interpreters and other collaborators, and chat window, as also found in prior research on videoconferencing access [9, 44, 52, 53, 80]. However, this situation played out in an even more complicated manner in the highly visual task of digital whiteboarding where DHH participants must carefully manage their screen space to accommodate various captioning and video interfaces while prioritizing the whiteboard for ideation (see Figure 3, left).

> *"I have a 16-inch laptop...I'll minimize the CART window to make it like one-fourth of my screen and to the side. Then I have sort of a square <office-mandated videoconferencing tool with static captions>...CART and video tool are covering each other. I'll have Google captions which is [placed] anywhere... And then Figma is like three-fourths of my screen. Maybe even 90%, if I feel really active there, immersed, I'll prioritize that."* - Jordan

D/deaf signers had to maintain an even more complicated setup including dual monitors to ensure that they *"can see the interpreter larger on the second device,"* said Paula (see Figure 3, right).

[2]In CART (Communication Access Real-Time Transcription) service, human transcribers provide real-time captioning.

Consequently, these participants found it *"very fatiguing for your eyes to look back and forth at the captions and the interpreter and Zoom and the design screen. It's a lot to take in visually and it's easy to miss things,"* explained Lily. The complexities with *"divided attention"* across multiple interfaces and monitors have been well-documented in prior work on videoconferencing access [9, 44, 71]. However, digital whiteboarding in a professional setting had a compounding effect on this already complicated process and added to the logistical work signers must perform to create access. For instance, when a collaborator refers to an object on the whiteboard, *"there is a few seconds delay for the interpreter to process cognitively... because they're having to look and describe something that's not on the same screen that they're looking at. So, they're not sure specifically what you're pointing to"* (Paula). To mitigate this issue, Paula managed her interpreter to log in to the whiteboard workspace, which required her to get additional security approvals from her company. Nevertheless, the challenge still persisted when hearing colleagues—being unaware of the interpreting delay—quickly moved on to different topics with their *"mouse pointing to a different picture"* on the whiteboard by the time the signer identified what their colleagues were pointing at before. Thus, it became increasingly difficult for the signers to keep up with the pace of ideation.

Overall, our analysis revealed that the multifaceted access barriers on digital whiteboards coupled with collaborators' lack of awareness and/or consideration for access needs made it challenging for our disabled participants to contribute equitably during collaborative ideation.

4.2 Collaboratively Configuring Accessible Tools and Practices for Ideation

To navigate the multifaceted access barriers in digital whiteboards, disabled people have to piece together various strategies for making the process of ideation more accessible to themselves.

4.2.1 Developing Shared Strategies to Work through Inaccessible Tools. Since digital whiteboards were not at all compatible with screen readers or braille displays, our blind participants sometimes worked with a sighted collaborator or an assistant to come up with alternative plans to share their ideas with the entire group. For example, they would send their ideas via chat to sighted collaborators who then posted those on the whiteboard on behalf of them. The sighted collaborators also shared some highlights from the whiteboard with the blind participants. Similarly, Aaron (low-vision) requested his sighted collaborators to provide directions or *"vigorously move cursors"* that would indicate a high-activity zone and make it easier for Aaron to find areas of interest (see Section 4.1.4). An example of collaborative workarounds also came forth on the Miro forum, where one poster shared a photo of a guide they created showing *"text labels of color names"* for a colorblind coworker to help them *"identify and distinguish between colors."*

Importantly, we found that people with different disabilities supported each other in developing workarounds for access barriers by *"volunteering for their strengths"* (Sylvie), and thus creating a form of access synergy [36, 50]. Saba (blind) recalled a brainstorming session where *"my friend would write my ideas down for me. She has cerebral palsy and so is a wheelchair user but can write on the board."* Aaron (low-vision) whose color perception was intact, helped his colorblind collaborator by sending hex values of colors to be used in coding and design projects instead of referring to whiteboard content by colors. Sylvie, who had limited use of her dominant hand, described how her collaborators divided work such that each could contribute aligning with their access needs. Her non-disabled collaborators did *"a lot of the fine motor work"* involving mouse interactions on whiteboards, whereas another collaborator with similar disabilities as hers did *"a lot more of the logistical project management work."* Similarly, non-signer collaborators (both hearing and hard-of-hearing) often worked as a *"scribe"* for d/Deaf signers who found it *"challenging to sign and type at the same time"* (Paula) during ideation, as also found in prior work [71, 74].

Developing these strategies is an important part of access work that *"takes intentionality and forethought of— even when tools aren't fully accessible, what can we do [to] make this as accessible as we can and actually plan for it?"* (Mia). Even when collaborators were not fully aware of each other's access needs beforehand, they sometimes developed temporary strategies *"on the go"* (Kai). Paula (Deaf signer) recalled a late-night ideation session with a hearing collaborator where they utilized the *"text tools"* on Figma to communicate with each other in the absence of an interpreter [74]. In another situation, she was ideating with a blind classmate in the absence of an interpreter when a hearing signer classmate *"showed up in the room. And then, they would take over and become like a middleman, the communication manager, and mediate a conversation between the two of us."*

While participants appreciated their collaborators sharing access labor to make it work within *"deeply inaccessible"* whiteboarding tools, they also pointed out that these stopgap strategies were not feasible and sustainable in broader contexts. As an example, Mia recalled a situation where sharing her ideas on a whiteboard through a sighted collaborator quickly became *"overwhelming,"* because *"it was just a lot happening that was not working for me."* Furthermore, she felt that relying on sighted collaborators to access the content of a whiteboard was *"less autonomous than me just being able to scroll through things"* directly with the screen reader. Thus, although participants were able to find workarounds to access whiteboards in some cases by working with their disabled and non-disabled collaborators, these strategies may not generalize across different team configurations and cannot be considered as solutions for the inherent limitations of ideation tools.

4.2.2 Creating Ideation Workflow using Mainstream Writing Tools. Considering the access barriers described above, participants often *"abandoned"* digital whiteboards and instead switched to mainstream collaborative writing tools and spreadsheets for brainstorming. Among our blind and low-vision participants, Google Docs and Microsoft Word were the most frequently used alternatives followed by Google Sheet, Excel, Google Slides, and PowerPoint. Although these writing tools also had many accessibility issues, participants preferred to *"stick with"* these traditional tools primarily because, as Mia (blind) said, *"People are already super familiar with that. Don't require a whole set of new skills with keyboard commands, figuring out how to navigate this... Both my sighted and blind colleagues could collaborate simultaneously in an accessible way."*

During our sessions, participants (Mia, Jason, Saba, Kai, Julia, Sylvie) demonstrated how they facilitated brainstorming sessions using regular writing tools. In Word or Docs, they used heading/subheading structures to organize ideas under separate prompts and themes. Within each heading, they used bullet lists to type new ideas along with sub-bullets to add links and additional resources related to individual ideas. This organization with headings and bullets was easily navigable with keyboard shortcuts, and thus more accessible to screen readers users and those with limited hand dexterity. Despite being a primarily text-based medium, the typographic differences between headings/subheadings along with the indentation differences between regular text and bullets/sub-bullets made the documents *"both visually and auditorily (with screen readers) easy to differentiate and section off,"* explained Jason.

Orientation and navigation within traditional writing tools are also much smoother for low-vision people compared to the *"freeform nature"* of whiteboards. Aaron (low-vision) recalled a positive ideation experience where the facilitator organized content in a *"one-dimensional... directionally boxed-in flow"* on Google Slides, which provided him with an *"easily followable path"* to different elements of interest. He explained, *"Google Slides gives you index at the level of the slide, and then if you have the information in one column, then you have easier indexing, like, 'Go to question two of slide one.'"* Similarly, Kai (blind) showed how spreadsheets made it easy for him to navigate between cells in a *"grid layout"* using screen readers where he could organize themes in separate columns and use the 'merge cells' feature to *"bucket"* subthemes under each theme.

Interestingly, the way participants structured ideas in a text document, spreadsheet, or slide-deck has similarities with how content is typically arranged in digital whiteboards with sticky notes and categorized by colors/tags within separate frame boundaries. Mia commented, *"It's an equivalent for me of moving sticky notes around if you had a whiteboard and you wanted to put them all under specific buckets."* Jason also called this structure a *"DIY (Do-It-Yourself) whiteboard kind of setup without being Jamboard or Zoom Whiteboard. It's still a perfect brainstorm setup to keep it nice and neat and tidy."* For instance, an important phase of brainstorming is to identify the most salient ideas and converge on preferred action items. While digital whiteboards have built-in voting features to support this task, Kai, Jason, and Mia showed how they had come up with *"easy to read [with screen readers] and easy to see"* notations to triage ideas collected in a document, such as by using asterisk (*) or exclamation (!) to denote preferred ideas and question (?) to indicate unsure ones. Jason commented, *"We're talking about features that have most likely already been put into these whiteboard things. And with a plain old Google Doc, you have to get creative... [and] improvise."*

Despite being more accessible than digital whiteboards, mainstream writing tools were not free from problems either. Echoing findings from prior work [20, 22, 23], participants in our study shared that these tools *"get finicky"* (Saba) with verbose screen reader announcements for collaborators' edits; yet do not clearly convey who is editing what and where. Additionally, Aaron (low-vision) explained that real-time editing on these tools gets *"jarring"* for him because *"I'm generally only appreciating a couple characters at a time, and so when co-editing content with someone, things get nudged out of my field of view"* by characters being continuously inserted or deleted by others. Moreover, screen readers do not announce when text on Google Docs or Sheets is highlighted with color or checked off using strike-through, a common practice among Kai's sighted collaborators for de/prioritization of ideas. This made it difficult for Kai *"to recognize that this text is emphasized, or it looks different than something else."* Thus, although many participants preferred using traditional writing tools as a more accessible alternative to digital whiteboards, there is no avoiding the accessibility issues present on these writing tools themselves.

4.2.3 Balancing the Promises and Perils of Digital versus Physical Tools. A challenging aspect of collaborative ideation is that different tools work better for people with different disabilities in diverse contexts. Hence, before deciding on an optimal setup for their work, group members must weigh pros and cons of using physical tools (e.g., whiteboards, markers, post-its, pen and paper), digital whiteboards, or digital writing tools for satisfying everyone's access needs. Other factors related to ideation such as the ease of documentation, storage and sharing, reusability, and support for creative thinking also impact their decision. On the whole, seven participants (Julia, Sylvie, Gina, Sofia, Ella, Avery, Chloe) preferred physical tools, six (Mia, Kai, Jason, Carla, Saba, Aaron) preferred digital writing tools, three (Jordan, Zoya, Giselle) preferred digital whiteboards, and Paula and Lily liked both digital whiteboards and physical tools in different contexts.

While digital whiteboards pose significant access barriers for blind and low-vision people, for visual learners including some neurodivergent and DHH people, these tools enhance the exploration and expansion of ideas. Giselle (autism, ADHD) shared that they *"thrive on visual information on Jamboard... [Because] I don't have to just rely on my working memory."* Jordan (hard-of-hearing) echoed this sentiment, highlighting the benefits of visual-spatial hierarchy in whiteboard content compared to writing-heavy tools: *"If something's essay format and a list, you don't have that creativity or that spontaneity and possibility to move ideas around like that. I feel like visuals support that more."* Although physical whiteboards also support visualizing and reflecting on each other's ideas in a co-located space, for DHH participants, maintaining a *"line of sight"* with live or CART captions on a computer becomes difficult during in-person ideation. Jordan explained, *"I have to look back and forth [to cover] a further distance for pivoting to see others, lip read, [follow] captions, stuff that's* *happening, making your own stuff [on the whiteboard] ... So, it's definitely a lot more effort with physical [tools]."* Deaf signers also preferred digital whiteboards for working with hearing and/or non-signer collaborators where captioning is a must. In an all-signer group, however, in-person setups with physical tools worked better, *"because you can see more of the person's body language, their facial expressions are more clear, more accurate and you can see some hidden details as well"* (Lily). Thus, whether one relies on captioning or signing becomes an important factor in the choice of digital vs physical whiteboarding setup.

Beyond sign access, some other participants preferred physical tools to digital ones for various reasons. Due to her dyslexia, Sofia felt that *"It's easier to annotate, read and comprehend... when you can physically draw with freedom on a piece of paper, when you're not restricted to lines of text and speech bubbles."* Gina (ADHD) also found in-person ideation with physical tools more conducive for maintaining focus in her work. She said, *"While doing it physically, I'm a little more present and I don't zone out that soon because you're standing, sitting, talking—when all that happens, I tend to feel more energized, and I can pay more attention."* Julia and Sylvie also favored physical whiteboarding tools primarily due to the scale and enlarged space they offered. Sylvie who had *"minimal functional use of dominant hand"* found it easier to work on physical whiteboards because *"I can write really big and I can use gross motor movement to control it,"* whereas mouse-intensive work on digital whiteboards required fine motor control of upper limbs that was painful for her. Julia (low-vision, migraine), another strong proponent of physical tools, explained, *"A lot of my positive experiences rely on being in the physical space with someone and being able to put those post-it notes all over the wall and draw pictures on giant easel size, like 3′×3′ poster boards."*

Despite its enlarged space, whether or not content added on a physical whiteboard is readable by a low-vision person depends on their distance from the board and the size of texts or sketches drawn on it. When located at a distance from a physical whiteboard, Aaron (low-vision) said he had to *"look through the phone camera"* using its 'zoom' feature to magnify and read content on the physical board, making the process *"draining"* for him after a while. Considering this tradeoff, he preferred digital tools despite their access issues, *"because I can still retain the capability to zoom into stuff."* For a similar reason, screen reader users unanimously preferred digital writing tools to physical whiteboards because they could not directly read content on a physical board.

The diverging preferences and opinions on ideation mediums among the participants allude to an important concern for ability-diverse teams: how to find a balance between competing access needs among collaborators with different disabilities.

4.2.4 Addressing Access Conflicts in Collaborative Ideation. Amidst the benefits and drawbacks of various modalities and tools, access conflicts frequently arise in collaborative ideation [9, 24, 36, 50]. Considering this, participants who regularly facilitated brainstorming sessions (Mia, Jason, Sylvie, Julia) said that they make advanced planning to figure out *"how we can fulfill the greatest number of needs at the same time"* (Mia). Prior to any session, they check in with all group members about their individual access needs and *"assign kind of a point of contact for any access needs that might arise"* later in the ideation process. Additionally, while deciding on an ideation tool or setup for the entire group, they consider *"who's using what AT (assistive technology) and what setup works the best for everyone's set of AT ... cuz just because something works well with your AT doesn't necessarily mean it works better with others"* (Jason). In cases where a consensus is not possible, they choose a setup that may not be the most preferred by everyone but at least acceptable to all and not *"terrible for any one person"* (Julia) or *"did not set fire to [their] productivity"* (Jason). Sofia said, *"We find good compromises that make it much less difficult for each of us to work together."*

Thus, figuring out *"a happy medium"* (Sylvie) becomes key to reconciling access conflicts in ability-diverse teams. Sofia recounted a collaborative project where she and her collaborator had contradictory access needs. Due to her dyslexia, Sofia needed to highlight text with bright colors to distinguish between adjacent lines. Her collaborator, however, felt overwhelmed by the use of extraneous colors due to a different type of neurodivergence. Eventually, Sofia and her collaborator identified *"a sweet spot where the lines were easily distinguishable for me, but not overwhelming to the other person. We just had to highlight with soft colors and make sure the text was really big, so I didn't have to use as many colors."* Julia described a similar access conflict involving d/Deaf signers and people with ADD (attention deficit disorder) in her group. During remote brainstorming, ASL interpreter's camera needed to be enabled all the time for d/Deaf signers' access. However, Julia said, *"if you are ADD like I am, and you have somebody gesticulating beautiful sign language, you can be assured that I can't follow a conversation because I just watched the sign language interpreter."* To balance these conflicting needs, all group members had to learn how to *"pin the people that you want to see and hide the people that you don't wanna see"* on the videoconferencing tool.

Yet, finding a middle ground gets difficult in certain situations and it becomes important to prioritize some needs over others. In such cases, participants often prioritized the needs of those who were the most impacted by inaccessible technologies or collaboration norms [50]. For instance, one participant who was a professor moved away from their typical ideation setup on Miro and recommended that their students use Google Docs or Sheets instead, prioritizing the need of a blind student who otherwise would not have been able to meaningfully participate. Sylvie similarly prioritized her junior colleagues' needs for an accessible brainstorming workspace over her own need to avoid mouse-intensive work. She talked about spending hours in *"putting alt text, captioning videos, changing colors and fonts of all my slides... because of a different attendee's access needs in a different session... It's a lot of typing, clicking, and dragging. But it's too important. So, I'm doing it."*

Furthermore, participants provided additional support to those whose needs could not be met at a given instance and considered alternative ways to mitigate impact. For example, even when shifting to a screen reader-compatible text medium for ideation, Mia (blind) attended to the needs of neurodivergent group members and other visual learners. She often chose word processing tools over spreadsheets, because *"when it comes to the visual aspect, it's easier to create consistency with the font on Word docs, whereas with spreadsheets, you're always having to think about, is the text wrapping? Are things getting cut off [by cell boundaries]?"* Similarly, when choosing spreadsheets for brainstorming, Kai (blind) updated the visual formatting to support his sighted collaborators' understanding of the content. During our session, he demonstrated how he merged multiple cells to increase its length and width, since text overflowing out of cells *"might intuitively not be very clear to the sighted person... even if I can write something in one cell for me as a screen reader user."*

As the examples above indicate, resolving access conflicts needs continual, deliberate effort from all collaborators. At the same time, these vignettes raise questions about how access labor can be distributed equitably so that disabled people do not have to disproportionately take the brunt of this work. Participants who were professors mentioned requesting external support from a teaching assistant or the disability services center for preparing accessible teaching materials when students' needs contradicted with their own access needs. However, organizational bureaucracy often complicates this situation and perpetuates harms for both disabled professors and students [25, 38, 69, 76, 77]. One professor expressed frustration that due to the *"lack of planning"* of the university's disability services center in response to their students' accommodation requests, they had to do *"a ton of work"* that was necessary to support the students' needs but caused access friction [33] for themselves.

> *"You can't add 40 hours a week to my schedule...<Disability Center> does not understand that there are disabled faculty... I have tried and failed to describe this. And they are at best incompetent, sometimes I think they're malicious and ableist. The more charitable take is that they are so under-resourced that everything just falls through the crack."*

Negotiating who is going to shoulder access labor is one of the various ways in which disabled people navigate interpersonal and organizational ableism, power dynamics, and systemic oppression, which we discuss next.

4.3 Braving Ableist Collaboration Practices and Professional Standards

Configuring accessible ideation workflows requires careful negotiation of access needs among collaborators, and the decision of when and how to advocate for access needs is fraught with professional and ability-based hierarchies [20, 50]. When working with non-disabled collaborators, our participants had to expend significant time and effort on *"educating people about why we need to have accessibility"* (Carla) and how to develop workarounds for inaccessible technologies. Jordan (hard-of-hearing) talked about an inadvertent *"teaching moment"* with a colleague where they shared their entire desktop screen via video call instead of a specific FigJam board, revealing their complex setup with multiple captions, video calling window, and the whiteboard. Their colleague exclaimed, *"Whoa, I've never seen that! It's just interesting to see your setup and what you're looking at... That was such a learning experience for me."* This example indicates that disabled people's access labor remains invisible to their non-disabled collaborators if not *"literally spelled out"* [9, 15, 84]. The inaccessible features of technologies also remain hidden from non-disabled collaborators and the onus falls on the disabled person to bring forth these issues to the entire group. Kai (blind) noted, *"People can't make out if there is an alt-text [of images] or not, and I have to tell them."*

Negotiating access needs gets further complicated when collaborators have *"inherent prejudice toward disabilities"* (Sofia) and perceive disabled people as being *"difficult"* (Sylvie), *"disagreeable and a pain in the a**"* (Julia). Participants felt that colleagues in predominantly able-bodied workplaces sometimes remained *"willfully ignorant"* (Julia) to their accommodation requests. Mia recounted a design thinking session where despite her calling out the accessibility issues on Miro, facilitators carried on with it. She left that session altogether, *"because it was just not worth my time or effort and frankly the stress level I was experiencing."* She added, *"A lot of the time you can voice how things won't work for you, but they will happen anyway because your needs aren't really relevant."* Mia acknowledged having the *"privilege to walk out"* of the inaccessible brainstorming session, because *"My boss is very supportive. I don't have to justify myself and I know I'm not gonna lose my job because of it."* Others, however, did not have the job security or were not in a position of power and had to resort to *"faking participation"* during inaccessible ideation sessions. For instance, Aaron said he would *"linger or pretend to look at a Miro board"* knowing that *"I won't be able to perform at the same pace as others"* and would not get sufficient time to meaningfully participate.

Adding to the stress stemming from colleagues' indifference towards inaccessible ideation practices, workplaces introduced *"a new tool every other week"* (Aaron) and participants had to spend inordinate time and effort to learn these constantly evolving—and yet inaccessible—technologies. While some participants waited to see if a tool stuck long-term before committing to learn it, this was not always possible, particularly when inaccessible technologies were mandated at workplaces because of either dogfooding of internal products or commercial deals between organizations. As one student noted, *"I've seen this across <University 1> and <University 2>. Miro seems to be the choice of schools right now and I'm just kind of beholden to those decisions."* Similarly, Jordan's and Mia's companies required using their internal videoconferencing tools that were less accessible than other competitors' products. To make matters worse, professionals in certain disciplines (e.g., UX or human-centered design) *"tend to make extensive use"* of emerging *"fancy"* whiteboarding tools whereas relatively accessible alternatives (e.g., Google Docs) are not considered *"professional or polished enough"* for the purpose of ideation. Considering this professional demand, Sofia had to *"just suck it up and use the inaccessible tool, if it's a powerful audience."* Others who could not use these tools at all felt that certain *"parts of the HCI career path aren't digitally accessible"* to them.

The examples above point to broader organizational ableism that makes it *"impossible for people to separate your ability to tool from your broad competency,"* said an HCI grad student who was formerly a UX designer. Thus, participants' inability or unwillingness to make do with inaccessible technologies often *"comes with a huge career cost."* Julia shared not being able to take a position because it required using digital whiteboarding tools. Some participants called out the deep-rooted systemic oppression that fuels this practice of tying professional competency with proficiency to use inaccessible technologies, thwarting disabled people from reaching positions of power.

> *"We don't often design technology with the broadest access needs in mind—and Miro is a classic example of that. The assumption that people with disabilities will not be in the room to contribute their ideas, that is systemic oppression. Because if you create a tool where disabled people can't contribute, it means that then their voices will always remain marginalized or completely unheard."* - Mia

Our analysis revealed collective advocacy from disabled people and their allies towards creating accessible and equitable opportunities for people with disabilities in collaborative ideation. On Miro and Figma forums, 16 posts described industry or higher education institutes going back to more conventional tools because their organizations wanted to *"make every aspect of our collaboration and digital work accessible"* and the lack of accessibility support in ideation tools was considered to be a *"deal breaker."* Some interview participants who were in authoritative positions led similar activism and advocacy efforts. At her organization, Mia *"advocate[s] to use the most accessible methods and tools that we have... And we have worked with Miro to really push them to kind of improve their accessibility."* Similarly, in her role as a disability liaison, Julia *"made the case that it would be cheaper for <Organization> to buy more expensive accessible software than to continue paying out lawsuits... And I won that argument. <Organization> now has a policy that says it will not purchase a software that is not WCAG AA compliant."* These examples illustrate participants' advocacy efforts to *"fight the hegemony of inaccessible software choice...on an institutional level."*

In summary, forging accessible ways of ideation in predominantly able-bodied workplaces requires disabled participants to tread carefully around interpersonal relationships and power differentials but also combat ableist organizational policies to make impactful changes.

5 DISCUSSION

Drawing on Disability Studies scholarship [11, 12, 25, 33, 34, 37, 41, 55, 65], we now revisit our findings to unpack the deeper implications of collaborative ideation technologies on the professional success of disabled people and their continuous, thoughtful effort towards reconciling competing access needs within ability-diverse teams. Through this, we call for a careful reevaluation of established—but ableist—norms in collaborative ideation and redesign of systems to support diverse ways of thinking and communicating ideas among disabled people.

5.1 Revisiting Access in Collaborative Ideation

Ensuring equitable access in collaborative ideation requires revisiting how the process of ideation has been conceived of over the years [27, 48, 59, 62, 68] and how the design of technologies have mediated and remediated this process [18, 39, 45, 51, 75]. Ideation technologies of modern times enable a wide variety of visual stimuli, dynamic flow, animation, pictures, and visual communication channels to inspire new, hard-to-express ideas [42, 75], foster awareness of ideas as they are generated [18] and encourage building off of each other's ideas [85]. Bulk of these systems and the ideation practices shaped by these systems are rooted in the underlying notion that "the ability to *see* and reason about it is fundamental to 'designerly' thinking" [42, emphasis added] which reinforce the assumption of a "normate" [30], non-disabled user. The critical question is, then, how do disabled people engage in ideation with disabled and able-bodied others and how do technologies and work practices impact their participation in building and sharing ideas?

Our analysis revealed that certain aspects of the mainstream ideation tools aligned with access needs of some, especially those who required visual anchors to perceive, navigate, and create content. However, others who relied on alternative modes of interaction such as through screen readers, braille displays, screen magnification, and keyboard-based navigation encountered severe barriers on digital whiteboards to the extent that they had to *"opt out"* (Sylvie) or *"fake participation"* (Aaron). Even DHH participants who could follow the visual elements still had to manage complex communication setups to compensate for the lack of built-in caption and ASL interpretation support. Similarly, neurodivergent and chronically ill participants had to deal with cluttered content and technology-induced pain and illness. As these examples indicate, by focusing solely on augmenting creative thinking capability of the normate user, existing digital whiteboards disadvantage and exclude disabled people from collaborative ideation practices. Moreover, disability experiences are diverse, evolving, and relational [11, 12, 41, 55, 57]. Thus, a singular understanding of what it means to be creative or produce innovative ideas, as has been viewed in collaborative ideation literature [42, 85], fails to capture the varied ways in which disabled people think, perceive, imagine, and express ideas [34]. Indeed, our findings show instances of disabled participants crafting artful strategies to make ideation process more accessible to themselves, thereby challenging the monolithic way of ideation that current technologies strive to establish as the standard. For example, blind screen reader users constructed *"DIY whiteboard"* setups using conventional text-based writing tools and spreadsheets while DHH participants made use of text boxes on digital whiteboards to exchange ideas with hearing collaborators in the absence of ASL interpreters [71, 74]. As long as these unique ideation practices and preferences of disabled people are positioned outside the standard norms of collaborative ideation, disabled professionals will not have an equitable opportunity to bring their ideas to the table and contribute to their fullest potential.

Analyzing the case of collaborative ideation also prompts us to rethink how the advancement of technologies produce "digital ability expectations" [17, 87] and further marginalize and stigmatize disabled people who, being expected to use such technologies despite their access issues, fail to meet those expectations [26, 57]. As our analysis illustrates, the widespread use of digital whiteboards in professional and educational settings [28] renders compulsory particular ways of ideation (e.g., sorting sticky notes on a digital whiteboard) that are inaccessible to a broad range of disabled people. Yet, professional competency is measured by the ability to demonstrate proficiency with these technologies [72], leading to the erasure of disabled people from certain career paths [25]. Participants in our study led advocacy efforts to defy these ableist norms and standards and limit the use of inaccessible technologies within organizations. As Hamraie and Fritsch [34] assert, "Disabled people use technoscience to survive and alter the very systems that produce disability or attempt to render us as broken." Thus, disabled people rejecting ideation technologies in this context demonstrates a form of resistance and collective advocacy against systemic ableism that fuels the design and adoption of technologies with imposed ability expectations.

5.2 Towards Reconciling Access Conflicts in Ability-Diverse Collaboration

Our work joins that of others [9, 24, 25, 36, 49, 50] who foreground how different access needs sometimes come into conflict such that making activities more accessible for one impedes participation of another. A deterministic view may probe us to figure out a 'fixed' set of checklists or guidelines that would ensure accessibility for all. However, access conflicts trouble this assumption and instead encourage us to rethink "access as a process" [12] in which diverse needs engage, synergize, and collide with one another [25]. With this perspective, we synthesize stories of participants in our study with those in prior work [9, 50] to elucidate the continuous process in which people fluidly

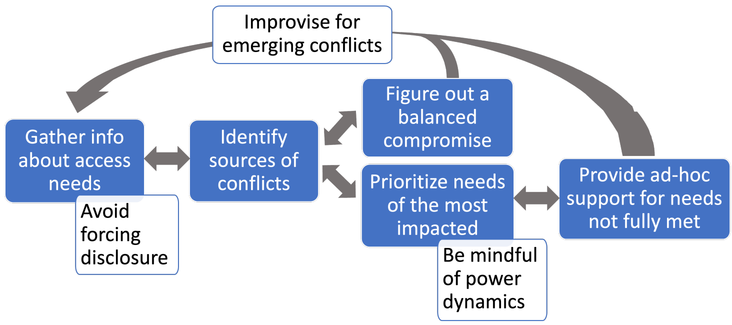

Fig. 4. The process to move towards recognizing and reconciling access conflicts, as outlined in Section 5.2.

move towards recognizing and resolving access conflicts in ability-diverse collaboration (Figure 4). This process to reconcile access conflicts is a fragment of the overall workflow in which access is co-constructed (see e.g., [37, 50, 65]). While our analysis mainly focuses on the ideation phase, insights around access conflicts, as we discuss below, can be transferable [47] to other phases of creative collaboration (e.g., implementation, critique, and project management) [29] more broadly.

Drawing on our findings, we recommend that prior to the collaboration sessions, facilitators initiate conversation with team members to **gather information about their access needs**. Important to note is that people may not always feel comfortable to reveal their disability to collaborators due to social stigma, as some of our participants (Gina, Ella, Chloe) also did not. Instead, they communicated their access needs without explicitly mentioning their disability. Thus, while asking for access needs, facilitators must remain mindful about not forcing someone to disclose disability.

Upon collecting information about access needs, facilitators should **identify sources of potential access conflicts**. They need to factor in whether and how individual team members' communication modalities (e.g., visual, auditory, textual, tactile), assistive technologies or services used, preferences of ideation tools (e.g., digital whiteboards vs writing tools), settings (e.g., in-person vs remote) and specific access measures (e.g., color coding) aligned with or cut across one another to locate areas of friction [33].

To resolve these frictions, facilitators and team members should try to **figure out a balanced compromise** that would be equitably accessible to all (or most). For example, Sofia and her collaborator found highlighting with soft color as a middle ground between Sofia's need for bright color-coding to distinguish adjacent lines and her collaborator's need for removing color to avoid feeling overwhelmed. However, reaching an equilibrium is not always possible, especially in large groups involving people with diverse disabilities. In such cases, facilitators may adopt an approach that is accessible to most team members while not being entirely exclusionary to someone. In other words, they may **prioritize the needs of those who are the most impacted** by inaccessible technologies or procedures. For instance, a professor in our study switched to text-based writing tools abandoning the digital whiteboards that they typically used in classes to accommodate needs of a blind student who would have not been able to participate at all otherwise. However, power dynamics play a key role in the negotiation for access needs [20, 49, 50]. A blind participant recounted a negative ideation experience as a junior team member where their access needs were overlooked, resulting in them feeling left out of the conversation altogether. Thus, team members should be mindful of not letting power differentials adversely affect a collaborator's access needs.

Finally, facilitators and team members should **provide ad-hoc support to those whose needs could not be fully met.** For example, when Kai's (blind) group shifted to text-based writing tools to accommodate his needs, he and other collaborators adjusted visual and spatial formatting to make the documents easier to follow for sighted members. These ad-hoc supports may require reaching out for external help (e.g., from the disability resources center at a university), although organizational constraints and bureaucracy may hinder this work at times. Overall, we recommend that collaborators think of access needs as continually evolving and remain open to *"improvise in the moment"* to account for uncharted needs and conflicts emerging later in the process [50].

5.3 Design Considerations

Drawing on our findings, below we enumerate considerations for designing accessible collaborative ideation systems to better support the needs of disabled people. These recommendations are not intended to be a checklist that would render ideation technologies fully accessible to all. Instead, these technological improvements should be considered alongside—not apart from—the broader social and organizational efforts to building access [12, 25, 79, 83].

5.3.1 Enable Hierarchical Structure within Whiteboard Content. Our analysis showed that the freeform nature of digital whiteboards makes them extremely difficult to navigate for people with a broad range of disabilities. Instead, whiteboards could implement a hierarchical structure that would provide a direct indexing of content (e.g., sticky note 5 in frame 3) and make navigation easier for screen reader, magnification, and keyboard-only users. At the same time, collaborators could support this hierarchy by maintaining a clear structure (e.g., a linear path or a grid layout) in the whiteboard content they create.

5.3.2 Integrate with Conventional Writing Tools and Spreadsheets. Disabled people, especially blind, low-vision, and keyboard-only users need to expend considerable time and effort to learn new ideation tools that are primarily visual and reliant on mouse-intensive interactions. To minimize the learning differentials, digital whiteboards could be integrated with traditional writing tools and spreadsheets that these people have been using for a long time to ideate. While some digital whiteboards (e.g., Miro, Figma) allow exporting content as a spreadsheet, these features could be further enhanced to support synchronous and seamless translation between these two formats such that content updated on a linked spreadsheet is posted real-time on a whiteboard with appropriate visual representation and vice versa. This way both visual and non-visual learners could express and exchange ideas in a format that is most accessible to them.

5.3.3 Allow Customizable Representations of Whiteboards. Another relevant design possibility could be to incorporate features that semantically extract how visual elements are used in a whiteboard (e.g., different colors of boxes denoting different categories or spatial proximity of sticky notes denoting the relatedness of ideas) and then allow the user to ask for those semantics to be rendered in a more accessible way. For example, a color-blind user could have an option to reconfigure the UI such that any semantic use of color is represented through color-blind friendly palettes, distinct shapes, or text labels.

5.3.4 Provide In-App Guidance for Creating Accessible Content. Our work and that of others [9, 15, 20, 76, 84] demonstrate that access breakdowns in technologies and the work needed to repair these breakdowns remain largely invisible to non-disabled collaborators, putting the 'burden' of educating them on disabled individuals. Technology design could improve awareness about content and system inaccessibility among all collaborators and guide them towards making accessible content. For instance, digital whiteboards could warn users when they choose color schemes that are inaccessible to low-vision and color-blind people, add images without alt-text, select fonts and typographic styles that make text difficult to read for dyslexic people, and then teach them how to remedy these issues. Similarly, when collaborators exhibit quick movement or add animated, jarring content on whiteboards, they could be alerted about potential motion sickness their actions might induce for others. More importantly, workplaces must encourage people to heed to these technological alerts—and go beyond—to make ideation content more accessible.

5.3.5 Incorporate Established Accessible Design Principles. Maintaining properly labelled UI elements for screen reader access, appropriate color contrast, dark mode, reduced motion, live captions for audio-video calling—all are part of well-established accessibility guidelines and best practices [6, 7]. Yet, our findings revealed the glaring disregard for these accessibility principles in mainstream ideation technologies. Beyond this, our DHH participants desired customizable features for signing and captioning that have been extensively covered in prior work on videoconferencing access [10, 44, 52, 53, 73, 80]. For example, enabling built-in captions and interpreter's video in a movable picture-in-picture overlay [43] on digital whiteboards could reduce the delay, information loss, and cognitive load for splitting attention across multiple interfaces and monitors [9, 71]. Incorporating these features into mainstream whiteboarding tools and maintaining accessibility compliance should be the first—but definitely not the final—step towards broadening opportunities for disabled people's participation in collaborative ideation.

5.4 Limitations and Future Work

In this study, we chose to focus on the experiences of people with different disabilities to uncover the challenges and opportunities of ideation technologies across diverse modalities of accessing information and how access conflicts unfold within ability-diverse teams. Future work could dive deeper into the perspectives of people with specific disabilities and develop access recommendations and technologies to support their ideation needs. Moreover, although we intended to recruit broadly, our interview sample was not comprehensive. For instance, we were not able to gather experiences of augmentative and alternative communication (AAC) device users (and others) who may have unique access needs and challenges for ideation that future work should investigate. Another potential future direction could involve capturing disabled professionals' experiences specifically in non-academic settings to complement our findings that are informed by many participants (11 out of 19) who are affiliated with higher education institutes. Additionally, although our interview sessions included an observational component to supplement the retrospective accounts of disabled individuals and online forum content, future work could further extend our analysis through a contextual inquiry into collaborative ideation practices of existing ability-diverse groups and/or co-design sessions with ability-diverse participants to unpack richer details of in-the-moment adaptations and emerging dynamics within teams.

6 CONCLUSION

Through interviews and a thematic analysis of online forum content, our research delves into the experiences of disabled individuals in collaborative ideation, uncovering multifaceted access barriers in digital whiteboarding tools related to visual features, technology-induced pain, unstructured content, and complicated communication setups. We shed light on the complex dynamics of constructing access in collaborative ideation that require shared strategies to work through inaccessible technologies and negotiating distinct, and at times competing, access needs within ability-diverse teams. Through our analysis, we call attention to the "career cost" that disabled people must bear when inaccessible ideation tools are widely integrated within workplaces. Hence, to promote equitable participation for disabled people, we call for a reevaluation of ability assumptions in prevalent ideation practices and professional standards as well as designing technologies that center disabled perspectives in collaborative ideation.

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