

“The World is Designed for Fluent People”: Challenges, Benefits, and Opportunities of Videoconferencing Technologies for People Who Stutter

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This work studies the experiences of people who stutter (PWS) with videoconferencing (VC) and VC technologies. Our interview study with 14 adults who stutter uncovers extra challenges introduced by current VC platforms to people who stutter. While some of the challenges are a direct result of the characteristics of stutter (e.g. people/systems mistaking pauses as end of turn), a bigger yet less visible challenge comes with the significant amount of emotional and cognitive efforts required to manage one’s speech and identity over VC, in which people’s existing communication strategies - such as body language and eye contact - are under-supported and their biggest discomfort - such as seeing oneself stutter - are exacerbated by preset features like self view. Overall, our work sheds light on the structural barriers and the opportunities for PWS to engage and enjoy virtual communications via VC technologies.

CCS Concepts: • **Computer systems organization** → **Embedded systems**; *Redundancy*; Robotics; • **Networks** → Network reliability.

Additional Key Words and Phrases: datasets, neural networks, gaze detection, text tagging

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1 INTRODUCTION

Stuttering is a complex neurodevelopmental condition that affects approximately 1% of the world’s population [32]. Traditionally considered as a speech *disorder* characterized by atypical speech behaviors such as sound repetitions, prolongations, and speech blocks [32], recent research on stuttering has underscored its emotional and cognitive impact to people who stutter [3, 40]. Stuttering comes with substantial social penalties, including negative listener reactions, bullying and teasing, social harm and rejection, and stereotypes of being less intelligent, less capable, less attractive, less socially competent, and more anxious than fluent speakers [4, 8, 10, 12, 14, 17, 40, 45]. As a result, people who stutter (PWS) often develop strong emotional and cognitive reactions towards stuttering, including feelings of fear, guilt, shame, helplessness, social anxiety, self-stigma, as well as avoidance of certain sounds, words, situations, people, and relationships. Despite the success of a few notable people who stutter - such as President Biden, research shows that people who stutter are structurally disadvantaged and have an overall reduced quality of life: stuttering is associated with less satisfying personal relationships, higher risk of mental health problems, lower educational attainment, underemployment, and 20% - 35% reduced earnings compared to people who do not stutter [10, 20, 40].

Rooted in ableism and stigmatization, the marginalization of people who stutter is often exacerbated by and materialized through communication technology. For example, as many people who stutter find phone calls more difficult than in-person conversations, phone interviews and phone conversations at work create barriers to employment for people who stutter [20, 24]. As we enter a new era in which videoconferencing becomes the dominant and normalized mode for interpersonal and professional communications, it is crucial to understand its impact on people who stutter. Despite its widespread adoption, videoconferencing comes with unique challenges, such as the reduction of non-verbal

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53 cues [2, 31], turn-taking confusion, connectivity/technical difficulties, and generally “Zoom Fatigue” [2]. While most
54 of these challenges are also experienced by the general population, a recent study showed a disproportional effect of
55 such challenges on people with aphasia that made it even more challenging for them to stay connected during the
56 pandemic [31]. We thus hypothesize that people who stutter also face greater challenges with videoconferencing, and
57 such challenges impact not only communication efficiency but also the social-emotional wellbeing of people who stutter.
58 In this work, we explore the experience of people who stutter with videoconferencing technologies through interviews
59 with adults who stutter. The interviews and data analysis were conducted to understand the challenges, benefits, and
60 strategies for people who stutter during video conferences, in comparison to in-person meetings.
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63 This paper provides a unique contribution to HCI and accessibility research by presenting to our knowledge the first
64 formal study of the lived experiences of people who stutter with video conferences and videoconferencing technologies.
65 Distinct from previous work on videoconferencing challenges for the general population [2, 18, 28], our study emphasizes
66 the emotional and cognitive impact of such challenges beyond observable outcomes such as communication accuracy and
67 efficiency. Rather it examines how videoconferencing technology interacts with core elements of stuttering experiences
68 such as stigma, avoidance, and acceptance. In this way, our study uncovers challenges that are unique to PWS - such as
69 signaling the intention to speak by speech itself, audience confusion between stuttering and connectivity issues, as well
70 as known videoconferencing challenges that have a disproportional effect on PWS - such as the lack of connection with
71 audience and the mental stress with seeing self on camera. While most of our participants reported spending extra effort
72 to participate in video conferences due to such challenges, they also identified various benefits of videoconferencing
73 for PWS, including the increased connectivity within the stuttering community, and general public empathy towards
74 communication disruptions. Taken together, our work sheds light on the structural barriers and the opportunities for
75 PWS to effectively communicate and emotionally connect with others via videoconferencing.
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81 2 BACKGROUND

82 2.1 Stuttering

84 Stuttering is a genetic, neurodevelopmental condition that impacts people who stutter in behavioral, emotional, and
85 cognitive aspects [3]. Illustrated by the “stuttering iceberg” analogy, the observable behaviors associated with stuttering,
86 such as speech disruptions and facial tension, are only the “tip of the iceberg”, and most of the affective reactions
87 to dysfluencies - including fear, guilt, shame, and helplessness - lie below the surface [38]. These negative affective
88 reactions often lead to an increased level of social anxiety and self-stigma, and over time develop into cognitive reactions
89 such as “avoidance strategies” to cope with the fear with stuttering and pass as fluent [3].
90

91 The hidden nature of these emotional and cognitive challenges also leads to limited visibility and public awareness
92 of struggles and needs of the stuttering community. Despite clearly documented social and occupational disadvantages
93 associated with stuttering, people who stutter are rarely offered or ask for reasonable accommodations, such as extra
94 speaking time to account for unpredictable blocks [10]. As a result, people who stutter often need to go through interview
95 processes with disabling barriers or get passed over on career opportunities that involve verbal communications [7].
96 This work aims to contribute to the public knowledge on the experience of people who stutter - and the barriers they
97 face - in professional and social communications mediated by videoconferencing technologies.
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100 Our research is also inspired by the recent breakthrough in stuttering research and therapy that emphasizes the
101 subjective experience of stuttering rather than the perspectives and observations of the listeners [11, 40]. This epistemic
102 shift led the field to understand that the biggest struggle with stuttering moments is not the dysfluencies but the feeling
103

105 of “being stuck” and “losing control” [33, 40], and people who stutter find it most satisfying when their speech is
106 spontaneous, regardless of how fluent it is [11]. Combined with the theoretic framework from the social model of
107 disability, these insights empowered the stuttering community to push back on the listener-oriented, fluency-focused
108 notion of stuttering as an impaired, undesirable form of speech, and advocate for the right to stutter in public life [10].
109 Following a similar approach, we collect and study first-person accounts and reflections from people who stutter, of
110 their experience with video conferences and videoconferencing technologies, to unpack the emotional and cognitive
111 impact imposed by these technologies on people who stutter, beyond what is typically observed by third-parties, such
112 as other meeting participants, employers, and communication researchers. Our findings highlight the significant hidden
113 costs people who stutter have to pay in order to effectively participate in video conferences, calling for structural
114 changes in videoconferencing technologies as well as the meeting culture to create a more inclusive and empowering
115 digital communication environment for all.
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120 2.2 Assistive Technologies for stuttering Speech

121 Despite the prevalence of stuttering [32], little attention and research efforts haven been devoted to understanding and
122 improving the experiences of people with speech diversity with technologies. A search of the keywords “stutter” or
123 “stammer” over the proceedings of CHI conferences in the past 10 years (’12 - ’22) only returned 6 papers, and among
124 them, only one was tangibly related to stuttering [46].
125
126

127 Although stuttering has been neglected by technological research, technology has played an active role in the
128 marginalization of people who stutter. For example, as automatic speech recognition (ASR) systems become more and
129 more prevalent through smart speakers and automated phone menus, people with stuttering speech suffer a degraded
130 performance with such systems comparing to people who are fluent [30] and can be denied access to opportunities and
131 services as a result.
132

133 While there have been some efforts improving the experiences of ASR systems for people with atypical speech, most
134 these improvements were evaluated over static speech datasets using standardized metrics (e.g. word error rate, WER),
135 without formal evaluations with users who stutter in real world scenarios [29, 30]. As a result, little is known about
136 the user experience of these adapted systems. This disconnection between subjective user experience and ASR system
137 evaluation is particularly alarming in our context, given the recent movement by the stuttering community to take
138 agency in one’s speaking experiences [19, 40].
139

140 On the other hand, current technical products designed for people who stutter tend to focus on “fixing” or “masking”
141 stuttering speech rather than embracing it. They either ask a user to practice traditional fluency shaping techniques over
142 a software (e.g. Stamura¹, BeneTalk²), or try to induce a temporal, non-stuttering voice of their users (e.g. SpeechEasy³,
143 Whispp⁴). These products profit from the fear of stuttering and reinforce the notion that stuttering is unacceptable
144 - something that the stuttering community are trying to push against - and have not been widely adopted by the
145 community, perhaps unsurprisingly.
146
147

148 Overall, we see a tremendous gap in the technical research and investigation in the space of stuttering, and hope this
149 work contribute to the literature by uncovering the needs and opportunities for technologies to empower the stuttering
150 community, in a communication environment that is increasingly shaped and defined by digital technologies.
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153 ¹<https://stamura.com/>

154 ²<https://www.benetalk.com>

155 ³<https://speecheasy.com>

156 ⁴<https://whispp.com/>

2.3 Videoconferencing and Its Challenges for Communication

Since its first introduction of this concept [1], videoconferencing and videoconferencing technologies have played a more and more significant role in interpersonal communications. Despite several well-known issues with videoconferencing - such as the challenge with maintaining eye contact [37, 42] and surveillance effect of the camera feed [6, 16] - videoconferencing was widely adopted during the Covid-19 pandemic, and has since then become an increasingly dominant channel for professional and personal communications [21]. Recent work [2, 28] have examined the phenomenon and causes of “Zoom Fatigue”, a term used to described the exhaustion as a result of excessive videoconferencing. [2, 18, 28] outline the major challenges with videoconferencing and contemporary videoconferencing technologies, including: nonverbal overload, close-up gaze, extended screen time, reduced mobility, and self-view.

Some recent work studied the use of videoconferencing technologies for communities with atypical communication patterns. For example, [31] investigated the experience and challenges of people with Zoom videoconferencing platform, uncovering additional challenges for this demographic introduced by the lack of non-verbal communication channels. [26, 36, 41] examined the accessibility of videoconferencing for d/Deaf and hard of hearing (DHH) people, highlighting unique challenges such as difficulty in lip reading, the design of identifying active speaker based on voice, and the additional delay between the signer and the ASL interpreter.

Our work contributes to this area of research by presenting the experiences of videoconferencing by people who stutter - a population that have traditionally faced systematic challenges in in-person communications. We hope our insights will uncover unique challenges for the stuttering community and inform the design and development of a more inclusive video-based communication environment for all.

3 METHOD

We conducted semi-structured interviews with adults who stutter from the US and UK to learn about their experience of videoconferencing.

The participants were recruited directly by the author(s), through speech therapy groups, stuttering community events, and social contacts. We continued the study recruitment process until consistent high-level themes emerged. The interviews took place between February 2022 and August 2022 over Zoom videoconferencing system, and were recorded with explicit consent from the participants for later transcription. Understanding the multiple forms of suppression at play during professional and public communications, we prioritized the recruitment and inclusion of participants with multiply marginalized identities besides stuttering, such as, women, first-generation immigrants (P1, P4, P5, P6, P10), and people of color (P1, P3, P4, P5, P6, P8, P10). Cognizant of the potential challenges and discomfort for people who stutter to speak over Zoom, we made conscious efforts to create an accommodating environment for participants to speak freely and comfortably. For example, for multilingual participants, we conducted the interview in their preferred language (e.g. P4 in Mandarin Chinese) rather than in English. The transcription was later translated by one of the authors for analysis and reporting purposes. While respecting the participant’s time, we always left ample time after the scheduled interview slot and let the participants know that there was no time pressure for them to speak fast or concisely. Additionally, all but two (P1, P10) interviews were conducted by a research team member who stutters and had moments of stuttering during the interviews. As a result, the length of the interviews varies, lasting between 45 mins to 1.5 hours. The participants were not compensated.

The interviews were structured with the following four components.

Table 1. Background Information of Interview Participants

ID	Gender	Country	Occupation	Self-identified Stuttering Characteristics
P1	F	US	Software engineer	Covert, filler words, blocks, word substitution, loss of eye contact
P2	M	UK	Professional athlete	Covert, blocks, word substitute, raising heart rate, sweat
P3	F	UK	Ophthalmologist resident	Covert & mild, avoid sounds, reorder words
P4	M	US	Postdoc researcher	Blocks, word substitute, struggle more with starting vowels
P5	F	US	SLP grad student	Blocks, some repetition
P6	M	US	Product designer	Mild to moderate, blocks, backtracking, word substitution
P7	F	US	Preschool teacher	Blocks, facial tension
P8	M	US	Medical student	Filler words, pauses, tongue clicks
P9	F	UK	University staff	Covert, blocks, some repetition, word substitution
P10	F	US	PhD student	Blocks, repetition, some prolongation, facial tension
P11	M	US	UX researcher	Covert, speak slowly, word substitution
P12	F	US	Geospatial Analyst	Covert, mild, blocks on names
P13	M	US	Program manager	Blocks, word substitution, look away when stuttering
P14	F	UK	SLP	Stutter openly with little struggle

Table 2. VC Experience and Technology Use

ID	VC Frequency	Platforms (most to least used)
P1	Several times a day for work; weekly with family & friends	Zoom, Google Meet, MS Teams, WeChat
P2	4-5 times a week for work; daily with family & friends	Zoom, Microsoft Teams, Facetime
P3	Several times a week for work & school	Zoom, MS Teams, Google Hangout
P4	Several times a week for work; weekly with community	Zoom
P5	All classes for master program; weekly with community	Zoom, Google Hangout
P6	Several times a day for work	Zoom, Slack calls, MS Teams
P7	Daily for 3 months for work, weekly for therapy & church	Zoom, Google Meet
P8	1-3 times a day for work, several times weekly with community	Zoom, Google Meet, MS Teams
P9	Several times a day for work, weekly for therapy	Zoom, WebEx
P10	Several times a day for work & school	Zoom, weekly for church, FaceTime, WebEx
P11	Several times a day for work	Zoom
P12	Daily for work	MS Teams, WebEx
P13	Several times a day for work	Zoom
P14	Several times a week for work	Zoom

(1) *Personal background and characteristics of one’s stuttering.* Stuttering is not monolithic, and our participants described their stuttering in terms of the speech and non-speech challenges with stuttering, impact of stuttering, coping behaviors, and current attitude towards stuttering. This helped us assess the representativeness of our participants to the stuttering community, and understand the challenges with videoconferencing in relation to the speech/behavior, affective, and cognitive aspects of stuttering. The key data collected from this part of the interview is reported on Table 1⁵.

⁵Several participants described their stuttering as “covert”, a term used in speech therapy and stuttering research to characterize the type of stuttering with little or no disfluencies that can be effectively passed as fluent speech to the listener [?]. It is equivalent to “interiorized stammering” in the United Kingdom, and we use these two terms interchangeably.

- 261 (2) *Use of video conferencing technologies.* We asked about the frequency of videoconferencing, top use cases for
 262 videoconferencing (e.g. school, work, community, friends & family), as well as the types of videoconferencing
 263 technologies used (e.g. Zoom, Google Meet, Microsoft Teams, Skype, Facetime, etc).
 264
 265 (3) *Experience of videoconferencing.* We asked about participants general experience of videoconferencing in
 266 comparison to in-person meetings: whether they find one more challenging than the other, and in what
 267 situations. We also asked the participants to reflect on the top challenges and benefits they experienced with
 268 videoconferencing, as well as the role of stuttering in those experiences. We also inquired about the strategies
 269 participants have developed to manage their videoconferencing experiences.
 270
 271 (4) *Future of videoconferencing.* We brainstormed with the participants for technical or non-technical ways to make
 272 videoconferencing experiences easier and more comfortable for them and/or for the stuttering community in
 273 general.
 274

275 The interviews were transcribed and analyzed using inductive qualitative methods drawn from grounded theory [?].
 276 The authors reviewed the interviews and performed thematic analysis for each interview. The authors then discussed
 277 the themes identified in individual interviews and used an affinity diagram to organize them into different areas of the
 278 findings we discuss below.
 279

281 4 FINDINGS

282 Overall, all participants had used videoconferencing in professional and/or personal settings (see Table 2 for summary)
 283 and reported various degrees of satisfaction with their video conferencing experiences. While most of the participants
 284 agreed that video calls are easier than phone calls with no video, the preference for video conferencing versus in-person
 285 meetings varied, depending on the meeting context as well as the amount of experience participants had with video
 286 conferencing and the video conference platforms. For some, video conferencing is more suitable - or most similar to
 287 in-person experiences - for small groups or 1-on-1 conversations (P3, P4, P7, P9); and for others, it is easier to have larger
 288 meetings or public presentations over video conferencing platforms than in-person (P2, P6, P11, P13). While several
 289 participants (P3, P4, P10, P12) cited the lower expectation for active participation as a benefit of video conferencing,
 290 some (P1, P13) felt more comfortable when they served an active role with control over a meeting's agenda, content,
 291 and norms.
 292

293 As the trend with videoconferencing persists, our participants' perception of it evolved as well. For those who only
 294 started serious videoconferencing since the pandemic (P2, P3, P4, P5, P7, P9, P14), they found their experience improved
 295 over time.
 296

297 *Video calls were a nightmare for me, at least at the beginning. But now I am getting used to this nightmare.*
 298 (P4)

299 *At this point, I think I am about 50:50 [Zoom : in-person]. Just the amount of time we used it, just the*
 300 *practice we have had [since the pandemic] (P9)*
 301

302 However, the participants with the most remote work and video conferencing experience found themselves much
 303 more accustomed to speaking in video calls, sometimes at the cost of lower comfort level with in-person interactions:
 304

305 *With work, on VC, I stutter much less because I got used to. I do stutter, but much less. In person, just an*
 306 *aspect that we haven't had too much in person calls or conversations recently. Because I work on software, I*
 307 *have been working remotely for the past few years, I lost some muscle memory of that kind of interactions.*
 308
 309
 310
 311

313 *[...] I haven't had too much opportunities to interact with people in person recently.[...] Having small talks*
314 *with people in person, as an introvert, that was difficult. (P6)*
315

316 *In terms of me leading a meeting, or facilitating something, events like if I'm in the hot seat, talking on a*
317 *panel, or something like that, I, at this point - that I never would have said this before the pandemic - but I*
318 *would actually rather do it virtual.[...] I actually don't have a lot of experience facilitating, or panel, in*
319 *person, because a lot of those opportunities came to me during the pandemic. The idea of doing a live TED*
320 *Talk freaks me out, but I've just done a half hour presentation over the computer, and I loved it! (P13)*
321
322

323 In the rest of this section, we will describe the benefits of videoconferencing as identified by our participants, the
324 challenges they experienced, and the strategies they have developed to alleviate these challenges. All the benefits and
325 challenges of videoconferencing were discussed in comparison to their in-person equivalent, unless otherwise specified.
326 Although the majority of our participants draw their insights heavily from virtual meetings at work or school - a setting
327 where most of their video calls took place, many of the findings are generally applicable to other context such as social
328 and community activities.
329

331 4.1 Benefits

332 Although the usage and context for videoconferencing varies, all of our participants saw some benefits of videoconferencing,
333 throughout the Covid pandemic and extending into the future. While all the benefits noted by our participants
334 are applicable to people who do not stutter, some of these benefits are particularly appreciated in the context of
335 stuttering, which we will highlight in the subsections below.
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337
338

339 *4.1.1 General Videoconferencing Benefits.* Similar to everyone else who has gone through the pandemic and experienced
340 the shift towards online communications, our participants appreciated the utility of videoconferencing in maintaining
341 social connections and empowering distributed collaboration across geographical boundaries. As expressed by P9, video
342 conferencing “is a vital way to keep in touch with everybody, especially during lockdown”. And P11 mentioned, “I am a
343 fan of the COVID shift, I think it has opened the talent pool to much broader geographies... It has democratized the access
344 to talent.”
345
346

347 Like the general public, our participants noticed the trend in remote and hybrid work, accepting the fact that
348 videoconferencing would be an increasingly important channel for human communications: “Zoom, and virtual, and
349 hybrid working, is never going away. There is still collaboration across coasts, across countries, that is not gonna go away”
350 (P13). In any case, videoconferencing was preferred by our participants over audio-only phone calls - a situation noted
351 as most challenging by many people who stutter [24], including our participants. Our participants chose to embrace
352 videoconferencing - together with its challenges - in the post-pandemic era, and even considered it an opportunity to
353 redefine meeting dynamics and norms. For example, P13 has been hosting training on virtual meeting etiquette and
354 best practices at his workplace, leading the effort to build a more inclusive, humanized communication environment
355 over videoconferencing:
356
357
358

359 *I want everyone to use the same, or similar practices, when it comes to communicating through the*
360 *computer. Because if we all use the same, best practices, everyone is better off, not only the people you*
361 *presenting to. [...] If I model behavior, it's like, “I like he did that!”, that might trickle to the next meeting.*
362 *(P13)*
363
364

365 4.1.2 *More Control on One's Environment.* People who stutter often have more speech difficulties in new and unfamiliar
366 environments [15]. Videoconferencing makes it possible for people who stutter to participate in a wide range of speaking
367 situations while staying in a consistent, familiar environment that is customized to their preferences and comfort.
368 Many of our participants appreciated this aspect of videoconferencing and noted its positive effect on their speech and
369 emotional wellbeing.
370

371 Several of our participants spent intentional efforts setting up the physical environment they video conference in, as
372 a way to achieve psychological comfort and eliminate potential stress brought by stuttering:
373

374 *I feel comfortable, I'm in my house, I'm in my chair, I'm very comfortable with my setup here. I have two*
375 *screens. (P13)*
376

377 *I certainly try to create a working environment that feels very positive to me, so choosing a blouse I like, a*
378 *shirt, or doing my hair how I like it, or choosing artwork in my office that makes me feel comfortable. It's a*
379 *way I can shape my environment to make me feel more comfortable, and also feel like I have a personality*
380 *that I am presenting. So that you are not focusing on my stutter. (P12)*
381
382

383 *I can manage my energy a little bit better on VC, because you are in your own environment. For people*
384 *who stutter, going to a bar is very challenging, the office can have a similar effect.[...] you just have more*
385 *control on VC than in person environment. (P6)*
386

387 The physical distance with other videoconferencing participants also created a psychological “safety distance” that
388 protected our participants. As expressed by P5, “on Zoom, you see the person, but that person is still some distance. I feel
389 it's still safer for me. It's less intimidating to meet person on Zoom than in person.”
390

391 Besides the control over their physical environment, videoconferencing technology also allowed the participants
392 to customize their communication environment. By adjusting the position, layout, and size of the display of their
393 audience and conversation partners, several of our participated indicated gaining the sense of “in control”, especially
394 when speaking to authority figures and in bigger groups - settings that are generally more challenging for people who
395 stutter [15]. As P6 explained: “the other thing with VC is that it can be one or with a thousand people, you can change how
396 many people you view on the screen. VC makes it easy for you to speak to a larger group. [...] I will be more anxious in
397 person for larger group meetings, maybe even holding the mic is a different dynamic, versus on Zoom, it doesn't feel too
398 much different to me, one person or a thousand people”.
399
400
401

402 4.1.3 *More Control on One's Self Representation.* Beyond the control over their own environments, our participants
403 also believed that video conferencing technologies have provided them more control over how they were perceived by
404 others as well.
405

406 In additional to speech disfluencies, people who stutter often struggle with stuttering associated secondary behaviors,
407 such as facial tension, flushing, sweating, and sudden head and body movements [3]. While most of these behaviors
408 are involuntary, they can trigger negative social reactions due to the stigma towards stuttering [3]. Several of our
409 participants called out the benefit of videoconferencing as to hide their secondary behaviors more easily when they
410 stuttered. For example, P1 perspires more when she stutters, and often worries that others would see or smell her
411 sweat at in-person meetings. Videoconferencing largely eliminated this worry for her, so now she had one less thing to
412 worry about during meetings. Similarly, P10 noticed, “I sometimes get really shaky if I'm presenting in person. By if I'm
413 presenting on Zoom, I am already sitting down so it's okay. And nobody can see me even if I'm shaking”.
414
415

417 Videoconferencing also allows our participants to utilize existing or new strategies to manage their speech, without
418 drawing unnecessary attention to their struggles. For example, both P1 and P12 mentioned the strategy of rehearsing
419 what they wanted to say beforehand with both microphone and video turned off. P12 gave the example of rehearsing
420 her self-introduction in a video call:
421

422 *When I know I have to introduce myself, but I am a little nervous because it's a new group, or in front of*
423 *leadership, and so I want to impress them. So I won't have my audio on, I won't have my video on, I will*
424 *just like quietly say to myself and I'll practice my breath work with it. [...] I try to do that, so that I can add*
425 *the skill set I have to try to mitigate any disfluencies, [...] just to make myself more confident. So when that*
426 *[self-introduction] does happen, I can say, okay, I think this is what I need to do to get through this. I will*
427 *probably do that, like, 30 seconds before, or even before the meeting starts, so I feel a little more confident.*
428
429 (P12)
430
431

432 Other speech and identity management strategies that worked particularly well over videoconferencing include
433 squeezing a stressball (P1), tapping the feet (P1, P6), turning off the camera when struggling with facial tension (P6,
434 P12), blaming the Internet connection for speech blocks and long pauses (P2, P3, P11), and using fluency-inducing
435 technologies (P4). Our participants were acutely aware of the potential biases and discrimination against their stuttering,
436 as well as other marginalized identities of theirs, and appreciated the possibility to blend in with the majority through
437 their self-curated virtual presence:
438

439 *In my mind, it's easier to control how I am being perceived when all you can see is a square. [...] I'm 5'3, I*
440 *am a small Caucasian woman, there is nothing remarkable about me. [...] I'm not tall, and I'm not a man.*
441 *A lot of my colleagues are men, my clients are men, [...] The leadership are typically male, so I want to look*
442 *like tall when I try to introduce myself. That - in my mind - creates a little bit more of an even playing*
443 *field. If the only thing you can see about someone is their background and they are out there, I think that*
444 *kind of makes me feel more comfortable. It's a very controlled setting. (P12)*
445
446

447 P4 used DAF Pro, an smartphone App that enables the user to hear themselves speaking with a 60ms delay, for virtual
448 job interviews, and managed to have perfect fluency during the interviews. However, this strategy did not come without
449 a cost. After starting on the job and experiencing the effect of delayed auditory feedback (DAF) worn out - a common
450 phenomenon for DAF users, P4 struggled with not only speech difficulties, but also the feeling of embarrassment and
451 guilt at the workplace:
452

453 *I felt a little bit guilty that I spoke very fluently during the interviews by using the DAF app, but showing*
454 *stutter afterwards. I don't want my supervisor to think that I cheated. I wanted to be an honest person, but*
455 *during the interview I did want to cover up the fact that I stutter, so I didn't disclose during the interview,*
456 *and I was also a bit worried that my stuttering would impact whether they give me the offer. I am a bit*
457 *embarrassed now. (P4)*
458
459
460

461 4.1.4 *Reduced Barrier to “Show Up”.* Research has shown that adults who stutter suffer from heightened social anxiety
462 and are more likely to avoid social situations as a result [22]. The avoidance behaviors (e.g. not showing up, avoiding
463 speaking, avoiding eye contact) would then elicit negative responses from others and reinforce existing social anxiety [34].
464 Modern speech therapy research and practice has accumulated evidence that by reducing avoidance behaviors, people
465 who stutter can break from this vicious cycle to live and speak much more comfortably [9, 22]. Videoconferencing
466 has reduced the barriers to join meetings. P8 noted “*the ease of joining*” as one of the biggest advantages of Zoom and
467
468

469 commended Zoom for “*make it easiest possible for people to find and join meetings*”. The convenience of videoconferencing
 470 has also greatly reduced the physical labor for the participants to attend to social events and meetings that they would
 471 otherwise pass over:
 472

473 *I can definitely see that as a good tool to kind of help me show up to places. There were so many times [in*
 474 *the past] that I just didn't show up to things. [...] I feel that [Zoom] is an advantage cuz you don't have to*
 475 *get to your car and travel [...] I think for me, because you don't have to travel, you don't have to dress up,*
 476 *just dress up top of your body and put whatever pants on underneath, it just feels easier to say that I can*
 477 *come. (P7)*
 478
 479

480 While stuttering is often a very isolating and heavily stigmatized experience, our participants were able to leverage
 481 videoconferencing platforms to connect with others who stutter, and build communities that are safe yet supportive. P5
 482 shared that her journey of self-acceptance, started with a weekly global support group meeting over Google Hangout
 483 that she participated in without turning on her camera or microphone for several months, before her “coming out”
 484 as a person who stutters and eventually hosting the Google Hangout support group. For PWS who experience social
 485 and self stigma towards stuttering, **the anonymity and passive participation afforded by videoconferencing**
 486 **technologies pave the way for them to take the first step of reaching out to the stuttering community.**
 487 Inspired by her own journey, P5 started a Chinese-English bilingual stuttering support group over Zoom, with people
 488 joining from China, US, and the Europe. While almost all the attendants from China joined with a pseudonym and
 489 camera off at the beginning, P5 noticed that people gradually became more comfortable showing their faces and
 490 introducing themselves after a few calls. For P5, “*Zoom play an important part in my education and in my healing*
 491 *journey*”, and this sentiment is shared by many other participants of our interview study. P1, P4, P9, and P12 started
 492 acceptance-based speech therapy and meeting other people who stutter since the pandemic, over videoconferencing
 493 platforms. P8 remarked the community connections that were facilitated through videoconferencing: “*the world has*
 494 *become more and more connected. Now, on a regular basis, I talk to people across the world, because people are used to*
 495 *Zoom. I know people across the world who stutter, that is a blessing.*”
 496
 497
 498
 499
 500

501 **4.1.5 General Trend towards More Inclusive Meeting Behaviors.** As COVID-19 disrupted lives and blurred work-life
 502 boundaries, research also showed that people have developed increased empathy towards others since the outbreak
 503 of the pandemic [?]. In the context of video conferencing, our participants noticed that people have become more
 504 patient and more understanding with speaking-related challenges, which alleviated some pressure for people who
 505 stutter to participate fluently. P7 felt “*people are more used to things like pauses*”. And P3 noticed, “*even fluent speakers*
 506 *have difficulties on Zoom, [...] having challenge of being heard is more understood now*”.
 507
 508

509 Most videoconferencing technologies, as well as the telework environment, have also provided more options to
 510 participate in meetings. All but two participants mentioned the “hand raising” function in Zoom, and found it effective
 511 at getting people’s attention when it was understood and enforced as the norm. Chat is another feature that some
 512 participants appreciated. As P7 explained, “*try to get into a conversation with your voice would be difficult; using the chat,*
 513 *it can be a good way to ease into that*”. Compared to in-person conversations, P2 felt it was helpful to have the option to
 514 type in the chat, as “*in some way you can avoid having to speak, it does give you that option; whereas when you are face*
 515 *to face, [...] it's be a bit strange to text them, or email the message*”. However, several participants also found the chat
 516 “ancillary”(P11), “unnoticeable”(P3), and “distracting”(P4), and would not participate through chat unless someone was
 517 actively monitoring and addressing it (P1, P3, P10, P11). The reaction feature in Zoom was not as popular, although a
 518
 519
 520

521 few participants (P8, P10, P13) did use it as a way to actively participate in virtual meetings. Besides the functionality of
522 videoconferencing platforms, participants also made use of the asynchronous communication channels:
523

524 *In distributed work, there are other ways for you to speak up - quote unquote “speak up”. You can speak up*
525 *in documents, you can speak up in posts. I think that’s extremely valuable. I think it is definitely something*
526 *I have leaned on more. [...] There are just more options to speak up in different ways. (P6)*
527

528 Overall, our participants saw a cultural shift towards more inclusive meeting expectations and behaviors that
529 empowered people who stutter to speak up:
530

531 *10 years ago, it was perfectly acceptable to just have one person speak in the entire meeting; but now, if*
532 *there is only one person speaking, I will definitely call it out. (P6)*
533
534

535 4.2 Challenges

536

537 Despite benefits, videoconferencing and videoconferencing technologies also introduced additional challenges for
538 people who stutter to engage and participate in meetings and conversations. While some of the challenges are a direct
539 result of speech related communication difficulties (e.g. people/systems mistaking a pause as the end of turn), the
540 bigger part of the challenge comes from the significant amount of emotional and cognitive effort required to manage
541 one’s speech and identity over voice-centric platforms like Zoom, in which our participants’s existing communication
542 strategies - such as body language and emotional connections with the audience - are under supported, whereas their
543 struggle and embarrassment with stuttering were directly exposed by the zoom-in view of one’s face and the preset
544 feature of self-view. As P5 pointed out:
545
546

547 *On Zoom, your voice is so much important for you to communicate than before. They can not see your*
548 *body, your gestures, your words carry more meaning, you have to impress people with your words, for*
549 *someone who stutters, that’s a disadvantage. (P5)*
550

551 Such challenges not only limited the participation of PWS during meetings, but also created emotional and cognitive
552 burdens that reinforce some of the most negative impact of stuttering, preventing PWS from engaging and enjoying
553 communications via videoconferencing technologies. P7 mentioned, *“I have the same [social anxiety] in person, but it is*
554 *heightened in VC.”* And P2 described his experience with video conferencing as *“exhausting”* and *“not rewarding”*. While
555 that exhaustion from VC meetings was shared among many people who do not stutter [2], P2 noted that the exhaustion
556 was exacerbated for people who stutter as *“I have to focus so much on trying to say the right thing at the right time and*
557 *then also alongside managing the stammer”*.
558
559
560

561 4.2.1 *Self-view.* Numerous studies have shown seeing oneself in a mirror can induce self-evaluation and distress [2, 18,
562 43], and the effect is stronger for certain social groups such as women and Asian, as comparing to men and White,
563 respectively [35]. Not surprisingly, the “self view” function - turned on by default on most video conferencing platforms
564 - stands out as one of the top challenges with videoconferencing in our data. Almost all of our participants indicated
565 some discomfort with the self-view, finding it “distracting” (P1, P7, P9, P19, P14) and anxiety-triggering. P7 related the
566 self-view with traumatizing experience in the past when she had to watch her own recorded speech at speech therapy.
567 P5 considered self-view as a “curse” in which *“you have to face your worst fear as a person who stutters”*, noting that
568 *“before, when you talk to a person, you don’t necessarily see your own face; seeing your own face puts the person who stutter*
569 *in a direct confrontation with your stuttering”*.
570
571
572

573 Although the challenge with self view is not unique to people who stutter [2], our participants reported heightened
574 mental stress when confronted with the self-view in video conferences. As P11 illustrated, “*during COVID, people would*
575 *share that, for the first time, they were very self-conscious in meetings, because they see themselves, and hear themselves,*
576 *and I was like, ‘oh my god, this is the first time that you have been that conscious about how you talk?’ Because that’s how I*
577 *am all the time. But now I am like 2x, because I am concerned about how I am coming off but then I am also seeing how I*
578 *coming off. And it was just like that much mental energy.” As a result, seeing the self-view can make people who stutter*
579 *struggle more with their speech: “definitely it is harder [with the self-view], I can feel the tension but now I can see it*
580 *myself, from the other person’s point of view. You are in the moment, you are also seeing it, that made it more difficult.” (P7)*
581

583 Participants also found the self-view distracting as it directed more attention to their own speech behaviors and less
584 to their conversation partners: “*seeing yourself is definitely a different experience, especially for someone for stuttering. I*
585 *realized there is something I do with my face that I didn’t know. [...] Sometimes, seeing myself, and what I am doing with*
586 *my mouth, distracts myself.” (P7)*
587

588 To mitigate these challenge with the self-view, more than half of the participants had turned it off, at least for some
589 meetings (P1, P4, P8, P9, P10, P12, P13, P14), or tried to avoid looking at it even when it is on (P4, P12). P13 explained
590 his rationale behind turning off self view: “*I turn off my self-view, every meeting of it, so I don’t see myself. Cuz I hate to*
591 *see myself, I hate to see myself talk, I don’t need to see. For me, personally, because I really don’t like seeing myself talk, it*
592 *makes me more self-conscious, it makes me look at myself more. Then, generously speaking, when you turn off your self*
593 *view, it’s more like mimic a real life conversation, because in real life conversations, you are not looking at yourself all*
594 *the time, unless you are talking to a mirror! You can actually be more engaged with the person you are talking to, if you*
595 *hide yourself, or no longer caring about yourself, only caring about the person you are with.” In fact, the impact of the*
596 *self-view was so detrimental, that P13 deliberately avoided videoconferencing platforms that do not let people hide their*
597 *self views, and questioned the very idea of self-view in videoconferencing:*
598
599

600
601 *There are still some platforms, including Room, which is a product from Meta, where you can’t turn off*
602 *your self-view, so you have to watch yourself. So, any meeting I setup, I do Zoom, because, I can do that*
603 *[turning off self-view]. I’d be curious to hear what the rationale is for that as a preset feature, cuz it doesn’t*
604 *make sense to me. (P13)*
605
606

607
608 Nevertheless, some participants found a silver lining and started to accept the self-view as a therapeutic tool for
609 them to self-monitor and desensitize stuttering. P7 explained her current approach with the self-view: “*I am able to look*
610 *at it as information: this is what I look like when I struggle; when I am tired, my eye contact is not great, I close my eyes, I*
611 *block more. It’s interesting to get more feedback, that I normally wouldn’t get.[...] For me, it’s helpful. How I am gonna use*
612 *that information? I am blocking, I am holding back, if I am gonna change that, what I need to do. I use it [self-view] in an*
613 *informative way.”*
614
615

616 4.2.2 *Turn Taking.* While the connectivity issue and the lack of non-verbal cues over videoconferencing have created
617 difficulties for taking turns and jumping into a conversation for everyone [2], such difficulties are multiplied for our
618 participants. By default, many videoconferencing platforms rely on audible sound to detect and switch the current
619 speaker, making the first sound/word crucial to signal one’s turn. However, several of our participants found themselves
620 struggle the most with initializing a sentence. With a limited channel for non-verbal communication strategies such as
621 body language over videoconferencing, they would often be held back by that very first word:
622
623

625 *I find things just like saying “hello”, that’s probably the hardest bit. [...] Then once you get into the flow of*
626 *things, it becomes easier. [...] The hardest things for me is starting the sentence of a conversation. (P2)*

628 *As a stutterer, it is harder to get your first sound out. Body language is more visible in person. That’s*
629 *particularly challenging. I am trying to say something but before I can say something, somebody also*
630 *already got the word out. (P6)*

632 On the other hand, the limited perception of other meeting participants on videoconferencing platforms also made it
633 harder for others to support people who stutter on turn taking. P14, a SLP who has been conducting group therapy
634 sessions with PWS via Zoom since the pandemic, noted that:
635

636 *With timing, there is sometimes a delay, and if you deal with that, in a group situation, and you’re*
637 *stammering, maybe it is hard to indicate that you want to speak. When you are in the same room, you can*
638 *see more of the body language that you want to speak, versus when we are just in the screen, it’s harder to*
639 *read the room, read the group in the same way, get a sense that that person is wanting to talk now. I think*
640 *we are more focused on just looking at the one person who is talking, and not having the peripheral vision*
641 *of the whole group.... that’s true for everyone, not just for people who stammer, but I wonder whether your*
642 *stammer adds an extra layer of difficulty, that you can’t get in. (P14)*

645 Even after PWS successfully cut into the conversation, they could face higher risk of losing their turn involuntarily
646 because of their stutter. Without sufficient non-verbal cues, P10 was concerned that people would assume she’s finished
647 when she was in fact having a long pause due to stutter. Some participants noticed that it could be challenging to
648 differentiate a stuttering block with the loss of Internet connectivity in some situations, especially when the block is
649 long and silent: *“if the person is not able to get any sound out, they can’t say to people, I am not finished yet. that’s the loss*
650 *of body on Zoom. because often you can tell somebody is still trying to speak based on what they are doing with their body.”*
651 *(P14)*
652
653

654 To overcome the challenge with jumping into the conversation with speech, our participants leveraged videoconferencing
655 platform features such as “hand raising” and “chat” extensively, and found the hand-raising function relatively
656 effective at signaling their desire to have a turn. However, the participants also reported that the “hand raising” was
657 sometimes ignored/unseen - especially when the speaker was in presentation mode. P10 sometimes raised her physical
658 hand in front of the camera at the same time as she pressed the hand-raising button, in the hopes for attracting more
659 attention to her willingness to participate. Some participants (P1, P10) also shared that they would not feel comfortable
660 to be the first/only one to use the hand-raising function, if others in the meeting were getting their turns through voice.

662 Another strategy our participants adopted for easier turn taking is to proactively setup the structure and norms of
663 participation during virtual meetings they hosted. For example, P1 tried always preparing an agenda for the larger
664 meetings she hosted, with speaker name and timing assigned for each agenda item to ensure people on the agenda
665 (including herself) have their turns. P14 would ask people who did not speak to type out their ideas in the chat, and
666 reserved time to read and respond to all chat messages. P13 would give people a heads-up on who would go next during
667 round-the-room introductions or updates. And P9 would proactively check in with people who did not get a turn or
668 people who had expertise on the topic for things to add.
669
670

671 Our participants also developed various strategies to protect one’s turn during stuttering moments. For instance,
672 using, and getting everyone else to use, the hand-raising button was found helpful by a few participants, as it often
673 created a break between speakers, giving PWS more time to unblock themselves before losing their turn. P14 would
674 check with people when in doubt, asking whether they were finished, and stopped other people from cutting in before
675
676

677 getting an affirmative answer. P10 leaned on the non-verbal signals available on Zoom, keeping her camera on and
 678 making her facial expression more pronounced even though it felt “tiring” to have camera close-up for a prolonged
 679 period of time.
 680

681 **4.2.3 Emotional Connection with Others.** With a strong association between stuttering and social anxiety, people
 682 who stutter are more sensitive to negative evaluations from others, and more likely to engage with safety behaviors
 683 such as loss of eye contact [22]. While the reduction of social cues during video calls has made everyone feel less
 684 connected to their conversation partners [2], the lack of emotional support from others could exacerbate the social
 685 anxiety experienced by PWS, causing further behavioral and emotional struggles.
 686

687 Preconditioned by their experiences with social discrimination towards stuttering, our participants were more likely
 688 to associate the lack of responses from the audience with the loss of interest or patience with their speech:
 689

690
 691 *I think when you have a stammer, people can be at times, not intentionally, but unintentionally a bit*
 692 *more impatient with me. [...] In the context of a zoom call, they have the same impatience stance toward*
 693 *you when you are talking, and then they clock off straight away. That you start stammering on the first*
 694 *word and then they go “here we go”. I definitely think it is heightened for stammers. [...] Whereas in a*
 695 *face-to-face interaction, [...] people can’t clock off as easily without being rude. Whereas in a zoom meeting*
 696 *you can kind of clock out and it’s not necessarily, obviously rude. (P2)*
 697
 698

699 Even when the audience gave responses, they could be interpreted more negatively, especially when non-verbal cues
 700 such as facial expression and eye contact were inaccessible. P11 shared the experience of giving a Zoom presentation to
 701 his CEO, who used phrases like “*alright, let’s move on*” to communicate that he had comprehended the content of the
 702 presentation:
 703

704
 705 *I think that’s a unique challenge for people who stutter, because anytime we are talking, and someone*
 706 *indicates “let’s move on”, we will always interpret it as “oh they are commenting on my speech, rather than*
 707 *my content”. I would say that I am self conscious about it, I spent a lot more time worrying about it. I stayed*
 708 *up last night writing out my slide, because I want to be super crisp, even though I don’t do that for any*
 709 *other meetings, because I actually find my stutter is worse when I am reading off something, so there is*
 710 *added burden. (P11)*
 711

712 When asked about most satisfying meeting experiences in the past, several of the participants recalled group meetings
 713 or conversations where they clearly perceived the appreciation and attention by the listeners. For example, R4 called
 714 out one presentation he gave: “*one girl in the project was listening very carefully, and I could tell from her eye contact the*
 715 *warmth, acknowledgement, and appreciation. I felt so much better immediately. I was basically fluent throughout the talk.*”
 716

717 Our participants found eye contact crucial in building human connections: “Eye contact is everything. Good eye
 718 contact means much more than what you say. Eye contact is indicative of the enthusiasm of your conversation” (P8).
 719 Even though many of the participants have a tendency to look away when they stutter, they were aware of the power of
 720 eye contact and worked on improving eye contact with others. However, the design of most modern videoconferencing
 721 platforms has made effective eye contact almost impossible, especially in group settings:
 722

723
 724 *It’s hard for people to know who to look at on Zoom. In terms of eye contact, who do we keep eye contact*
 725 *with. Even if we all know who we want to keep eye contact with, do they know that? How can they tell,*
 726 *they probably can’t. (P14)*
 727

729 As a result, our participants were often deprived from an important source of the positive social support that they
730 sought out in-person from others in the videoconferencing setting:
731

732 *I kind of grew to like the fact that, eye contact - when someone is looking at you - it's kind of like you*
733 *have the floor, [...] you just had as much right as the person next to you to say what you have to say, the*
734 *story you want to tell. [...] If I am in person, I can pick someone to say what I want to say. In zoom, I don't*
735 *know what to look. I can look at someone's face, but I don't have the connection, the feedback that they are*
736 *looking at me, even though that I know when I look at their face, I know they are listening, but I just can*
737 *not get the feedback of the eye contact. (P7)*
738
739

740 Videoconferencing also disabled some of the participants' existing strategies for social and emotional support in
741 in-person meetings. For example, when attending in-person group meetings, P3 and P10 would chose to sit next to
742 friendly, familiar people to feel more relaxed. Small talk and chitchat right before a meeting starts is another strategy
743 that P10 and P14 took to serve a similar purpose. P11 have developed a personal “charisma” to compensate for his
744 stutter, and found himself “less effective on VC ” due to the limits videoconferencing put on communicating “body
745 language, energy, and interpersonal chemistry”:
746
747

748 *I like to shake hands, I will give people a hug if I know them. If I am comfortable, I will talk with my*
749 *hands, I will also be open, I will lean back on my chair, I will think out loud, try to model that this is a*
750 *space where I hope you can be yourself. I can do that via VC, too, but I think it's much more noticeable*
751 *when I am in person. (P11)*
752

753 To compensate for the lost connections with others, our participants extensively utilize available channels to make a
754 conscious effort in communicating their emotions and intentions. For example, several participants (P1, P8) deliberately
755 lifted the position of their camera to the eye level so that they could mimic the in-person eye contact. Almost all of our
756 participants indicated that they were making an effort for maintaining eye contact over video conferences, and some
757 even turned off the self view to better direct their gaze to the conversation partners. Some participants tried to make
758 their facial expression more salient by lightening up their faces (P1, P8), putting on make-up (P3), and positioning the
759 camera for a close-up view (P8, P10). And some participants (P1, P8, P10, P13) leveraged the reaction feature on Zoom
760 to both give and gather direct, positive emotional feedback. Despite potential speech challenges, some participants
761 actively describe their body language and the intention behind it to avoid misinterpretations. For example, P13 would
762 explicitly tell the speaker that he was looking away only to open up the document the speaker just mentioned.
763

764 Our participants also leveraged their identity as PWS to better connect with others in virtual meetings. Most of the
765 participants had proactively disclosed their stutter in high-stress video conferences (e.g. job interviews, presentations,
766 orientations) to build the connection with their audience, and found that effective at reducing mental stress and bringing
767 in audience's emotional support, even though it did not change how fluent they were. Some participants purposefully
768 embraced the vulnerability that came with the identity as a person who stutters, as a way to empower others to all be
769 more open and collaborative in virtual meetings:
770
771

772 *As soon as I say something deeply personal, [...] about my stutter, [...] it's not top of mind for other people,*
773 *and when they hear me saying that, they go, 'this guy is being open, okay, maybe I will be open, too!' I think*
774 *the whole modeling behavior is huge over Zoom, and over virtual communications. Modeling behavior is*
775 *massive, because all you see is this much of me, and you are constantly seeing me. I always want to model*
776 *the behavior of being open and collaborative. (P13)*
777
778
779
780

5 DISCUSSION

5.1 The Hidden Cost of Videoconferencing for People Who Stutter

Despite the benefits identified by our participants, videoconferencing has introduced significant emotional and cognitive costs to people who stutter.

The constant close-up view of their facial features and speaking behaviors by self and others has contributed to heightened self-consciousness and more negative thoughts. Although the challenge with “Zoom gaze” is widespread [2, 18], people who stutter are more likely to pay disproportional attention to “negative” behaviors (e.g. stuttered words, facial tension) that reinforce existing self stigma and social anxiety [22]. The increased difficulty with turn taking over videoconferencing platforms posed structural barriers for people who stutter to have their voices heard and points across, deepening people’s existing feeling of social isolation and reject, and preventing participants such as P6 and P12 from seeing themselves as leaders. The uncertainty with turn taking and audience reactions further contributes to the sense of loss of control, one of the defining characteristics of stuttering and a direct cause of many negative emotional and cognitive reactions when people stutter [40]. While the emotional connection with their conversation partners was highlighted by several of our participants as the hallmark of their most rewarding communication experience, our participants are systematically disadvantaged in seeking and sharing emotional support now, as their previous strategies - such as physical proximity, hugs, and good eye contact - were largely unsupported by today’s videoconferencing technology.

To overcome these VC challenges, people who stutter had to adopt strategies that often require extra time, labor, and mental efforts, on top of the existing cognitive and emotional loads associated with stuttering. For example, our participants made an effort to put on make-up, well-position themselves in front of the camera, give others more verbal and non-verbal feedback, and over-prepare themselves with the content and agenda of meetings. As P11 put it, “*it is an extraordinary mental effort, [...] my brain is always in the 5th gear, like 150mph, I can’t get it to stop.*” Even the use of the hand-raising feature and a predetermined speaking order worked at the expense of *spontaneity*, one of the top predictors for how satisfying a speaking experience is to people who stutter, ahead of even fluency [11]. It is perhaps not surprising that our participants reported feeling videoconferencing particularly “exhausting”, “draining”, and “unrewarding”, something that they - while still participating in - did “not look forward to”.

Even the named benefits of videoconferencing could lead to questionable long-term outcomes for the stuttering community. For example, the convenience and comfort of a familiar, controlled videoconferencing environment could potentially disincentivize PWS from engaging in in-person meetings and social interactions. The ability to hide one’s stuttering behaviors and identity via videoconferencing is also a double-edged sword. Although it does serve PWS with better impression and identity management at the moment, it could also hold people back from accepting their stutter and stuttering identity, reinforcing negative emotions associated with stuttering such as embarrassment, guilt, and fear [9]. Collectively, if people who stutter all manage to hide their stutter and stutterer identity during video calls, speech-related challenges would be even less understood and further marginalized by the mainstream society. While VC reduced the barriers for PWS to find and join the stuttering community, the bonding and commitment within the community might be weakened due to the difficulty in forming emotional connections via video conferences, making the community more fragmented and superficial.

To summarize, videoconferencing and videoconferencing technologies have substantially changed the dynamics and the structure of interpersonal communications, charging potentially profound emotional, cognitive, and social costs to people who stutter. The very design of the videoconferencing technologies that induced such costs (e.g. lack of

833 non-verbal communication support), has also helped render these costs **invisible**, preventing public awareness on the
834 structural barriers for PWS to participate and engage in the age of videoconferencing.
835

836 While the research on technology-mediated communications tend to evaluate the effectiveness of communication
837 from the perspective of a 3rd party observer, the importance of communication participants’ subjective experience
838 is often overlooked. Similarly, mainstream assistive technologies were typically designed to enhance “productivity,
839 efficiency, normalcy, and speed” [25], without sufficiently attending to the user’s emotional needs [27]. We argue that
840 the subjective experiences of marginalized users - such as people who stutter - should be respected and prioritized over
841 external observations in the research and design of videoconferencing technologies, in order to create an inclusive
842 and equitable communication environment for all. Foregrounding the lived experiences of people who stutter not only
843 offers us insights of communication technologies that were inaccessible from an observer perspective, but also serves
844 epistemic justice to the stuttering community which - similar to many other historically marginalized groups - had
845 long been treated as epistemic subjects rather than the knowers.
846
847
848

849 5.2 The Future of Videoconferencing

851 Discussing and re-envisioning videoconferencing tools with the stuttering community also creates space and op-
852 portunities for videoconferencing technologies and video-mediated communications that have not been explored
853 before.
854
855

856 *5.2.1 Enhance Non-verbal Communications.* Our findings highlight the importance of non-verbal communications for
857 people who stutter in offline and online meetings. While the current design of videoconferencing technologies has
858 over-indexed on verbal channels, our participants saw many ways that non-verbal cues can be better leveraged by
859 videoconferencing platforms. For example, the camera can detect and communicate meaningful body movements and
860 facial expressions, such as leaning forward, clapping, and smiling. To reduce the mental stress from “Zoom gaze” while
861 maintaining communicative facial expression and eye contact, VC systems could deploy filters/avatars that capture
862 exaggerate these features in a context appropriate way (i.e. no cat filter for court appearance).
863
864
865

866 *5.2.2 Support For Atypical Speech.* Videoconferencing platforms also need to accommodate and empower more diverse
867 speech patterns.
868

869 Several of our participants noted that Zoom’s auto-captioning and translation function worked poorly for people
870 who stutter. Although there have been some research efforts in improving the performance of speech recognition
871 models for stuttering speech [??], more investment is required in this domain to close the performance gap between
872 stuttering and fluent speeches, especially in a more dynamic setting like video conferences.
873

874 Similarly to how the hand-raising button signals one’s intention to speak, videoconferencing platforms could also
875 design a way for the user to express “*I’m not done, please hold the floor*” during a stuttering moment. The message could
876 potentially be customized to provide more context about stuttering and educate others on respectful ways to support
877 someone during the stuttering moments (e.g. stop repeatedly asking “*are you still there?*”).
878

879 The idea of a “voice mask” that auto-filters disfluencies from stuttering speech was discussed heavily by our
880 participants. While most participants saw the benefit of having the option to sound more fluent in certain situations, all
881 but two participants also mentioned that they would not use it themselves, as technologies like this could potentially
882 undermine their self-acceptance and the space for disfluent speech in our society.
883
884

885 5.2.3 *Videoconferencing as Speech Therapy.* Videoconferencing platforms could also serve as a therapeutic tool for
886 people who stutter, offering them insights and support during stuttering moments and reinforcing positive mental
887 images. For example, the platform could remind PWS to maintain eye contact during stuttering moment if that is
888 something they are working on, or display tips like “*keep moving forward*” when a severe speech block is detected.
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891 5.3 Intersectionality

892 Our research also highlights the need for intersectionality [13] in understanding and designing technological experiences
893 with marginalized communities. For instance, over half of our interview and focus groups participants are women, and
894 surfaced the tension between “taking up space” with their speech disfluencies and the socialized “supportive” role in
895 conversations for women [47]. A third of our interview participants are first-generation immigrants and non-native
896 English speakers working in an English environment. They have experienced confusion by others of their stuttering
897 with a lack of language proficiency. They also reported higher levels of pressure to perform and establish themselves in
898 the workplace, which could cause additional stress in both virtual and in-person meetings on top of the challenges
899 brought on by stuttering and language barriers. Many of our female participants and participants with ethnic and
900 racial minorities also recalled being talked over at video conferences or being labeled as “quiet” by their colleagues - an
901 experience well-documented for minority groups at work [23, 44] but extra difficult for our participants to push against
902 when they are already burdened with existing speech and emotional challenges from stuttering.
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907 6 LIMITATIONS AND FUTURE WORK

908 This work has a few limitations. First, the fact that our participants were recruited from stuttering community events
909 and group therapy program determined that all the participants had at least partially accepted their identity as people
910 who stutter, and were comfortable enough to talk about their experience and vulnerability with stuttering. As a highly
911 stigmatized identity, many adults who stutter do not self identify as a person who stutters or speak openly about their
912 stuttering experiences [5], and their perspectives and needs with videoconferencing technologies might be different from
913 the participants in our study. Second, although we did not set recruitment criteria on stuttering severity, all participants
914 had relatively mild speech disfluencies, with a large percentage of the participants stuttering covertly. For future work,
915 more efforts are needed to reach out to the PWS population with more speech challenges, as they might have different
916 types of communication challenges within the videoconferencing context. Third, while our recruitment was targeted at
917 adults with videoconferencing experiences, all our participants were relatively young (the oldest participant is in their
918 40s). The intersectional experiences with older adults who stutter would be an interesting topic for future research.
919 Finally, although we tried to cover diverse demographics in our study, all participants were recruited from and resided
920 in the US and UK, a geographical region with a relatively greater awareness and acceptance of stuttering [39]. Future
921 work should explore and compare the videoconferencing experiences for PWS across countries/cultures.
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927 7 CONCLUSION

928 Although typically considered a speech disorder, stuttering comes with strong emotional and cognitive reactions, and
929 can have a profound effect on how people engage and experience conversations in-person and virtually. In this paper,
930 we present one of the first studies that examines the experience of people who stutter with videoconferencing and
931 videoconferencing technologies, based on interviews of 14 adults who stutter.
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934 Our findings reveal that, despite benefits, videoconferencing presents extra challenges for people who stutter due
935 to the reduction of non-verbal communication channels and the constant surveillance by self and others in the call.
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937 Although these issues are also challenging for fluent people, they are greatly exacerbated when interacting with the
938 characteristics and nature of stuttering. Confronted with the social stigma and negative assumptions associated with
939 stuttering, people who stutter spend more time and effort curating their physical environment and virtual presence for
940 video conferences, and have adopted different strategies to compensate the lost non-verbal and seek/provide emotional
941 support in video calls. Besides being technically challenging, videoconferencing also become an mentally draining
942 experience, creating significant - yet invisible - emotional, cognitive, and social barriers for people who stutter to
943 engage and enjoy. Even though most of our participants were generally accepting of their speech and their identity
944 as people who stutter, videoconferencing brings new struggles when their speech behavior violates the hardcoded
945 assumptions made about human speech and communication behaviors (e.g. the length of a pause, the existence of
946 blocks) by the technology. They are also more likely to be emotionally impacted by the lack of attention and feedback
947 from the audience, and further develop social anxiety and negative self-image as a result.

951 We hope our findings and discussion shed light on the gap between current videoconferencing technologies and the
952 needs of people who stutter, and inspire the research and development of more inclusive communication environment
953 for all.

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