Re-envisioning Remote Meetings: Co-designing Inclusive and Empowering Videoconferencing with People Who Stutter

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ABSTRACT

Videoconferencing (VC) has become a prominent and normalized mode of professional and personal communication, introducing universally experienced challenges such as reduced non-verbal cues and "Zoom Fatigue." But People who stutter (PWS) encounter these obstacles with extra hurdles as existing VC technologies often rely on assumptions about speech patterns that don't accommodate stuttering. Leveraging and driven by the unique insights and experiences of PWS on VC, we conducted a two-phase co-design study with PWS to explore and reflect on the design space for inclusive and empowering VC technologies from their perspectives. Our findings present a broad design space for tools that support PWS before, during, and after VC, focusing on aspects such as supporting self-disclosure, educating non-stuttering audiences, and promoting personal reflection for long-term self-growth. While many design ideas by our participants embody universal value to all VC users, some carry an activism approach that proactively disrupts existing communication flows and norms to redistribute the power between stuttering and non-stuttering speakers in VC meetings. This work contributes to a thorough analysis of the design space and empowering PWS to be drivers and designers of inclusive VC experiences.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in accessibility**; **Computer supported cooperative work**; *Interaction design theory, concepts and paradigms.*

KEYWORDS

stuttering, videoconferencing, co-design, computer-mediated communication, accessibility, Zoom

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1 INTRODUCTION

In this post-pandemic era, videoconferencing (VC) has emerged as a prominent and normalized mode for professional and interpersonal communications. This shift from in-person communication towards VC brings a myriad of challenges that are universally experienced by a wide range of users, such as reduced non-verbal cues, turn-taking confusion, constant distractions, heightened self-consciousness from self-view, connectivity/technical difficulties, which collectively lead to "Zoom Fatigue" [4, 35].

However, the impact of these challenges is not uniform across all users. Individuals with invisible disabilities, such as those who stutter, encounter these obstacles with extra hurdles as current VC technologies are often designed with assumptions and heuristics about the user's speech and speech behaviors that are incompatible with stuttering. Stuttering is typically characterized by speech disfluencies such as repetitions, prolongations, and blocks, and it is estimated to affect one percent of the population globally [9]. Beyond speech disfluencies, stuttering often leads to negative emotional and cognitive impacts during daily communication, significantly affecting the overall quality of life of people who stutter (PWS) [57]. Prior work on stuttering and VC technologies identified both challenges and benefits of PWS and highlighted the significant yet invisible emotional and cognitive efforts PWS had to take for participating in VC, undermining not only their productivity but also their social and emotional well-being [60].

Despite these increased challenges, previous work also showed PWS actively employed various strategies to navigate and mitigate the challenges posed by VC such as utilizing the "Hand Raising" function, setting up meeting structure and norms beforehand, and turning off the self-view [60]. Additionally, Wu's extensive 15-month autoethnographic study highlighted that despite the socio-technical limitations of VC and speech difficulties, PWS can still achieve positive VC experiences through practicing mindfulness, self-compassion, and the support from their audience [61].

Leveraging and driven by the unique insights and experiences of PWS on VC, our research engages the stuttering community in the co-creation of inclusive and empowering videoconferencing tools. Our overarching research question is: **What is the potential design space for inclusive and empowering VC, from the perspectives of PWS?** T address it, we conducted a two-phase co-design study with people who stutter (PWS) to explore the design space for inclusive and empowering virtual conferences (VC). The first phase involved seven participants in individual co-design sessions, while the second phase included five participants in group sessions, divided into two sessions (two in one and three in another).

Our findings present a comprehensive design space of inclusive and empowering VC, spanning before, during, and after VC. Before VC, we identified tools for facilitating self-introductions and ice-breaking activities, setting up clear VC policies for respectful engagement, and educating non-stuttering participants to enhance empathy. During VC, we identified 6 categories of design ideas including supporting self-disclosure, displaying empowering messages, supporting pronouncing difficult words, facilitating turn-taking, masking or amplifying stuttered speech, and enhancing non-verbal communication. After VC, we identified opportunities to design for personal reflection, constructive feedback, and community support to cultivate personal growth and self compassion. While many design ideas by our participants embody universal values to all VC users, some carry an activism approach that proactively disrupt existing communication flows and norms to redistribute the power between stuttering and non-stuttering speakers in VC meetings.

Our contribution to HCI, DIS, and accessibility research is threefold: (1) We presented a co-design process and a thorough analysis of the design space for building inclusive and empowering VC technologies through co-designing with the stuttering community. (2) While our research is specifically grounded in the experiences of PWS, the implications of our findings can be extended beyond this group. These insights have the potential to benefit a wide spectrum of users from marginalized groups, and raise awareness for designing future communication tools that go beyond productivity to embrace genuineness, connectedness and empowerment. (3) By centering the lived experiences and creativity in the co-design process, we also contribute to empowering PWS — a community frequently marginalized by communication technologies — to be the *drivers* and *designers* for more inclusive videoconferencing experiences.

2 RELATED WORK

2.1 Stuttering as a Social Identity

Stuttering is typically considered a "speech disorder that involves frequent and significant problems with normal fluency and flow of speech" [2]. However, current academic and clinical research has increasingly emphasized the "hidden" struggles with stuttering — such as negative feelings and thoughts about talking — beyond speech disfluencies [1, 9]. There has been a methodological shift in stuttering research and therapy to investigate and improve the *subjective* experience of stuttering, rather than the perception of listeners [10, 56, 57, 62]. Instead of speech disfluencies, recent speech language pathology (SLP) research defined the "core" components of stuttering as the "sensation of being stuck or losing control", "the affective, behaviors, and cognitive reactions" in response to that sensation, the listener's negative reactions to the observable stuttering behaviors, and the adverse impact to one's life as a result [56, 57]. Similarly, research showed that the experience of speaking *effortlessly* with little premeditation or hesitation is more meaningful and satisfying for people who stutter than having effortful but fluent speech [15]. In clinical practice, holistic and stuttering affirming approaches have emerged and prevailed in stuttering therapy, delivering a sustainable long-term positive effect on the quality of life of PWS that was previously difficult to achieve in fluency-focused therapy programs [7, 10, 14, 52].

Along with the epistemic shift in stuttering research and clinical practice, the stuttering community and its allies are also pushing back on the ableist expectations on speech fluency [25]. Leveraging the social model of disability [43–45], the stuttering community has been rejecting the notion of stuttering as "broken" speech [47], celebrating "stuttering gain" (finding value and strength in the experience of stuttering) [11] and pride (demanding recognition for what voices of PWS add to the conversation not for what they lack) [46], and advocating for a more stuttering friendly environment [12].

However, loaded with normative assumptions about human speech and speech production capacities, communication technologies — designed to facilitate communication — could introduce additional, disabling barriers for PWS to effectively communicate themselves. For example, speaking over the phone or VC has been shown to be particularly challenging for PWS, as these technologies prioritize the verbal channel over non-verbal ones, undermining PWS's ability to leverage their non-verbal communication skills and strategies [28, 60, 61]. Similarly, recent research on voice interfaces and digital assistants powered by automatic speech recognition (ASR) has found that these systems perform poorly for PWS, due to hardcoded heuristics on the duration of silence between words and sentences and the inability for embedded language models to decode partial words or interjections [34, 40]. The result is functional inaccessibility and emotional harm to users who stutter [8, 34]. Even technologies specifically designed for the stuttering community, such as SpeechEasy[1] and Whispp[2], predominantly focus on making PWS *sound* more fluent, further reinforcing the ableist superiority of fluency over stuttering [25, 46, 53]. In this sense, designers of communication technology haven't caught up with the view of stuttering as a social identity, rather than a disability that needs to be "fixed".

Following the contemporary trend in stuttering research, therapy, and activism, our study is positioned to represent diverse and alternative perspectives on the design space for an increasingly popular communication technology - VC, with emphasis on improving the cognitive and emotional experience of stuttering and reducing socio-structural barriers for PWS in virtual meetings.

2.2 Technology for Accessible Videoconferencing

Videoconferencing has emerged as a prominent mode of professional and social interactions, especially in light of the widespread transition to remote and hybrid work models. VC offers unique advantages while also posing additional accessibility challenges for people with disabilities [18, 55, 64]. For example, Tang et al. [55] explored the experiences of 25 people with varying disabilities on telework and found that while VC offers them greater flexibility and a preferred working environment, it also presents distinct challenges especially with the visual channel, which demands additional effort and can lead to accessibility issues. Specifically, blind participants might choose to disable their video feed as they cannot see or don't want to see themselves, making it difficult for Deaf and Hard-of-Hearing (DHH) participants to read lips and expressions.

[1] https://speecheasy.com/how-it-works/
[2] https://whispp.com/

Neurodivergent people often need to take much effort in managing video and audio in VC settings. Zolyomi et al.'s [64] research also highlights how sensory sensitivities, cognitive challenges, and anxiety can make VC interactions challenging for autistic adults.

To address these challenges, accessibility research delves deeply into the strategies currently adopted by people with disabilities, aiming to inform and develop more inclusive video conferencing practices and features [3, 18, 20]. For example, Maitraye Das et al. [18] studied working-from-home (WFH) experience of neurodivergent professionals and identified the need to rethink accessibility in remote work, highlighting essential strategies to improve inclusivity, such as normalizing video use, providing meeting agendas in advance, and establishing clear turn-taking protocols, which are not just "nice to have". Davis et al. [20] developed a collection of tools named Erato to assist DHH participants by providing real-time feedback on their speech performance and remind the audience of appropriate communication etiquette.

Furthermore, commercial communication aids such as Otter.ai [3] and Read.ai [4] leverage ASR to provide real-time captions and post-meeting summaries of topics and action items, which aim to enhance productivity for all VC participants. However, the reliance on observable signals (such as speaking speed and airtime) in the coaching features of these tools, along with a speaking behavior modification approach, may inadvertently create pressure for PWS to "pass" (hiding their stuttering or making it less noticeable to others) than be authentic and spontaneous [16, 60]. This, in turn, undermines emotional and cognitive needs such as feeling connected and supported during a meeting, and feeling empowered to speak up despite speech struggles [60, 61].

Our research aligns with the neurodiversity movement within disability studies [24], advocating for the acknowledgment and respect of neurological differences as natural human variations. From this viewpoint, stuttering is not seen as a flaw to be corrected but as an integral part of an individual's identity [12, 13, 47]. Our goal is to adapt communication platforms to better support and accommodate diverse speech patterns, rather than trying to "fix" or "mask" stuttering. Next, we highlight the potential and need for conducting co-design research with the stuttering community to design accessible video conferencing technology.

2.3 Co-design for Accessible Communication Technologies

Co-design, with its originals in participatory design, is a methodological approach that involves "the creativity of designers and non-designers in the design development process" [50]. This approach transforms the traditional role of users in HCI research and design from passive subjects (e.g., survey participants, interviewees, or usability test subjects) to active co-designers, with agency, autonomy and responsibility.

The co-design approach has been widely adopted for developing accessible communication technologies for people with disabilities, such as DHH individuals [32, 51], children with limited communication abilities [26], and individuals with aphasia [19]. For instance, Seita et al. [51] conducted remote co-design workshops with DHH and hearing participants to explore accessible ASR-supported communication technologies. They identified key design dimensions such as correcting errors in ASR output and implementing notification systems to influence speaker behaviors, along with guidelines for conducting online co-design workshops with DHH. Hamidi et al. [26] utilized participatory design with proxies (PDwP) to develop accessible digital media technologies for children with communication challenges by involving proxies such as parents and therapists, alongside the children.

These studies underscore the significant potential of co-design in identifying nuanced design opportunities and creating accessible communication technologies for people with communication challenges, acknowledging them as "expert of their experience" [50]. While much of the co-design work had been done with DHH communities for more inclusive communication technologies [32, 38], there is only limited co-design work on people who stutter. To our knowledge, aside from ethnographic methods [60, 61] such as interviews, there is only one stuttering-specific work in HCI, "StammerApp" [39], which utilized in-person co-design workshops to gain insights into developing tools to support PWS in their daily interactions, with a focus on self-reflection and goal setting. However, as VC has become a prevalent mode of remote and hybrid work, there remains a limited understanding of the design space for inclusive VC technology from the perspective of PWS, especially through remote co-design workshops. Our work aims to address this gap by directly involving PWS in the design process, utilizing their knowledge and experience, and empowering them to be the "designers" of inclusive VC technologies.

3 METHOD

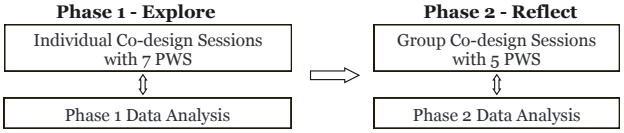

Figure 1: An overview of our two-phase remote co-design method.

Our remote co-design method with individuals from the stuttering community involved two phases: *explore* (Phase 1) and *reflect* (Phase 2) as illustrated in Fig. 1.

The purpose of Phase 1 was to explore and establish the potential design space for inclusive VC from the participants' individual perspectives. It consisted of a series of co-design sessions over Zoom, each with one participant who stutters. We encouraged participants to think out loud and come up with as many ideas as possible, without considering technical or practical constraints. As a result, we were able to gather a relatively large number (10+) distinctive ideas from each session. We categorized and mapped ideas onto the design space after each session, and stopped after the seventh session as ideas became repetitive. As a result, Phase 1 provided us with a broad range of design ideas of VC tools for PWS.

The transition to Phase 2 allowed us to leverage the diversity of ideas collected individually and engage in a collective reflection and

[3] https://otter.ai/
[4] https://www.read.ai/

Table 1: Overview of participants' demographics, phase participated, stuttering characteristics and VC Use

Pseudonym	Phase	Gender	Occupation	Stuttering Characteristics (self-described)	VC Frequency	Platform
Teresa	1	F	Data scientist	Blocks, repetition	Daily	Zoom, Teams, WebEX
Jun	1	M	Energy industry	Frequent blocks, repetition	Daily	Tencent Meet, Zoom
Eric	1	M	Software engineer	Moderate to severe, repetition, head movement, closing eyes	Daily	Zoom, Teams, Google Meet
Jane	1 & 2	F	SLP grad student	Repetition, blocks on names	3-5 times a week	Zoom, WebEX
Matthew	1 & 2	M	UX researcher	Covert, speak slowly, word substitution	Daily, 6h	Zoom, Teams, Google Meet
Tara	1 & 2	F	Business owner, writer	Moderate to severe, blocks, repetition	> 3 times a week	Zoom, Skype
Rebecca	1 & 2	F	Grant management	Covert, word substitution	Daily	Teams, Zoom
Xuan	2	F	UX researcher	Blocks, repetition	Daily	Zoom

synthesis, fostering a deeper understanding of the community's needs. The purpose of Phase 2 co-design was to delve deeper into the design space outlined in Phase 1, understanding how different areas of the design space should be prioritized and implemented with the current socio-technical constraints. Phase 2 consisted of two group co-design sessions with two or three participants in each. During the group co-design sessions, the participants and the research team worked together to reflect, discuss, and rank representative design ideas chosen from Phase 1. Phase 1 focuses on divergence while Phase 2 focuses convergence. We also encouraged participants in Phase 2 to consider the value and applicability of various ideas, not only to their own experiences but to other stutterers they knew of, trying their best to represent the collective opinions of the stuttering community.

3.1 Participants

Eight participants (5 female, 3 male, ages 25-64) were recruited for Phase 1, Phase 2, or both phases of the study (Table 1). All participants self-identified as people who stutter and used VC technologies at least once a month in the past year. We summarized the speech and behavioral characteristics of their stuttering with the keywords that participants used to self-describe their stutter. Two participants identified their stutter as covert stuttering, "a type of stuttering experience that occurs when a person who stutters conceals his or her stutter from others, attempting to be perceived as a non-stuttering individual" [22].

The second author identifies as a person who stutters, who has personal and professional ties with the stuttering community. This close relationship provided us with community access and trust. We therefore recruited participants through the second author's personal contacts, word-of-mouth, and advertisements on the National Stuttering Association's annual conference. Priority was given to participants with intersectionally marginalized identities, such as women, non-native English speakers, and people from the LGBTQ+ community. As a result, female stutterers are over represented in our study than the reported 20% or less among adults who stutter [9], and in one Phase 1 session (with Jun) we switched midway from English to Chinese (Jun's native language). All participants lived and worked in the US except for Jun, who lived in China and signed up to our study per the referral of another participant (Jane). Each participant received a $50 gift card for participating in Phase 1 and a $75 Amazon gift card for participating in Phase 2.

3.2 Co-design Session Procedure

Sessions took place over Zoom, from July to October 2023 (Phase 1: July to August; Phase 2: October). In addition to the participants (one in Phase 1, 2-3 participants in Phase 2), each session included at least three research team members: the session facilitator (either the first or the second author), one UX researcher, and one designer. The latter two observed, took notes, asked follow-up questions, and contributed to the brainstorming part of the discussion. Some sessions were joined by additional UX researchers, designers, and software engineers working on VC technology.

We made deliberate efforts during the sessions to establish an accommodating environment for participants to express themselves openly and comfortably, following strategies adopted in previous remote interview studies with the stuttering community [60]. For instance, we planned ample buffer time for the sessions and made it clear at the beginning to the participants that there was no time pressure for them to talk, while also respecting their time and letting them decide whether to continue or conclude the session once the allotted time had elapsed. As a multilingual research team, we also gave multilingual participants the choice of preferred language during the session instead of the default English. All participants chose English except for Jun, who chose English at first, but switched to Mandarin Chinese later in the session (Phase 1). The first author later translated the transcript of Jun's session into English for analysis.

3.2.1 Phase 1: Individual Co-design Sessions. Each of the 7 sessions in this phase lasted 60-90 minutes and was structured as follows:

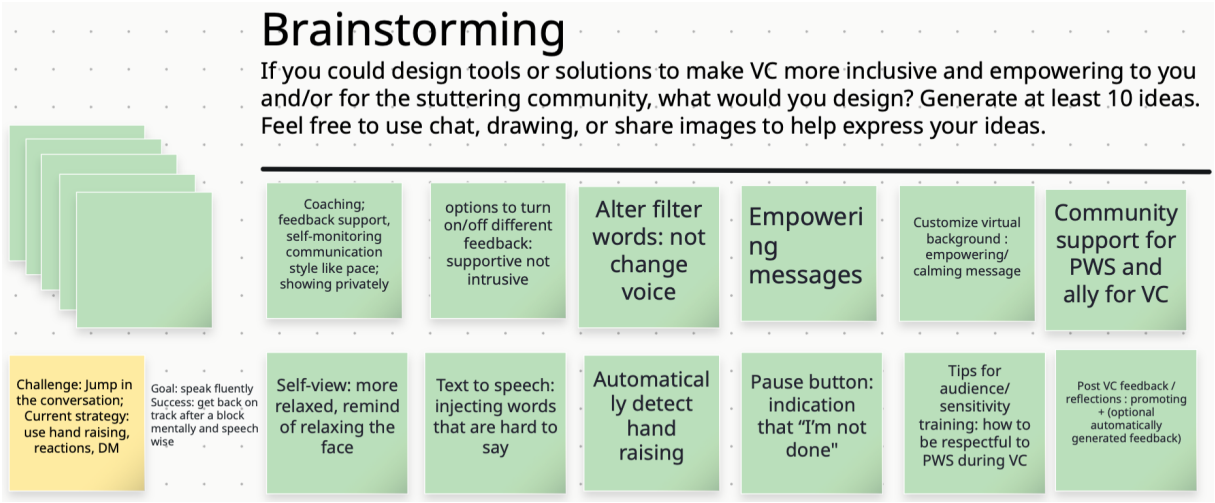

Figure 2: A screenshot of Zoom whiteboard used by participant Tara to brainstorm design ideas. Each idea was documented on a green post note. Yellow note and typed text were used to document other thoughts.

(1) **Introduction:** We started with a round of brief introductions of the research team members and the purpose of the study.
(2) **Background interview:** Using a semi-structured interview protocol, we asked the participant about their background on stuttering, their use of VC, challenges they faced and current strategies. In addition, we shared key findings from previous research on the benefits and challenges PWS encountered in VC [60] and asked about their opinions on these findings. Reflecting and comparing their personal experiences with the general findings helped the participants to think more deeply and broadly on stuttering and videoconferencing, preparing the participants to brainstorm wider range of design interventions for the next step. Hearing which previous findings resonated or not resonated with each participant also allowed the research team to better understand the diversity within the stuttering community and tailor the scope of the co-design to the needs and characteristics of different participants. For example, if a participants resonated strongly with the benefit of VC to "mask" stutter [60], the co-design could emphasize interventions to conceal stuttering more effectively and comfortably.
(3) **Brainstorming:** We then asked the participant to generate at least 10 ways that could make VC more inclusive and empowering to them and/or for the stuttering community more generally. Drawing on the best practices of brainstorming for ideation and considering the uniqueness of stuttering [59], we encouraged them to express their ideas through various ways such as thinking out loud, using virtual post-it notes on the Zoom whiteboard, using chat, drawing, or sharing images. Non-digital solutions such as physical props and drawing on paper were also welcome when brought up. The research team were also encouraged to generate ideas based on information shared in the background interview. We documented each idea on the Zoom whiteboard and built on each other's ideas by asking questions or commenting on the look and feel, interaction flow, and technical feasibility of the ideas. We also discussed the motivation and needs for the proposed ideas: why these ideas are important to the participant, which pain point(s) they address, and how often the participant expects to use tools built from these ideas, etc.
(4) **Closure:** We wrapped the session by encouraging participants to tell us anything else they wanted to share and ask us questions. We also asked if they would be willing to participate in Phase 2 of the study.

3.2.2 Phase 2: Group Co-design Sessions. Prior to the group sessions, participants were asked to complete a pre-session survey in a Google Form. This survey presented a series of representative design ideas with visual sketches from Phase 1 (the sketches were created by our team), and asked participants to rate each idea based on its perceived importance and their likelihood of using the feature. The survey aimed to provide a preview of design ideas and prepare participants for in-depth discussion during the group sessions.

We carried out two group sessions (with 2 and 3 participants, respectively) over Zoom for about 90 minutes, each structured as follows:

(1) **Introduction and icebreaker:** We started the session with a brief introduction by the facilitators, followed by an ice-breaking activity. Participants were encouraged to introduce themselves and share one word to describe their current feelings.
(2) **Presentation of design ideas:** One facilitator presented design ideas developed from Phase 1. We used a shared Miro [5] Board to present each design idea and encouraged participants to make comments with the post-its feature on the board (see an example in figure 3). Meanwhile, participants were encouraged to ask questions about each idea, and were

[5]https://miro.com/

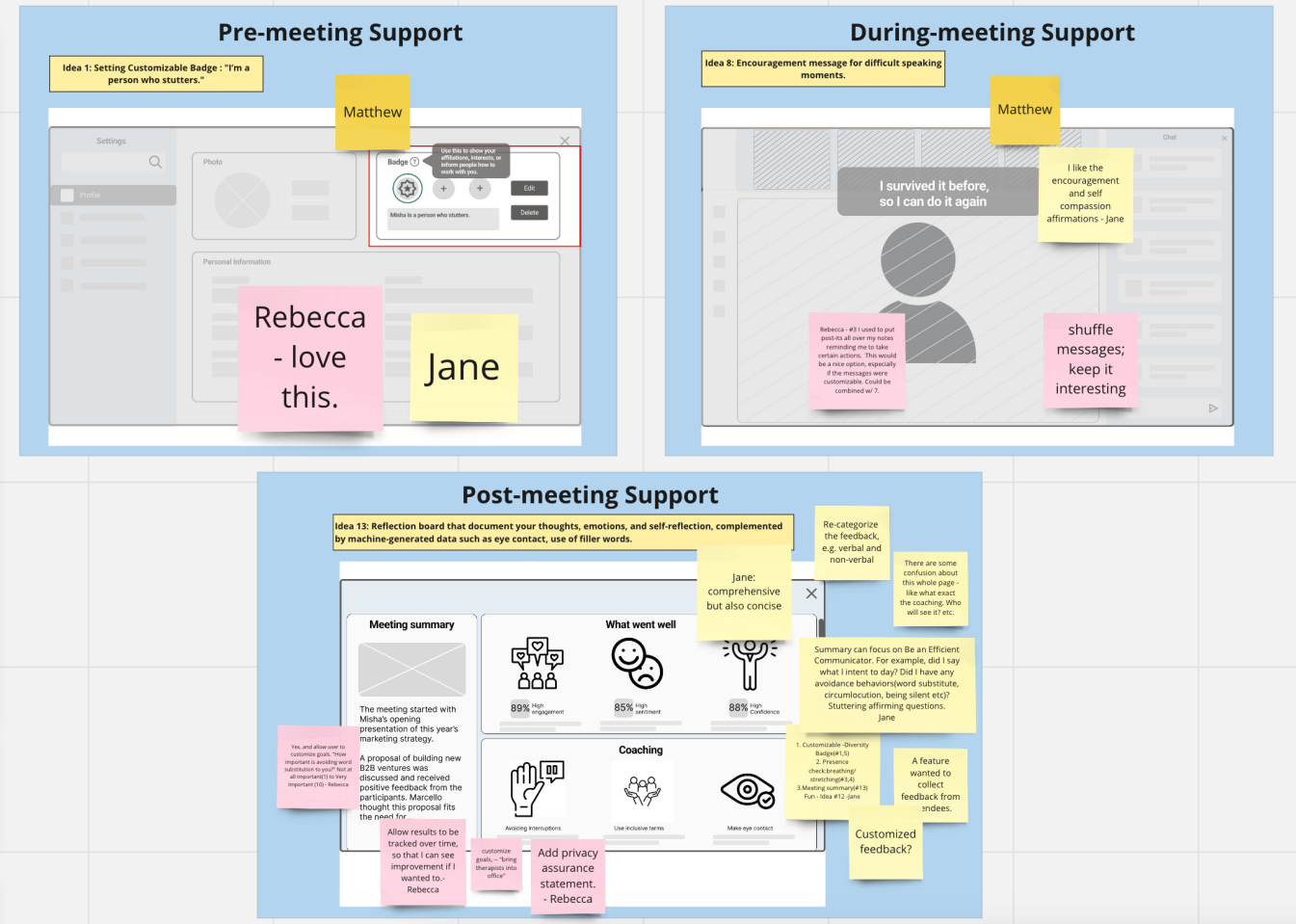

Figure 3: Example of a Miro board used by participants in Phase 2 to reflect on design ideas. We took a screenshot of one idea from each phase.

asked to rank the ideas and think about the reasoning for their rankings.

(3) **Discussion:** We facilitated a group discussion to collectively select and refine the top 3 design ideas. Participants first shared their personal top 3 choices, then discussed as a group, and finally presented these ideas along with their reasoning to us. We provided discussion prompts such as general impressions, potential pros and cons, and alternative suggestions. This activity aimed to encourage participants to reflect, justify, and understand not only their own but also other participants' preferences in the design space, thinking collectively as agents for the stuttering community beyond their individual needs.

(4) **Wrap-up:** We ended the session with time for participants to share their final thoughts, ask questions or provide suggestions that they might have.

3.3 Data Collection and Analysis

With participants' permission, we recorded the sessions using the Zoom video recording feature. We transcribed the recordings and replaced names with pseudonyms. We didn't correct the disfluencies in the transcripts but we lightly edited the quotes used in the paper for readability. Our data included session transcripts, notes taken during the sessions, and screenshots of the shared whiteboards. We placed all the data in one Google document.

Using an inductive open-coding analysis approach [49], the data analysis process included the following steps:

(1) Two researchers worked independently to carefully review the data multiple times and generate initial codes as comments on the document. For example, we had comments such as "difficulty in jumping in the conversation" and "get stuck in blocks" to describe the challenges that participants reported encountering during VC, and "self-disclosure badge" and "encouraging messages" to caption the descriptions of VC design ideas that participants generated during the brainstorming session.

(2) The two researchers then met to read through and discuss the commented data together. In the discussion, they refined the comments into agreed-upon codes and grouped the codes into categories.
(3) The researchers then identified key thematic insights emerging from the categories and summarized them for reporting.

We started analyzing the data immediately after the first Phase 1 session, and repeated the process after each session, with the most recent session data added to the document. We revisited the previously analyzed data as more data came in, going back and finding connections across the entire dataset. Once we stopped identifying new recurring patterns and insights, we stopped recruiting participants for more sessions in Phase 1. This allowed us to ensure the integrity of our findings without burdening more participants. We then repeated the data analysis process to augment our findings with data from both group sessions in Phase 2.

Our findings, presented next, focus on the design ideas generated by participants in the co-design sessions. Insights about experiences and challenges PWS face during VC meetings are presented as rationale and context for their design ideas.

4 FINDINGS

We report on the categories of design ideas generated in Phase 1 sessions and further developed in Phase 2 sessions. The design categories are organized chronologically: *before a VC meeting and kickoff*, *during* and *after* a VC meeting. It is important to recognize that the categories represent our own interpretative analysis of ideas and their reasoning and are not absolute or exhaustive. Further, the categories are not mutually exclusive, such that certain design ideas may be applicable to multiple categories. Ideas that were chosen for further discussion by Phase 2 participants are expanded and detailed in the reported findings. We summarize the categories of design ideas in table 2.

4.1 Pre-VC and Kickoff

4.1.1 Supporting Self-introductions and Ice-breaker Activities. Some participants reported difficulty in doing self-introductions, such as stuttering on their names, which increased their anxiety and fear of a leaving negative first impression. Teresa said: *"I had troubles in saying my name in starting the conversation."* Jun proposed having technology guide people through their self introductions, such as having introduction prompts displayed on the Zoom background instead of on paper, so he can do the self-introduction with ease while maintaining eye contact with the audience.

Alternatively, Eric highlighted the unexpected benefits of being open about stuttering in the self-introduction, as a way to foster deeper connections. He suggested that VC technology would prompt sharing personal vulnerabilities via ice-breaker activities for all attendees. He explained, *"stuttering can also enhance personal relationships, and in some cases, professional ones too. Because especially being open about stuttering shows openness [...], and shows your vulnerabilities And it allows people often to to feel more calm, more comfortable sharing that that their own vulnerabilities. And so I think it can make deeper connections more quickly."*

4.1.2 Setting VC Policies and Expectations. Some participants proposed setting up policies aimed at fostering inclusive conversations. For example, two participants (Teresa, Tara) commented on the difficulty to "hold the floor" for a duration of time during a meeting when they experienced an extended speech block. They proposed setting up shared timers for all speakers as a structured approach to managing the air time for each speaker. Although time pressure can heighten anxiety and potentially increase stuttering, shared timers for agenda items can ensure there is a fair amount of time allocated to PWS to articulate their points despite disfluencies:

> *"The host can open the timer, so everyone can speak for only two minutes. This way, everyone gets a chance to put in. In large companies, it's often the case that those in higher positions have the chance to talk fully, while others have to fight the chance to speak." (Tara)*

A few participants had ideas for other VC meeting policies that would be set up before the meeting starts. For instance, Rebecca proposed the idea of a video-on policy in meetings: *"I think there should be a telework or video conference policy. It shouldn't be the burden of the employee to say, 'Put your camera on,' or 'Can you please..."'* As PWS have often developed and relied on non-verbal communication strategies to communicate and connect with their audience, VC can be particularly challenging and anxiety-inducing without non-verbal signals such as the facial expression and body language of others [60].

Another meeting policy suggested in response to the challenge of fluent speakers dominating the discussion, leaving no space for PWS to interject and hold their turn in the conversation was a "cool-off" period: people cannot immediately speak up after they have spoken and need to wait a certain amount of time to speak again. Eric proposed combining this policy with a tool that privately notifies individuals identified as frequently interrupting. One suggestion for enforcing the cool-off period policy was through the "mute"/"unmute" feature, such that when one is done speaking (and hits "mute"), their "unmute" button is disabled for some time. Eric explained:

> *"if there is a tool that if you take yourself off mute and then once you put yourself back on, you can't unmute for a certain amount of time. It's almost like enforcing the idea in group discussions of having a stack of people who want to speak. But this [unmute] makes it so that no one needs to keep that stack, per se." (Eric)*

While some of these ideas might seem extreme or impractical, they underscore PWS's strong desire to create a fair and equitable environment for all voices to be heard in VC meetings.

4.1.3 Educating Non-PWS About Stuttering. Even with ways to support introductions and policies that make VC meetings more equitable and accessible, all participants discussed the need to better educate people before they meet with PWS, debunking misconceptions about stuttering and sharing tips and best practices on how to accommodate a speaker who stutters. Ideas for implementing such education included providing informative messages, quick tutorials on respectful communication, and reminders to avoid rushing the conversation.

Jane highlighted the need and responsibility for fluent individuals to become more supportive and empathetic of stuttered speech. She proposed educating the audience about stuttering to cultivate

Table 2: Summary of design ideas across different phases of VC

Phase	Categories	Design Ideas
Pre-VC and Kickoff	Supporting Self-introductions and Ice-breaker Activities	Introduction prompts, prompt sharing personal vulnerabilities
	Setting VC Policies and Expectations	Shared timers, video-on policy, cool-off period
	Educating Non-PWS About Stuttering	Informative messages, tutorials, tips
During VC	Supporting Self-Disclosure and Educating the Audience	Stuttering badge, displaying educational messages
	Empowering Messages	Affirmative messages, relaxation exercise
	Facilitating Speaking Difficult Words	Fixing transcripts, injecting difficult words
	Facilitating Turn-taking and Turn-maintaining	Automated hand gesture detection, communication indicators
	Masking and Amplifying Stuttered Speech	Subtle masking, literal transcription
	Enhancing Non-verbal Communication	Avatars, hardware support for body language
Post-VC	Prompting Personal Reflections	Performance reports, reflection space
	Providing Speech Feedback	Feedback on speech patterns, real-time coaching
	Community Effort	Sharing VC recordings, online support forum

their empathy and understanding: *"how do we train fluent folks to know that the people who stutter are stuttering, it's not like they're struggling thinking of the words, but it's just the nature of their stuttering, or train how do we become better listeners."*

4.2 During VC

4.2.1 Supporting Self-Disclosure and Educating the Audience. In Phase 1, four participants reported that they disclose their stuttering in VC meetings before they start speaking, whereas the other three said that they typically do not, instead assuming others would notice it in their speech. Many participants brought up ideas to self-disclose of their identity as a PWS more easily and comfortably in a meeting. These ideas support participants in communicating their condition of stuttering in a straightforward manner, increasing acceptance towards one's identity of stuttering through self affirmation, and educating the audience about stuttering and how to communicate with PWS. Jun explained: *"Supporting it helps because it reduces my stress to self disclose"*. Jane proposes a stuttering badge (e.g., an emoji) where PWS can display symbols next to their name or virtual representation to represent their identity, inspired by the LGBTQ+ rainbow flag that people attach physically and virtually:

> *"People who stutter hesitate to claim that space or claim that identity because of all this social stigma. But technology should help increase the representation of stuttering, like in daily life in the media, and a TV radio... Maybe some emojis can be labeled as stutters or it's just increased that exposure. For example, for the LGBTQ they have a rainbow flag. But now we do not have something that impactful."*

The badge offers a lighthearted method to represent speech differences and provides a sense of community. Besides the visual symbols, several participants suggested displaying a personalized slogan next to the badge such as *"I'm a PWS"* (Teresa).

While the responsibility of self-disclosure often falls on PWS, this disclosure often help the audience to better understand and accommodate stuttering speakers [63]. Rebecca further suggested to display educational messages for the audience over the self-disclosure badge (e.g., "we recommend waiting for ... before speaking"), serving as guidance rather than a simple label: *"I don't want it to be a label of negative. But more like this is how you should proceed."* Similarly, Teresa advocated for clarifying common misunderstandings of stuttering, like distinguishing stuttering from internet connectivity issues to *"address the elephant in the room:"*

> *"People's questions on the connection on the headphone, the WiFi speed were always annoying to me. I want people to know the fact that I stutter not because I didn't have a good platform or something." (Teresa)*

In Phase 2, four participants ranked highly the idea of a self-disclosure badge to represent their identity and emphasized the importance of combining it with informative messages about stuttering for the audience. Xuan explained: *"Not everyone understands what stuttering is. If I just put a label there, there might be various interpretations like what are PWS? Are they just anxious?"*

Participants in Phase 2 also mentioned that the concept of self-disclosure of stuttering could potentially be extended to a broader audience as a diversity badge. For example, it could help those with neurodiversity to disclose their invisible disabilities and offer accommodation suggestions to others. As Rebecca suggested, *"It could also be useful for people with hearing loss, someone who needs additional assistance in their work, even folks who have neurodiversity"*.

4.2.2 Empowering Messages. Three participants proposed displaying empowering and affirmative messages in VC technologies to support PWS during meetings. These messages respond to the lack of confidence, fear of talking, self-stigma, and apologizing for being a PWS when talking with others, with the purpose of shifting toward a positive mindset of acceptance, advocacy, and growth.

For example, Jun shared his experience of struggling with depression because of social stigma and self-doubt associated with stuttering, and how he gradually shifted his mindset to embrace his stuttering identity which led to improved mental wellbeing:

> *"Before I go to a date, because of the lack of confidence, I would go online to find some jokes, and memorize them, recite them, so that I can say them to my date. All*

> *my life was consumed by the fear of stuttering. I only realized that after I got severely depressed. You have to speak everyday, if you are worried about stuttering every time you speak, your life would be consumed by anxiety and fear." (Jun)*

Jun pointed out that stuttering is almost not curable, therefore the goal of achieving fluency only leads to repeated failures, silence, and withdrawal, as he explained: *"fluency is still 99.9999% of PWS's goal. But it's hard to achieve. PWS have to accept they need to live with stutter for the entire life not to overcome it (impossible goal)".* Adopting the right mindset can lead to positive reinforcement, creating a shift away from a fluency-centered mindset toward a communication-centered mindset, which breaks the cycle of silence and fosters self-expression.

Jun further emphasized the importance of self-acceptance in managing challenges associated with stuttering, especially when facing self-doubt in high-stakes situations such as interviews. He suggested that VC could incorporate strategies he has been using to overcome negative thoughts. He has utilized online resources such a Happiness Class from Harvard University and self-help books to shift his mindset to view communication as a learning opportunity rather than a potential source of embarrassment. He proposed a design that creates personalized messages that remind him that *"it is okay to stutter"*, and that *"stuttering is not the end of the world"*, reducing his self-imposed pressure and anxiety during video calls.

Tara suggested to use customized virtual backgrounds to display empowering or calming messages: *"customize the interface or like a virtual background or something to allow for an empowering message to make you more comfortable or relaxed. In this situation, you can have empowering image or message or something meaningful to remind you."* This approach mimics the personal note she would give herself to "relax facial muscles" to alleviate tension during blocks and help her continue speaking.

Jun and Teresa envisioned that, in the long-term, empowering messages could promote self-growth and cultivate a positive mindset. Teresa explained how this mindset shift encourages her to embrace her authentic self and view every speaking moment as an opportunity to advocate for the stuttering community:

> *"Now, I treat every presentation and speaking opportunity as a chance to advocate for stuttering and myself, and to show that despite my stutter, I have excellent presentation skills. The more I embrace this mindset, the more I notice changes in my speech and in how I prepare for everything."*

This mindset shift not only promotes her self-growth but also contributes to a broad social understanding of stuttering and reduces social stigma associated with it.

The idea of encouraging messages in challenging moments during a VC meeting was further developed in Phase 2 sessions. Xuan explained: *"I sometimes stuck on a word and cannot carry it out. It can be tough to get through that moment. If there's an encouraging message it may calm me down and help me just to say what I want to say."* Participants proposed that these prompts could be triggered when the system notices a PWS struggling, or PWS could customize when and how often they receive these messages. The content of these messages should be tailored and engaging. Providing those options makes this design helpful for many people beyond PWS. As Rebecca suggests, *"this is for the person who stutters but it can also be really for anyone someone with anxiety and I think it would be important to have a customizable so that I can put in certain notes to myself like 'relax vocal cords'"*.

In addition to encouragement messages, Jane suggested that reminders for deep breathing exercises also fall into the categories of supporting PWS in difficult moments, as it can remind PWS to relax physically and mentally. She further emphasized extending the use of these breathing prompts as an exercise of presence check-in for VC users in general, which addresses common issues of virtual meeting fatigue. Jane shared her personal experience:

> *"Sometimes when I am in a Zoom meeting for a three-hour lecture, I'm just zoomed out and zoned out. This is not just for the people who stutter. This is for all the Zoomers. It's just like remind you, you can stretch a little, you breathe a little, bring yourself to the meeting."*

4.2.3 Facilitating Speaking Difficult Words. Two participants proposed that VC technology could facilitate expressing difficult words through transcripts or text-to-speech, offering a dual-channel approach to support them in the moment of stuttering. Teresa suggested a plug-in that allows her to type in words to fix the auto-transcript, especially words that she finds difficult to pronounce and that are transcribed incorrectly. Another idea from Teresa involved a teleprompter function where she can input information beforehand. This would enable VC technology to learn intended messages and transcribe certain words more accurately:

> *"I give the app the context that I will stutter on words or sounds and then the prompt, I mean, transcription will help me to fix a few words. So like if the app says I am having trouble saying electricity, so whenever I say like, electricity, I don't have to say the whole word, but the transcripts will catch that." (Teresa)*

In addition to transcripts, Tara's suggestion involved a text-to-speech option for injecting words that are hard for her to say. This feature would enable her to pre-type specific words or phrases that the system would then voice out during the moment of stuttering, which facilitates a better communication flow and reduces her anxiety associated with difficult words:

> *"If at any point you block or freeze, it would jump in and say the next word for you after a certain amount of time. So, something like a text-to-speech integration where you could convert text to spoken word. This could be helpful for people who find it easier to type than speak. Imagine a system, somewhat like Stephen Hawking's, that could speak for you." (Tara)*

In Phase 2, Tara and Xuan voted this idea and recognized its potential benefits for them. However, Jane cautioned that this feature might serve as an avoidance strategy, explaining, *"This feature can be tricky. It might be useful but also potentially discouraging or used as a means of avoidance."*

4.2.4 Facilitating Turn-taking and Turn-maintaining. Participants came up with diverse design ideas to support them in turn-taking, from making hand-raising more noticeable and streamlined, to

communication indicators to overcome the challenges associated with reduced social cues in virtual settings.

Many ideas centered around "hand raising" in VC, a feature used by conversation participants to indicate their intent to speak. However, due to reduced social presence, it is easier to ignore a virtual hand raise compared to a physical one in a face-to-face setting. Teresa shared her strategy of intentionally using unmute as a signal of readiness to speak, and suggested VC technology can use sounds as an alternative way of hand raising: *"when you click the unmute button, some sounds will be made and the people will know that you want to say something" (Teresa).* For example, sounds like microphone taps can help PWS to break the initial barrier of silence and to get others' attention. Eric also tried to get himself "loud enough" to insert into the conversation and highlighted that unmuting sounds utilized the advantages of virtual space where everyone hears at the same volume, *"unlike in-person settings, where if you're at one end of the table, it might be hard for those at the opposite end to hear you."*

Alternatively, Rebecca proposed using automated hand gesture detection to alert the host of someone's intent to speak, eliminating the need to manually click the button. Rebecca's idea also included a "Queue Indicator" feature based on the order of hand-raising in the audience. She proposed that this would allow participants to know their position in the speaking order and create a more organized discussion flow: *"In larger meetings, I have something to say, but numerous people are raising their hands. It will be nice to know where I was in the queue."* This can reduce uncertainty and anxiety so PWS can get ready to speak when their turn is coming up.

In addition to injecting the conversation, PWS also faced the challenge keeping their speech turn, being interrupted by others when they haven't finished what they wanted to say, e.g., when they are in blocks. To address it, Tara proposed the idea of "Communication Indicators," that allows her to non-verbally signal that she has not finished her point. She envisioned such communication indicators as *"a pause button or gesture or indication"* that enable her to *"somehow show up, and be like, 'I just need a breath. I'm gonna finish my thought. Hold on a second'."* Similarly, Matthew proposed a "meeting bot" that informs others when the speaker is having a speech block, to clarity the situation to the audience and help the speaker maintain their turn: *"If I had a bot that joined the meeting, and knew when I was having a blocking moment, and it generated a note in the chat, like, 'Matthew is a person who stutters; he's just having a block'."*

In Phase 2, participants demonstrated strong interest in the "Communication Indicator" idea, and further developed it as a *"I'm not done"* button that, once pressed, would show a salient visual on one's video feed and send other participants a customizable message on how they could accommodate someone experiencing a block (e.g. maintain eye contact and show patience, rather than trying to guess the word or making a joke about it). Rebecca also pointed out that, besides the practical benefits for PWS, the act of manually pressing a button to (re)claim one's turn would provide a sense of agency for not only PWS but potentially everyone who is interrupted in meetings.

4.2.5 Masking and Amplifying Stuttered Speech. Two participants, Rachel and Tara, have tried fluency-inducing technologies (e.g. DAF devices) but found the effect inconsistent or wore out quickly. Participants urged VC technologies to stay away from attempting to "fix" stuttering. Rebecca, who had spent "almost all her life" hiding her stutter, emphasized that the goal of VC technology should be to facilitate genuine communication, empowering PWS to focus on the purpose of communication instead of on concealing stuttering, as it may actually aggravate the stutter. She found that masking *"led to more severe stuttering and led to lack of engagement in the conversation. Because I was thinking, I hope I'm hiding it."*

However, participants also proposed ideas for *subtly* masking stuttered speech to help both PWS and other audiences better engage in the conversation, while still preserving their authentic identity as PWS.

Inspired by Zoom's "touch up my appearance" function that artificially smoothed out one's skin for a more polished appearance on screen, participants envisioned ways to smooth out one's speech while still maintaining the key personal characteristics. For example, Teresa suggested a feature in VC technology that tones down "background" stuttering such as reducing prolongation of stuttered speech. This feature could minimize the distraction of the stuttered speech to the audience and keep their attention on the speaker, as Teresa explained, *"it's not about to hide from stutter, but to let others know that we are present and we are speaking"*. Similarly, Tara proposed a feature that delicately adjusts filler words or specific speech patterns to make it less disruptive to listeners without compromising the individual's genuine voice or their mode of expression.

While subtly masking stutter is a delicate task for VC technology, some participants advocated for the opposite: that technology *amplify* stuttered speech in VC meetings, as a way to normalize disfluencies and create a more accommodating environment for all forms of speech in the long-term. For example, Jane proposed "literal transcription," a feature that normalizes stuttering by transcribing it verbatim in meeting captions and transcriptions, rather than attempting to "correct" it:

> *"Our society or our audience are not very well trained to our stuttered speech. And I am thinking, how do we normalize the stuttering speech. If the caption can transcribe my stuttered speech, as it is, but as you can see, it actually waits until you say it completely. Instead of, like, transcribe 'my' five times. I just feel if you can give that option to eliminate the disfluency or keep that this disfluency feature. Instead of making the people who stutter feel like they are in the process of me stuttering, the technology is waiting for a moment to correct my speech, just transcribe as it is." (Jane)*

This idea also responds to a strong desire to diminish the social stigma surrounding stuttering, as Jane advocates for increased representation of stuttering in digital platforms. She pointed out the significance of considering the long-term efficacy of technological solutions for stuttering. Technologies such as DAF that merely mask stuttering without addressing the underlying attitudes can reinforce the stigma and offer only short-term relief at the cost of long-term wellbeing and acceptance. For PWS, this small yet

powerful idea — literal transcriptions — creates a more accepting environment and reduces the pressure to conform to fluent speech norms:

> *"There is an app, you whisper to that app and they transfer, amplify your voice and change into normal speech. I heard people use that. But for me personally, any technologies used to mask stuttering actually reinforced that stigma in stuttering. It has helped people to hide longer. It's short term gain. But in the long term, it's very, very harmful." (Jane)*

Interestingly, while most participants focused on changing the speech of PWS, Teresa brought up the idea of slowing down non-PWS's speech to reduce the anxiety experienced by PWS: *"if presenter is speaking like 200 words per minute, the AI can slow and smooth the sentence... to help the person who stutters to calm down and to feel less intimidated by the person who speaks super fast."*

4.2.6 Enhancing Non-verbal Communication. Aware of the lost cues of the "talking heads" associated with VC, where non-verbal communication and body language are difficult to convey through the medium, participants had ideas for enhancing non-verbal communication in VC to convey meaning, emotion, and solicit emotional support. This is especially important to PWS, to bring in additional elements of interpersonal communication beyond the primary focus in VC on speech itself. Jane explained the importance of non-verbal cues for PWS such as nodding to indicate agreement: *"If somebody is speaking, I'm agreeing with them, like when I'm in person, I can nod my head and they can see that I'm nodding my head."*.

One idea, proposed by Jun and Jane, was to use avatars instead of the actual camera video. Jun explained that an avatar that represents him during video calls would allow him to attend interviews or meetings more comfortably, even laying in bed. This also alleviates the pressure and fatigue associated with maintaining a 'presentable' appearance and eye contact throughout meetings. Furthermore, Jane proposed that the avatar could not only *represent* participants but also *amplify* their body language such as intensifying head nodding, shaking, and hand gestures. In this way, avatars could serve as visual proxies, providing social cues even in scenarios where participants prefer to keep their cameras off.

Participants also brainstormed hardware support for enhancing non-verbal communication. Jane suggested simply using large screens that capture and display more of a person's body, so everyone can have a clearer view of each other's body language, *"so that you can read a room better."* Similarly, Teresa suggested that the speaker's view captures and displays more of the speaker's body, to better show their hand gestures and facial expressions, which adds flexibility for PWS to convey non-verbal cues effectively. She suggested options like wide-angle lens cameras and customizable frames that allow participants to choose how much of their body language they wish to share.

Finally, participants brainstormed ideas for mitigating some potential negative responses to involuntary stuttering behaviors. Teresa shared her personal challenge of losing eye contact during stuttering by closing her eyes and looking around: *"I used to close my eyes while I stutter so if the video can help us to open the eyes during these moments, that also will be helpful to make eye contact."* She proposed an idea of "Mask for Open Eyes," which simulates eye contact even when a participant diverts their gaze or closes their eyes. However, this feature provided the illusion of continuous visual engagement at the cost of authenticity.

4.3 Post VC

While many design concepts centered on offering real-time assistance to PWS during VC, participants also suggested a range of ideas aimed at providing support after the meeting for long-term empowerment.

4.3.1 Prompting Personal Reflections. Participants envisioned VC features that empower PWS to reflect on their experiences constructively and learn from their experiences. The purpose of such reflection would be to ultimately enhance their self-esteem, alleviate communication-related stress, and cultivate a growth mindset. For example, Jun, who often experiences significant stress and self-doubt following challenging meetings, sometimes finds himself unable to sleep if he stutters extensively. He said, *"if I introduce myself today, and I stutter, I will not be able to sleep tonight, I will think, 'I can not even introduce myself', what else can I do in my life. Everyone who heard of my self introduction would look down on me."* He proposed a feature that offers PWS a space for recovery, rest, and reflection after a potentially challenging VC experience.

Rebecca introduced the idea of reflecting on the anticipated versus actual impact of stuttering on the communication. VC could provide a "performance report," which could help PWS recognize that their stuttering might not have affected others' perceptions of their capabilities as much as they fear, promoting a more positive mindset: *"I've always had good performance reviews. And when I made the connection that my stuttering does not impact how other people view my performance. Wow, it really hasn't made a difference. I have the speaking ability."* She proposed integrating educational resources aimed at helping PWS understand, desensitize, and contextualize reactions from others. This could encourage PWS to not take every reaction personally, thereby reducing their speaking anxiety and building resilience:

> *"The goal was to desensitize the person who stutters so that when they're in the meeting, they're not always attributing other people's reactions to their stutter. Maybe the person who's leaving just has to use the restroom. Maybe you know the person who's gone talking to somebody else."* (Rebecca)

4.3.2 Providing Speech Feedback. Alongside utilizing self-reflection prompts to generate personal insights, participants envisioned various ways to provide automated constructive feedback toward improving their communication. Teresa, having a background in data science, proposed utilizing machine learning algorithms to help PWS learn patterns of their speech (e.g., difficult words) in the VC and provide tailored language feedback for them to improve after VC meetings.

Alternatively, Jun shared his personal challenge that his nervousness is related to speaking too fast. He proposed in-the-moment feedback that would remind him to slow down his speech, which he believes can help reduce his nervousness and improve communication clarity.

Tara further developed the idea of "coaching feedback" on communication style and pace, and suggested a feature for choosing its timing—real-time or post meeting. She also proposed including customization features for choosing what elements of speech it analyzes, to make it useful for the PWS, and the feedback intensity, to ensure the feedback is supportive and non-judgmental:

> *"if there would be a way, if you turn off/on the coaching feedback option service, it will send a report after so if it was like a pitch or a presentation, it could also help you to know whether you struggled, when you got to this part or you were having issues on this word or something. The coaching feedback could be like a post analysis of like a you know, game-like replay kind of a thing." (Tara)*

In Phase 2, the majority of participants (4 out of 5) showed a strong desire for a comprehensive post-meeting summary and reflection feature to foster self-compassion and personal growth. The initial visual prompts, inspired by popular commercial meeting analysis tools (e.g., read.ai, Otter.ai), primarily focus on content summaries and quantitative metrics (e.g. speech rate, speaking time). Participants highlighted that the information provided by current tools is still designed for fluent speech from a listener's perspectives, lacking relevance and sensitivity to stuttering. In response, Xuan wanted to customize the metrics for her own needs, such as frequency of pauses and the use of filler words. Jane further pointed out that quantitative metrics risk inadvertently conveying a judgmental tone about level of fluency, and suggested integrating the ABC framework[6] from stuttering therapy into post-meeting summaries. Specifically, Tara brought up the importance of reflecting on the positive aspects of a meeting, as a way to help PWS recognize potential negativity biases of the situation and develop self-efficacy for future meetings [36]. For example, the system could prompt the user to write down one thing they did well during the meeting (e.g. "asked one question and got the answer I needed") and display it before the next meeting as positive self-reinforcement. Rebecca envisioned the post-meeting summary and reflection tool as a potential self-tracking tool for PWS to manage communication-related progress and well-being in the long term:

> *"Everyone has a different comfort level with them. But yeah, being able to customize the goal is important. There are some folks who are working with speech pathologists, with their SLP, they come up with goals. How cool would it be to integrate those goals into their work life? Really bringing speech therapy into the office." (Rebecca)*

Building on these ideas, Jane and Tara further proposed prompting for post-meeting mindfulness exercises, such as stretching or taking an outdoor walk, to help participants unwind after meetings to *"shake off the tension."*

4.3.3 Community Effort. While self-disclosure is an immediate way to normalize stuttering during a meeting, our participants also considered ideas for community efforts that would empower PWS to increase their visibility. For example, Teresa advocates for PWS to share VC recordings of their public speaking experiences, which can increase public awareness of stuttering and encourage other PWS:

> *"As PWS, we should share our video conference recordings more so that people can see actual people speaking in the conference and how the audience are comfortable about having a PWS in the meeting. So publicity will help a lot. If you think of listening to the video conference, or people talking about the stuttering, in the way super fluently you just think that's actual case, however, see people stuttering using the tools to help them to cope with stutter, you'll find the power." (Teresa)*

Community efforts can also be directed inward, within the PWS community. Tara proposed having *"a user-support community of sharing experiences, tips and advice for managing stuttering and video calls such as a online forum."* In addition to learning from one another, sharing VC experiences can also provide social and emotional support, a sense of belonging, and help to build self-acceptance and self-confidence.

5 DISCUSSION

5.1 Inclusive Videoconferencing: Design Justice for the Stuttering Community

A lot of design ideas proposed by our participants could benefit other user groups beyond people who stutter, highlighting the ubiquitous value of inclusive and empowering virtual communication environment. For example, avatars with amplified facial expression could help autistic participants to better interpret non-verbal signals during VC meetings, a challenge reported in previous research [64]. Similarly, supporting tapping into and staying in a conversation without relying on speech could benefit DHH participants as well [31, 33, 48]. Tools to help pronounce or transcribe difficult words could be used by people with other speech diversities such as accents or aphasia [41]. Internalizing an empowering cognitive message and reviewing the positive aspects of a challenging experience have been proved helpful for people with imposter syndrome, social anxiety, and depression in general [7, 27, 30]. And the idea of having a more structured meeting agenda and fairness-oriented policies would support women to break into discussions and claim a fair share of airtime in professional meetings [29]. Even design ideas that target at the stuttering community specifically, such as self-disclosure of stuttering identity, could be easily adopted to empower all participants to speak up about one's needs and constraints, such as "having a sore throat today" or "having a poor Internet connection". These examples illustrate and echo the framework of universal design [54]: by incorporating the needs and insights of PWS - a group deeply impacted by communication technologies - in the design of videoconferencing products, we improve the videoconferencing experience for everyone.

We thus believe that the implication of the proposed design space goes beyond accessibility to inform the future development of VC technologies more broadly. As stuttering, with its social and situational variability, challenges the binary notion of "abled/disabled" [47], we argue that product features, derived from the perspectives of

[6] ABC framework is a model used to help individuals understand and manage their stuttering: A - Affective, feelings and emotions associated with stuttering; B - Behavioral, physical behaviors of stuttering; C - Cognitive, thoughts and attitudes. [9]

PWS, should not be hidden behind *accessibility* settings but integrated as standard elements in VC platforms, thereby creating a more inclusive meeting environment for all.

However, some of the design ideas proposed by our participants are more speculative and critical [5, 6, 23], deliberately rejecting the post-industrial value of speed and productivity to reclaim the space for stuttering in professional meetings [47]. For example, Teresa's idea of slowing down the speech of fluent speakers (in 4.2.5) would work against the conventional goal for "efficient informational exchange" in meetings and might be viewed as a technological setback for non-stutterers. Similarly, requiring a "cool-off" period (in 4.1.2) before somebody can speak again could be inconvenient and disruptive to the "pace" of conversations. While these ideas might not have a universal appeal to mainstream VC users and designers, they contest the established rhythms of communications and the "capitalist ideal of bodily mastery", directly responding to the body politics that often cast people with disabilities as "unproductive" and even "immoral" members of the society [47, 58]. By incorporating and developing these ideas from PWS into the design space for future videoconferencing, we have the opportunity to re-distribute the "affordance/disaffordances" in the design of meetings and VC technologies, seeking *design justice* for those who were traditionally marginalized and oppressed by communication technologies [17].

To better understand the potential tension between design universalism and design justice [17], we actively engaged our participants in deliberations and comparisons between design ideas that are more "universal" versus more "critical" in Phase 2 group sessions. We noticed that most participants resonated with the universal value of inclusive VC, as they anticipated designs with a universal appeal are more likely to be commercialized and less stigmatizing for them to adopt. Inclusive VC tools that directly contributed to a more friendly, effective communication environment were recognized as a net positive for PWS as well. For example, Rebecca considered post-meeting feedback valuable as *"it could be useful for everybody"* to be a better communicator. While our participants were generously aligned to prioritize designs reflecting universalism, they also stressed the uniqueness and value of stuttering experience when designing VC technologies. As Jane emphasized, *"stuttering has its uniqueness, it should be reflected in the design."* Designs oriented from the needs of PWS can also provide new value and affordances in VC technologies. For instance, while the "communication indicator" (in 4.2.4) might not seem universally useful for people without speech blocks, Rebecca speculated that the very act of pressing a button to call everyone's attention that "I'm still speaking" could provide a sense of agency to stuttering and non-stuttering speakers alike. Lastly, even for participants who had not thought of the more provocative design ideas or anticipated them implemented in VC products in the near future, they showed genuine interests in understanding and speculating about those ideas during the co-design sessions, finding them inspiring and liberating.

To sum, while the design ideas generated by PWS encompass a wide spectrum between universal and critical designs, the design space and our design approaches fit under the overall theme of design justice [17]. Through an exploration and articulation by and with PWS, of the design space for videoconferencing technologies, we center the perspectives of a social group deeply impacted by yet routinely excluded in the design considerations for VC technologies, uncovering new design ideas and values in videoconferencing that challenge existing power dynamics between "abled" and "disabled" speakers and seek social and cultural changes in video-mediated communications through the *re*-design of VC technologies [17, 53].

5.2 Designing for Social Dynamics Around Stuttering in Videoconferencing

Our participants generated many ideas for regulating their conversational partners and modifying the virtual communication environment, rather than focusing only on improving their own fluency. Based on this exploration of the design space, we advocate that VC support for PWS should address social dynamics beyond a deficit intervention. This perspective shifts the focus from fixing the fluency issue on the side of PWS to collective responsibility for creating a communication space that acknowledges speech diversities and accommodates stuttering. These design ideas mirror the stuttering community's push against ableist expectations of speech fluency [25], and embracing the social model of stuttering [12].

For conversational partners, participants generated design ideas aimed at educating audiences about stuttering and communication tips, with the purpose of changing public misconceptions of stuttering on VC from nervousness or internet connectivity issues [60] to a recognized speech variation [12, 13, 47]. In the long-term, this promotes social attitudes and behavioral changes to be more inclusive for speech diversity.

Moreover, rather than focusing on compensating for the so-called deficits of PWS, our participants suggested design ideas of making the VC environment more inclusive. Their ideas such as setting up turn-taking timers, establishing a "cool off" period to minimize interruptions, and regulating the pace of speech for all, resonate with existing literature on supporting remote and hybrid communication practices for people with disabilities [3, 18]. This support could extend beyond the meeting itself to include pre- and post meeting accommodations. For instance, calender invites or VC meeting announcements could collect accommodation needs of PWS and convey to meeting attendees openly or discreetly [3], depending on the comfort level of self-disclosure for PWS. Proactively setting meeting norms could alleviate the pressure of PWS to speak out about their accommodation needs.

5.3 "Soft" Aspects of Videoconferencing

Prior research has highlighted the importance of supporting soft aspects of meetings in VC such as authenticity, empathy, and emotional connections from the first-person account of PWS [61]. These values are also reflected in our co-design study where we take a step further to empower participants to be the co-designers for inclusive VC experiences. Our participants contributed concrete design ideas aimed at enhancing the relational aspects of VC, suggesting that VC can transcend its traditional role from facilitating information exchange to fostering deeper human connection. For instance, diversity disclosure badges may not directly enhance communication efficiency but may promote authenticity, leading to openness and deeper interpersonal connections — crucial elements yet often neglected in the efficiency-driven culture of VC. We urge

designers and practitioners to further consider these less visible yet important aspects of VC.

One direction to support these soft aspects is to adopt a "toolkit" approach for VC support, as participants propose various tools tailored to their individual stuttering experiences and personal values. The diversity in preferences — ranging from those prioritizing fluency without compromising authenticity (e.g., Tara's idea of subtle masking in 4.2.5) to those valuing authenticity and presence above all (e.g., Jane) — highlights the possibility of conceptualizing the design space as a toolkit. In practice, this toolkit can be implemented as a VC plugin, including various tools participants brainstormed in the design space. This approach positions VC as a container for self-discovery and personal growth, encouraging users to experiment with different tools and reflect on their impact on the communication experience. Furthermore, we can take a step further to empower PWS to take an active role in shaping their VC experiences. Drawing inspirations from prior autoethnography [37, 61] and autobiographical design [21, 42], we can further integrate the principles of these first-person methods such as carrying out collaborative autoethnography in the development and evaluation stage of VC. This involvement provides PWS with greater agency to act as co-researchers, designers, developers, and evaluators, in co-creating VC environments that support their values.

5.4 Bootstrapping Inclusive Videoconferencing: Limitation and Future Work

Our work presents an important and exciting design space for more inclusive VC experience, from the perspectives of people who stutter. While Phase 1 allowed us to map a broad, open-ended design space, our Phase 2 insights narrow it down to areas with high impact. This two-stage study design informed us how to bootstrap the design of inclusive VC platforms without being overwhelmed by ambiguity or misled by the engineering low-hanging fruits, allowing us to navigate a path between technical feasibility and meaningful impact to the stuttering community.

We acknowledge various limitations in our study: we have a relatively small number of participants in our study, which, while insightful, may not fully capture the diverse experiences and needs within the stuttering community. Additionally, the technical aspects of our proposed solutions have yet to be evaluated in real-world settings, in which new barriers and challenges might occur. Lastly, it remains uncertain how some of the inclusive design features proposed by PWS may support or conflict with the needs of other disability communities, as highlighted in prior work [3, 55].

Despite these limitations, our work marks an important step toward more inclusive VC environments, presenting exciting new opportunities to redefine VC experiences. Future work could delve into different areas of the design space with more intersectional subgroups, and materialize high impact design ideas through iterative design and evaluation with the stuttering community. Additionally, there is potential to extend this work to other communication technologies such as designing inclusive voice messaging tools.

6 CONCLUSION

Our work presents an exploration of the design space for more inclusive video VC experience from the perspectives of PWS. This work builds upon and extends previous research on stuttering and inclusive VC for people with disabilities, with a focus on improving the cognitive and emotional experience of stuttering and reducing socio-structural barriers for PWS in virtual meetings. We acknowledge PWS as crucial 'knowers' and 'makers' in crafting inclusive VC solutions. Bootstrapping from their lived experiences of marginalization and significant emotional and cognitive challenges in VC environments, PWS offered a wide range of design ideas across all VC phases to enhance inclusion and diversity for all. We reflect on the proposed design space using the lens of design activism, comparing values of universal design versus critical design in our participants' design practice. We also discuss the social dynamics of supporting stuttering in VC contexts, and highlight exciting opportunities for communication technology designers and researchers to re-invent VC with the stuttering community to facilitate authenticity, human connection and long-term personal growth.

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