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Students with cochlear implants' experiences of built, sound, and social school environments

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Abstract

Deaf and hard-of-hearing (DHH) students with cochlear implants (CIs) are increasingly attending mainstream schools but often encounter social barriers with peers. This study explores how environmental factors and individual adaptation strategies shape these social experiences, interviewing 13 CI users (aged 17–27) who attended mainstream education. Thematic content analysis revealed four themes and 12 sub-themes around social barriers: difficulties socializing, sound and built environment barriers, social environment barriers, and adaptive strategies. Findings show participants developed many effective internal and external adaptations to manage barriers, yet often at the cost of their comfort, energy, or social safety, thus requiring additional strategies to maintain balance. This highlights social and emotional aspects of inclusion and asymmetric distributions of responsibility. Findings also highlighted school design choices and cultural/social practices that could shape the cost of adapting, underscoring the need for structural changes in educational environments that facilitate more equitable social access for DHH students.

Introduction

As deaf and hard-of-hearing (DHH) students increasingly enroll in mainstream schools[1] due to inclusive education policies, and with the expectation of improved academic and career opportunities, their primary social context typically consists of hearing peers (Appropriate Education Act, 2014; van der Straaten et al., 2021). For these DHH students, informal social participation in predominantly hearing settings can be a major challenge: Stress with communication breakdowns, frustration, exhaustion, fatigue, social isolation, feeling different from hearing peers, and difficulties building friendships are commonly noted (Jepsen & Pedersen, 2025; Punch & Hyde, 2011; Rieffe et al., 2018; Rijke et al., 2022; Zaidman-Zait & Dotan, 2017). Thus, DHH students in mainstream settings, including those with cochlear implants (CIs), often face barriers to social interaction within their school environment daily. Meanwhile, being able to fully participate in one's regular social circle is important to feel a sense of belonging, to form supportive networks with peers, and to develop social–emotional skills (Rieffe et al., 2018). Many CI users thus experience loneliness and spend time alone, despite wanting to be with (hearing) peers (Rijke et al., 2022).

Effectively addressing these social challenges to achieve DHH inclusion beyond access to academic learning is an ongoing issue. Many DHH students navigate communication barriers individually and independently, by advocating for their needs or disengaging from social situations altogether. However, rather than relying on interventions addressing the capacities of the DHH student, research has called for structural changes in (school) social environments and greater attention to environmental factors that may hinder communication. These shifts are required to promote social inclusion and ease the burden of adaptation placed on DHH students (Eichengreen et al., 2025; Rieffe et al., 2018; Xie et al., 2014). Nonetheless, structural or systemic factors remain largely underexplored in research on DHH students' wellbeing and inclusion, particularly regarding how built features[2] (e.g., architecture) shape the conditions for social participation.

To address this gap in understanding how broader environmental factors influence social inclusion of DHH students in mainstream

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schools, this study focuses on CI users as a distinct and highly relevant subgroup. Given the specific ways in which CIs interact with physical environments, such as sensitivity to room acoustics (Badajoz-Davila et al., 2020; Langerak et al., 2024), their experiences may diverge from those of other DHH students. Furthermore, it is worth highlighting that CI users that pursue mainstream education typically communicate using spoken language in this setting (Hartman et al., 2023)—especially as the majority of (social) interactions occur with hearing peers who do not use sign languages. This study used interviews to examine how social and environmental conditions shape informal peer experiences of adolescent and young-adult CI users in mainstream educational settings, as well as the adaptive strategies they employ to navigate social challenges. The aim is to inform more inclusive school design and support, with particular attention to non-classroom social participation.

Adolescence & young adulthood as critical periods

Adolescence and young adulthood are especially important, as these periods involve major developmental transitions that can heighten vulnerability to social and emotional difficulties. Adolescents more strongly depend on peers for feedback and approval, intimacy, and companionship (Steinberg & Morris, 2001; van Hoorn et al., 2016). Psychological well-being in adolescence is intimately linked to feelings of peer (group) belonging, which also plays a central role in their identity formation, and is shaped by processes such as social comparison (Baumeister & Leary, 1995; Erikson, 1968). For CI users, however, feeling connected to hearing peers can be even more complicated because their identity formation is shaped by navigating between d/Deaf and hearing worlds (Rich et al., 2013; Wheeler et al., 2007), and their devices and communicative abilities can make them stand out (Punch & Hyde, 2011; Terlektsi et al., 2020). Research shows that stigma, peer prejudice, and lack of acceptance can be common daily life experiences among DHH students with CIs (Rieffe et al., 2018; Rijke et al., 2022; Zaidman-Zait & Dotan, 2017).

Moreover, conditions for successful social participation can be especially challenging for adolescents with CIs, particularly during the transitioning to or from the high school years, for multiple reasons. First, adolescents are expected to navigate complex, fast-paced social environments autonomously. Transitions between educational levels, such as from high school to higher education, often require students to re-establish peer relationships, and this can create a vulnerable period with students experiencing loneliness and mental health problems, especially without sufficient social support (Jindal-Snape, 2016; Sundqvist et al., 2024). Second, adolescence also introduces great listening demands in socially and acoustically complex settings, as peer interactions more often occur in group setting during this phase (Rubin et al., 2008). Such group interactions are a well-known challenge for many CI users (Bat-Chava & Deignan, 2001; Martin et al., 2011; Punch & Hyde, 2011). Third, a lack of structured support, such as consistent teacher supervision typically available in earlier school years, can further increase CI students' vulnerability to peer rejection and exclusion in mainstream contexts (Rieffe et al., 2018). Specifically, ostracism, micro-aggressions, or bullying may often go unnoticed by teachers unless reported—yet, having to report this can in itself create vulnerability, while not doing so may cause the issue to remain unresolved and the CI student dealing with it on their own. While moving into higher-education environments could provide positive experiences when there was higher DHH awareness, a sense of equality, and respect, Alsamih (2024) also found that a few students with CIs found the first year of university particularly isolating and stressful, possibly due to the lack of established social networks and non-DHH peers not knowing how to communicate with DHH individuals.

The psychological effect of social participation barriers on students with CIs

Although there is evidence that students with CIs can achieve good speech perception and academic adjustment (Lee et al., 2022; Rich et al., 2013), informal social participation and managing everyday listening challenges in hearing-centered settings remain key difficulties (Krijger et al., 2020; Vermeulen et al., 2012) regardless of students' hearing abilities or social skills. This has been referred to as "social deafness" (Michael et al., 2019; Punch & Hyde, 2011; Zaidman-Zait & Dotan, 2017), a phenomenon wherein DHH individuals often struggle to manage interactions in groups or noisy environments yet have little to no problem in one-on-one interactions and quiet environments.

The difficulties in informal group interactions with hearing peers emerge because of unique situational demands tied to turn-taking, rapid topic shifts, and indirect cues, as well as the need for CI users to simultaneously manage communication breakdowns while the conversation continues around them (Crowe & Dammeyer, 2021; Jepsen & Pedersen, 2025; Zaidman-Zait & Most, 2020). To prevent or repair gaps in verbal communication, CI users often rely heavily on visual cues like speechreading or body language (Rothermich et al., 2022; Tsou et al., 2021), which means that socializing is often a complex task that involves piecing together multiple sources of information, interpreting context, and maintaining a high level of attention.

Consequently, the sustained cognitive effort involved in socializing with hearing peers can be mentally exhausting for many students with CIs (Dammeyer et al., 2018; Klein et al., 2024; Philips et al., 2023), especially when poor listening conditions make speech understanding more difficult (Finke et al., 2016). Indeed, social participation challenges are further exacerbated by the typical adverse acoustic conditions in schools, characterized by background noise and reverberation (Crandell & Smaldino, 2000), which significantly compromise CI users' speech understanding and verbal communication (Iglehart, 2016; Krijger et al., 2020; Neuman et al., 2012).

Beyond immediately impacting communication, regular encounters with such difficulties can have more long-term emotional and cognitive impact that influences peer interactions and relationships. Firstly, DHH students may experience social–emotional fatigue from repeated struggles to keep up and falling "out of sync" with peers, feeling exhausted or overwhelmed by social demands requiring sustained emotional effort (Davis et al., 2021; Hornsby et al., 2016; Jepsen & Pedersen, 2025; Michielsen et al., 2004). This strain intensifies when students mask their difficulties to avoid stigma, often resulting in superficial participation and a loss of authenticity (Jepsen & Pedersen, 2025). Coping strategies involving active and unprompted support from peers (e.g., helping to carry class microphones and clarifying missed information) can ease communication demands more sustainably, alongside adaptive strategies that help students remain engaged and manage both cognitive and emotional load (Eichengreen et al., 2025).

Secondly, prolonged exposure to challenging conditions with limited opportunities to apply adaptive strategies (e.g., taking breaks) may

also lead to listening-related fatigue (Bess et al., 2020; Davis et al., 2021). Instead of trying to overcome challenges, fatigued DHH students may rather retreat to avoid exhaustion or negative reactions (Zaidman-Zait & Dotan, 2017). Thus, beyond stigma or the perceived inconvenience of communication breakdowns that may lead hearing peers to avoid interaction with CI users (Rieffe et al., 2018; Xie et al., 2014), students with CIs may also deliberately withdraw from social participation. Effective adaptation therefore depends on environments that help reduce the emotional and cognitive burden of trying to keep up or fit in during social interaction with their hearing peers.

Present study

The present study contributes to moving the discourse on CI and DHH inclusion away from personal responsibility and toward external factors that support socializing.

Despite growing interest in DHH students' social participation, there is scarce research on how external factors, particularly the built environment, interact with social dynamics to either support or undermine effective socializing and adaptation for adolescent and young-adult CI users in mainstream settings. To date, studies have mainly focused on individual and interpersonal factors like peer attitudes, coping strategies, and emotional fatigue, highlighting peer relationships, identity, and communication challenges for adolescents with CIs (Alsamih, 2024; Dammeyer et al., 2018; Eichengreen et al., 2025; Jepsen & Pedersen, 2025; Lee et al., 2022; Rijke et al., 2022; Terlektsi et al., 2020; Wheeler et al., 2007; Xie et al., 2014; Zaidman-Zait & Most, 2020). Next, it is important to extend these valuable findings by further investigating their situational context—for example, as this can dictate the types of strategies CI users are able to apply to overcome challenges and inform nondeficit-oriented interventions (Eichengreen et al., 2021).

While several studies note challenges in group settings or noisy environments (Duchesne et al., 2025; Punch & Hyde, 2011; Rich et al., 2013; Wheeler et al., 2007; Zaidman-Zait & Dotan, 2017), Krijger et al. (2020) address specific acoustic conditions in learning contexts, environmental contexts where informal contacts occur (such as hallways and cafeterias) rarely receive focused attention, as also noted in a review by Xie et al. (2014). Instead, "school" is often used as a generic backdrop, overlooking how specific spatial and social environments shape participation, adaptation, and belonging.

Focusing on nonclassroom spaces and understanding adaptation as relational and context-dependent may help inform more inclusive design and interventions for mainstreamed adolescent and young-adult CI users beyond academics. Moreover, reframing students' distress as structurally produced, rather than individual, can reduce self-blame and internalized ableism (Hunt, 2024). Applying this lens to school settings calls for a shift in focus from individual coping strategies to how environments afford or constrain social participation.

Building on this gap, the present qualitative study used interviews to explore how aspects of the built and social environment affect Dutch and German CI users during unstructured interactions with hearing peers in inclusive educational settings. The goal is to offer CI-user perspectives as actionable insights for inclusive school design and architecture.

We addressed the following research questions: (A) What are social experiences of adolescents and young adults with CIs in mainstream educational settings? (B) Which social and environmental factors hinder or support the social experience? (C) Which personal adaptation strategies do CI users use to navigate social challenges in these settings? This last question explores how external factors may influence or constrain the ways CI users respond to challenging situations, as we found it important to examine "social experiences" and "environment" not in isolation but in relation to each other.

Methods

Participants

Participants were recruited via the Otorhinolaryngology Department of Leiden University Medical Center, word of mouth, and a CI association event. Inclusion criteria were: (1) implantation with at least one CI; (2) current or past enrollment in Dutch or German secondary or higher mainstream education; and (3) age 16 years or older.

A total of 13 CI users participated (age range 17–27 years; 7 female, 6 male). For those who had graduated from mainstream education, interviews were conducted retrospectively about high-school, and higher education where applicable. For participants who had experienced both pre- and post-implantation inclusive settings, these experiences were carefully distinguished during data analysis. Ten of the participants were Dutch, and three were German. Participant demographics, including age of diagnosis, time since first implantation, and language modalities, are shown in Table 1.

Procedures and data collection

This study is part of a research project on supporting social participation of hearing diverse youth in the school context; other work within this project has been published (Libbi et al., 2026; Libbi et al., 2026).

Interview types and settings

We conducted semi-structured interviews ($n = 11$) and go-along interviews ($n = 2$). The semi-structured interviews followed a protocol co-developed with two CI users to ensure relevance, clarity, and appropriateness. The interview protocol (see Appendix A) contained open-ended questions about experiences and environment contexts of socializing in school or other educational settings, as well as wishes for change, and advice participants would give to others, guiding the conversation while allowing flexibility to explore participant experiences in depth. Individual participation or participation in a focus group was possible. No participants opted for focus groups, yet two brought their (hearing) parent or partner to join the interview. Semi-structured interviews were conducted in person ($n = 5$) at a quiet location selected by the participant or online ($n = 6$) via Microsoft Teams, in their native language (Dutch or German) by a native-level speaker. Accommodations, such as subtitling, interpreters, and table microphones, were available upon request. However, none of the participants used an interpreter for the interview, and all communicated with the interviewer in spoken language.

For two participants, go-along interviews (Kusenbach, 2003) were conducted, during which the first author accompanied participants in their educational setting, collecting fieldnotes, environment photographs, and conducting on-site interviews with them and people they interacted with. These were preceded by a preliminary unstructured meeting to build rapport and discuss logistics. Go-along interviews were conducted in English, given the participants' high proficiency.

Table 1 Demographic characteristics of participants.

Age in years [M (*SD*); range]		21 (3.61); 17–27
Uni- or bilateral CI/HA	Unilateral	3
	Unilateral + HA	3
	Bilateral	7 (1 of which only uses one side)
% of life lived with (first) implant[a]	>90%	7
	60%–90%	2
	<1%	4
First diagnosis	Prelingual/during early speech acquisition	11
	Postlingual	2
Additional language modalities used[b] *(all participants used spoken language as a primary language modality in daily life)*	Uses sign language	4
	Uses basic signs	2
	Uses no sign language	5
	n/a	2
Mainstream educational setting(s) visited[c]	Secondary	4
	Secondary & postsecondary	8
	Postsecondary	1

Note. n/a = information not available. (Age − age at implantation)/age (reported in % bins). Age refers to age at time of the interview. The table only reports active use of a language modality, not whether a language was originally learnt. Mainstream postsecondary education refers to vocational/trade school, preparatory education for university, and university. Attendance of nonmainstream educational settings is not listed here. We did not ask participants about their pre-secondary education.

Recruitment and consent

After expressing interest, participants received study information, a preview of interview questions (for semi-structured interviews) or a content overview (for go-along interviews), consent forms, and options for interview type and scheduling. Go-along participants also met with the researcher beforehand to finalize details, such as types of data collected and timing. Participants completed an online Qualtrics questionnaire regarding demographics, hearing history, and education. Ethical approval for the semi-structured interviews was obtained from the Non-WMO Ethics Committee of Division 3 of the Leiden University Medical Center, Leiden, the Netherlands (#23-3036), and for the go-along interviews from the University of Twente, Enschede, the Netherlands, CIS Ethics Committee (#230611).

Interview conduct and accessibility

At the start of each interview, researchers addressed any participant questions, confirmed informed consent, and ensured communication accessibility, such as providing printouts of questions or positioning themselves on the participant's better-hearing side. Participants were reminded they could skip questions or end participation at any time. All interviews were audio-recorded. Semi-structured interviews lasted between 63 and 140 min; go-along interviews covered several periods (e.g., breaks, lessons) during a school day.

To ensure consistency and appropriate communication, all three interviewers (two master students [authors A.G. and J.B.] and a PhD candidate [first author] in Psychology) completed training before data collection. Training included practice interviews with people matching the age of the sample (though non-DHH due to participant scarcity), a meeting during which the interview protocol was co-developed with CI users (both participants in go-along interviews), and guidance on DHH-specific communication strategies.

After interviews, participants were debriefed, which involved reiterating how to contact researchers with questions, explaining how the data will be used, and informing participants that they will receive the study results via email after completion (as also communicated before the interview, as part of study information and informed consent).

Data analysis

Audio recordings were manually transcribed and verified by a second transcriber. Automatic transcripts generated by Microsoft Teams were carefully reviewed and corrected. Dutch and German transcripts were translated into English by native speakers, with artificial intelligence (AI) translation tools such as DeepL and ChatGPT assisting in translating specific sentences or phrases. For go-along interviews, participants received a report summarizing fieldnotes and transcripts, giving them the opportunity to verify and amend the information to ensure accuracy.

Thematic content analysis followed the steps proposed by Braun and Clarke (2006, 2021). Coding was supported by ATLAS.ti software. The coding process was conducted by a team of four coders, including three co-authors and a student, supervised by a DHH co-author. Coders first familiarized themselves with the transcripts and systematically coded the data, iteratively developing a coding scheme with emerging themes and sub-themes. Following the phases of thematic analysis (Braun & Clarke, 2006), initial bottom–up coding involved identifying smaller meaning units in the transcripts, with irrelevant material removed. Starting with three transcripts, preliminary codes were grouped into potential themes, reviewed against additional transcripts, and iteratively refined, defined, and named as additional transcripts were analyzed, until all data were adequately represented. Finally, the resulting themes were refined, and exemplary quotes were selected for reporting.

The analysis was primarily inductive, identifying (sub-)themes emerging from the data. However, the semi-structured interview protocol influenced some overarching topics and themes, introducing a minor deductive component. The coding process was collaborative and iterative, inspired by the principles described by Richards and Hemphill (2017). First, coders individually or collaboratively coded portions of the data to create preliminary codebooks, which were discussed and refined in team meetings. Subsequent coding rounds with both new and existing data continued until consensus was reached and all transcripts were fully accounted for in the final coding scheme. Thematic saturation was determined retrospectively, based on the point at which no new (sub-)themes emerged in subsequent interviews (Constantinou et al., 2017). Saturation appeared to

Table 2 Summary of themes.

Theme	*Sub-theme (example codes)*
1. Challenges of social participation: barrier outcomes	1a. Running out of energy and sensory discomfort (e.g., "*Pushing self for fear of missing out (FOMO)/to fit in*") 1b. Communication barriers (e.g., "*Missing conversation topic*") 1c. Experiencing social isolation (e.g., "*Being bullied or ostracized/microaggressions*")
2. *"Nonhuman" external factors: effects of the built environment and soundscape on socializing*	2a. Impact of noise, acoustics, and crowdedness (e.g., "*Environment property impacts location preference/avoidance*") 2b. Architectural and infrastructural features (e.g., "*Sitting and standing arrangements*") 2c. Balancing Social Access and Environmental Comfort [Noise-Seclusion Tradeoff] (e.g., "*Examples of tradeoff situations/spaces*")
3. "Human" external factors: effects of the social and cultural environment on socializing	3a. (Un-)supportive peer behaviors and dynamics (e.g., "B*ehavior causes sense of exclusion*") 3b. Impact of group size, configuration, and positioning in social interactions (e.g., "*Impact of group configurations/interaction partners*") 3c. Informed and supportive social environments (e.g., *"Inaccessibility of support options*")
4. CI-users' coping/adaptation strategies to respond to social participation barriers	4a. Taking care of yourself (e.g., "*Managing wellbeing by missing out/disengaging on purpose*") 4b. Managing the environment (e.g., "*Asking to relocate*") 4c. Noninterruptive strategies to stay involved (e.g., "*Strategic use of assistive technology*")

be reached around interview 6 (of 13), after which only minor refinements to sub-theme definitions and titles occurred. Using standard techniques for defined verbal counting in qualitative research (Sandelowski, 2001), we report themes mentioned by 2–3 participants using the term "few," 4–6 participants using "some," 7–9 participants using "several or many," and "most or majority" for 10 or more participants.

Results

The analysis generated four main themes and 12 sub-themes that offer insights into participants' social experiences during unstructured interactions with hearing peers in mainstream educational settings. The results are presented according to the main themes of (i) challenges relating to social situations, (ii) external built and sound environment factors, (iii) external social factors, and (iv) CI users' coping and adaptation strategies related to social participation.

Table 2 summarizes the thematic structure. While most participants reflected on experiences following implantation, some also described relevant situations from before receiving their CI. Selected findings from these cases are presented at the end of results to provide additional context.

(Theme 1) Challenges of social participation: barrier outcomes

While participants' stories typically suggested that they had at least one friend to spend time with in their respective educational contexts, though not always throughout the entire time there, all participants reported challenges that limited or shaped their ability to participate socially.

1a. Running out of energy and sensory discomfort

Most participants described significant cognitive and emotional fatigue related to listening effort and navigating social spaces. Running out of energy after extended interactions was a common theme.

> *I have to pay attention to their reactions and body language, how the conversation is going, how I should respond. I'm constantly engaged. (P8)*

Several felt pressure to keep up with their hearing peers, responding to external or internalized pressures and expectations about engaging in social peer interactions like other students, for example, being part of larger groups, participating in the same spaces as others and not appearing awkward or antisocial. Furthermore, participants mentioned discomfort associated with CI use that indirectly related to their social participation, as discomfort could impact moods, energy levels, and the practical capacity to engage within a certain context. Several described occasions of emotional or sensory discomfort associated with the auditory experience of their CI or the practical use of the device, for example, relating to malfunctions and maintenance.

> *If it's really very quiet then my CI starts making crackling sounds on its own, which is also a bit strange. So that's why I turn on music to get rid of the crackling sounds. (P5)*

> *It was beeping all the time, but halfway through my CI failed. Because that morning I had grabbed the wrong battery that wasn't fully charged. So, that was really a bit nerve-wracking. (P7)*

1b. Communication barriers

All participants reported difficulties fully accessing everyday conversations with peers, often missing or misunderstanding speech or key information, feeling like they were missing out or falling behind. Some provided more nuanced insights, expressing concerns about losing track of the conversation topic, which made it harder to follow along and join in. Additionally, a few noted missing out on humor, sometimes realizing a joke had been made only by others' laughter, without having the context to participate. Some participants expressed ongoing worries related to socializing with peers.

> *…in a group conversation and everyone is laughing, and I didn't hear why, then I feel a little lonely. (P9)*

1c. Experiencing social isolation

Most participants reported experiences of social isolation. There were different forms of exclusion from the social environment; many were or felt left out of interactions with hearing peers struggled with feeling different from others and standing out, or encountered bullying or microaggressions. Consequently, some participants mentioned feelings of isolation and a few experienced loneliness.

> *In high school… I was often excluded…if you're just a little different from the rest, you immediately become a target as a victim … I was different from the rest, so I had a hard time socially at school … never had good friends… (P6)*

The sense of "being othered" could also arise unintentionally, such as when teachers inadvertently drew attention to the CI user by introducing microphones in class or addressing bullying and other related issues.

> *When the teacher stands in front of the class and says: "Hey, pay a bit more attention to [name], use the microphones a bit more"…you put yourself a bit in the centre … You don't want to permanently be the centre of attention, but somehow you do that with the microphones. (P12)*

(Theme 2) "Nonhuman" external factors: effects of the built environment and soundscape on socializing

Most participants explicitly described how the physical and auditory environment shaped their opportunities for and experiences of social interaction. These environmental factors were central to decisions about *where* to socialize, *whether* to engage, and *how* they adapted their participation.

2a. Impact of noise, acoustics, and crowdedness

The majority of participants described how poor acoustics, background noise, and crowdedness negatively affected their ability to engage in peer interactions. Unsuitable environments made it harder to follow conversations, especially in group settings, leading to frequent misunderstandings, missed cues, and difficulty keeping up with the topic. This disrupted conversational flow and often reduced the depth and spontaneity of social exchanges.

These disruptions were often linked to being in louder spaces like cafeterias or crowded outdoor areas. There, even when physically present, participants remained on the periphery of conversations, leading to outcomes also described in Theme 1: frustration, irritability, mental fatigue, feelings of alienation, and reduced social confidence. Repeated experiences of overload or disorientation could also lead participants to withdraw from interactions or avoid initiating them altogether. Conversely, participants sometimes sought out quieter, less crowded locations (such as certain hallways or outdoor spots in good weather) to facilitate clearer communication, greater comfort, and more ease in maintaining social connection.

2b. Architectural and infrastructural features

All participants identified specific environmental or spatial features in their educational setting that influenced the quality of social interaction, here grouped into spatial layout and room structure, seating and standing arrangements, acoustic conditions, and lighting. These features often related to the noise and possibilities to circumvent the difficulties it caused, affecting not only how easily they could hear or engage with peers, but also how emotionally and cognitively manageable the interaction felt (e.g., in terms of fatigue).

Spatial layout and room structure were emphasized by all participants as critical for accessing conversations and managing overstimulation. The physical arrangement of break areas influenced how peer groups formed and moved during interactions, and whether it was even possible to position oneself in a way that allowed for clear visual access to speakers without feeling awkward or excluded.

> *I really have to (twists to see people) … if I just have to do this then it's easier… (pointing at other student) she is sitting like this now so I cannot read her lips and he's standing behind the wall. (P10)*

Similarly, *seating and standing arrangements* (usually furniture) were mentioned by most participants, with preferences for those that supported face-to-face interaction and clear sightlines. Participants explained how properties of certain structures affected their own or peer behaviors, thereby influencing the ease and sustainability of an interaction. For example, sitting side-by-side in a hallway with the CI user in the middle meant having to turn the head or upper body left and right as speakers changed, with the same participant suggesting swivel chairs as a wish to support this movement when sitting in parallel or moving more flexibly in general.

> *The hallway wasn't that big… if you sat against both walls, you were still pretty close to each other… sometimes one person would sit in the middle of the hallway… I would lean forward to look at the others' faces… It can sometimes be really exhausting, especially because you have to keep moving your head in all directions. (P11)*

In general, (semi-)circular sitting or standing was preferred for groups, something that could be achieved by sitting on a grassy area, sitting in a "U" shape on a set of wide stairs, or, when available, using sitting booths or group tables. The presence or absence of appropriate seating sometimes influenced which spaces were chosen, even at the expense of acoustic quality (e.g., the removal of group tables led one participant to switch to a noisier setting that at least allowed for sitting with peers).

Acoustic conditions, shaped by sound-absorbing materials, room dividers, and overall room geometry and structures (e.g., the presence of nooks or quieter areas near walls), were mentioned by several participants as key to reducing listening fatigue and enabling sustained interaction. Highly reverberant spaces, such as echoing hallways crowded with peers or large, nonacoustically treated study areas, were often described as entirely unmanageable for conversation or only tolerable for short periods.

> *We're walking through this hallway I'm like "ok, s**t, I can't follow everything"... when all the people are walking here and talking to each other about everything, I'm like, "ok I just walk and I will wait until we are outside and then I can join the conversation but not in this hallway"... so most of the times ... I'm just walking on my own behind the group. (P9)*

By contrast, outdoor spaces were sometimes favored in good weather for their relative quiet and openness, if noise from other students could be avoided. Empty hallways and designated quiet rooms (e.g., libraries or study booths) could also offer calmer environments, although their suitability often depended on group size and availability. Participants also noted that, in spaces where this was possible, they would sit between a wall or window and a speaker so the speakers' voice could reach their better ear while there was less distracting noise input from the other side. Similarly, sitting booths that offered partial enclosure and improved sound conditions (e.g., shielding environment sound and reducing reverberation), while still maintaining a connection to the surrounding space, were described as good options.

Lighting was mentioned by some participants as important for speechreading and reading social cues. Poor lighting, such as uncontrolled glare, could disrupt interactions by forcing participants to reposition themselves or causing distraction when a clear view of the speaker's face became difficult or uncomfortable to maintain.

Overall, participants preferred or wished for spaces that offered both auditory and visual clarity, along with physical comfort. However, spaces fitting these criteria were often not consistently available, easily accessible, or recognized by peers or staff as good places to socialize during recess (see 2c. Balancing Social Access and Environmental Comfort (Noise–Seclusion Tradeoff).

2c. Balancing social access and environmental comfort (noise–seclusion tradeoff)

Most participants described facing tradeoffs between environmental comfort and social inclusion, sometimes explicitly wishing for (now nonexistent) break areas that were neither straining nor inaccessible or isolated from popular/central spaces for students.

> *Spaces where you can still be together, so for example with glass, so you don't feel like you have to sit somewhere else and because of that you also have to tell people let's go to that room...but that you are still connected to the large cafeteria but that it's just a space where there are 10 people instead of 100 or 200, so I think that would be a huge improvement for lunch breaks... I would say ensure transparency and openness but also that you can retreat without feeling like you're really in a different space. (P6)*

The most socially central spaces, like cafeterias or busy schoolyards, were often physically crowded and acoustically overwhelming, making these locations emotionally and physically taxing. Yet, participants frequently stayed in these spaces to avoid walking far from central areas or because school rules limited access to alternative locations (e.g., hallways) to students who had received special permissions—something that could be available to CI users willing to ask for a pass but not necessarily their peer group.

While quieter places like empty hallways, designated rooms, or outdoor areas (e.g., adjacent woods) could offer better communication conditions, hearing peers were not always willing to join such areas if they were remote or lacked amenities of more popular locations.

> *That wouldn't actually be my personal choice because it's noisy and bustling in the cafeteria...I would prefer to sit somewhere in the hallway with fewer people, so that I can hear better. But, because everyone just sits in the cafeteria, I don't really have much of a choice. (P2)*

Even if peers were willing to join, designated quiet spaces were sometimes completely inaccessible (a locked library) or governed by rules that explicitly restricted socializing to enforce quietness:

> *We have a quiet room here since a few months. I haven't been there because I want to talk to people. That's the quiet room. (P10)*

Sometimes, quiet spaces were still preferred by CI users who accepted or even welcomed the solitude they afforded.

(Theme 3) "Human" external factors: effects of the social and cultural environment on socializing

3a. (Un-)supportive peer behaviors and dynamics

All participants described peer behaviors or social dynamics that shaped their sense of inclusion and ability to engage, with the majority specifically noting how such behaviors impacted their ability to understand speech. Peers could support successful verbal communication by facing the CI user while speaking, speaking clearly without talking over others, repeating information when missed, and maintaining a steady pace. Beyond supporting speech understanding, most participants noted that behaviors or situations that created a sense of inclusion and comfort often involved attentive peers, typically (long-term) friends, who automatically applied helpful conversation strategies with little or no prompting. In general, displays of allyship, genuine interest, and a willingness to learn about CI users' needs and communication preferences were highly valued even when it was not an entirely effective solution to support all conversation (e.g., when others began using minimal sign language, e.g., for greetings).

> *[The previous friend group] made me tired and anxious... I was always walking on eggshells... if they laugh, you want to laugh too... I always had to pay attention... They weren't really reliable. [The current friend group] just tell me if I didn't hear something... that's really nice. (P8)*

Many participants described situations or behaviors that caused feelings of exclusion or discomfort: facing negative reactions, ridicule, or being ignored when asking for clarification or support. When peers downplayed the importance of what was said to avoid repeating it, this could feel like being denied control over deciding which information is important or meaningful. Furthermore, several participants' peers did not value CI users' needs for easier listening environments or forgot about their limitations, further contributing to a sense of exclusion. These experiences sometimes led participants to avoid (repeatedly) advocating for themselves.

3b. Impact of group size, configuration, and positioning in social interactions

Every participant emphasized that the physical and social configuration of groups significantly influenced their ability and willingness to participate, sometimes even more than, or regardless of, the surrounding sound environment. Most participants specifically highlighted how group size and composition shaped interaction dynamics, with larger groups generally being overwhelming and hard to follow. Many participants indicated that a too-large group size often led to reduced interaction, which could limit their ability to fully express themselves (e.g., acting "introverted" vs. "extraverted"). However, being with more than one person was sometimes preferred, as it alleviated the pressure to sustain constant conversation.

To support a (group) interaction, especially with difficult frame conditions, it mattered how peers were positioned relative to the CI user. Whether ideal configurations were possible was not only partly dependent on features of the built environment (see 2b. Architectural and Infrastructural Features) but also required peer compliance, for example, when being asked to "walk on the right side" or to switch seats.

3c. Informed and supportive social environments

Many participants shared experiences suggesting that their general social environments lacked awareness of their needs and experiences, resulting in increased pressure on CI users to explain, educate others, or navigate dismissive or uninformed attitudes (see 3a. (Un-)supportive Peer Behaviors and Dynamics).

> *People are mainly curious about how is it that you don't understand … "Does it sound like a robot? How is it that you hear this but not that"… the emotional or social burden…people don't realize that. (P6)*

Most participants emphasized the crucial role of close friends, family members, or long-term allies in navigating social situations, and highlighted the importance of support staff, such as itinerant teachers or therapists, in legitimizing and facilitating accommodations. However, DHH-specific staff were often external (e.g., itinerant teachers or interpreters) and inconsistently available, making support from peers and regularly present teachers particularly valuable. Participants noted the benefit of continuity with familiar peers while having to adjust to new groups during remote learning negatively shaped their ability to build and maintain supportive long-term relationships. Over time, this continuity allowed peers to move past stereotypes, better understand individual needs, and develop supportive conversational habits more naturally.

Broader systemic factors like school rules and information given to students also influenced whether the educational environment felt supportive or inhibiting. While most saw basic support options like preferential seating or classroom microphones as important for easing participation in class, preserving energy for socializing, the process of requesting accommodations involved practical and emotional barriers for the majority of participants. For instance, participants were hesitant to request special permissions due to the extra effort involved or uncertainty about whether the option was also available for DHH students:

> *They were quite strict about hallway passes; only people with mental health issues could sit there, so I didn't know if I would be able to get a hallway pass like that. I thought, probably not. (P8)*

(Theme 4) CI-users' coping/adaptation to social participation barriers

All participants described a range of strategies for navigating social participation barriers they encountered, demonstrating a high level of self-awareness and an active approach to adaptation. External factors illustrated in themes 2 and 3 played a role in the need and ability to balance self-advocacy with emotional and sensory regulation.

4a. Taking care of yourself

All participants described strategies aimed at sustaining their well-being and managing the psychological impact of hearing-related barriers. The majority of participants talked about managing self-expectations and attitudes, which involved accepting one's limitations while, in some cases, reframing the effort required for social participation as a personal strength. Notably, some participants maintained high expectations for themselves, adopting a mindset of having to work harder than others to succeed, particularly in academic and social settings. Participants typically viewed this extra effort as necessary and, in two cases, as a source of pride.

The majority of participants described intentional disengagement as a form of self-care, whether by physically withdrawing, mentally checking out, or turning down, off, or removing their CIs, though only rarely participants took hearing breaks outside their homes. Phones were also used as a tool to stay physically present in social settings while mentally disengaging. One participant described feeling comfortable sitting quietly with others, all on their phones, as this allowed for inclusion without the energy demands of conversation. Rather than viewing withdrawal as failure, most participants emphasized the deliberate choice not to participate in certain situations, especially when energy was low or past efforts had led to fatigue or misunderstanding. Here, participants described gradually coming to terms with this need as part of accepting their own limits.

> *You have to accept that certain situations are just not meant for someone with a CI …It's very important to accept that as a CI user or as a deaf person, you're just different, and things don't come naturally, that everything you do, you really have to work hard for yourself, so it's really important to rest, and that's very difficult, I still don't do it well myself, I do it, I try to do it better. (P6)*

Most participants described a process of coming to understand their own needs, often retrospectively contrasting their past uncertainty with a more secure present-day ability to advocate for themselves. This shift was experienced as an important form of self-care. It enabled participants to protect their energy and well-being by recognizing when to avoid or leave draining situations, ask for support, or adjust their coping strategies (e.g., taking hearing breaks). They emphasized the importance of taking their needs seriously rather than ignoring them, for example, out of fear of missing out. Participants also emphasized the process of developing the ability to ask for or accept support and to assess "which battles to fight" and when to step back.

> *I used to force myself … I would say: you have to participate now, otherwise you won't have any connections, otherwise you won't find any friends… But then at some point I really realized that I really just wasn't feeling well… I had such a bad headache, I was nauseous, I couldn't see well, everything was just too much for me, it was all too loud, I didn't get much sleep …and then I just burst into tears… that was the low point. And then I said: who f****ng cares, you've got your*

friends, make sure you keep them, but really look after yourself… if it's too much for you, then just really leave. (P12)

Several participants highlighted the value of contact with other DHH or d/Deaf individuals. These interactions helped normalize their experiences, offered emotional validation, and provided practical communication strategies. They were also described as affirming, with peers showing shared responsibility for managing communication:

Everyone [in the DHH self-help group] wants to understand something. Everyone has the same problem somehow, and everyone really knows the problem and knows how to deal with it. And because of that, it works much better, and I've found so many friendships through it. (P12)

4b. Managing the environment

Participants described strategies to shape their environments or guide others' behaviors in ways that could facilitate communication. For instance, all participants shared the experience of needing to remind others of their needs (depending on how supportive [see 3a. (Un-)supportive Peer Behaviors and Dynamics] and informed [see 3c. Informed and Supportive Social Environments] their social environment was), though fatigue, negative reactions, or social discomfort often stood in the way of self-advocacy.

Most participants described informing others about CIs and being DHH, while many strategically managed external expectations by adapting how they self-identified. Participants sometimes opted to minimize or delay disclosure to avoid stigma or over-accommodation (e.g., shouting or over-enunciating), while others openly labeled themselves to enable support.

4c. Noninterruptive strategies to stay involved

Participants used a range of strategies to stay engaged in (group) conversations without disrupting the flow, with most using speechreading or nonverbal cues including body language or facial expressions. Some described adjusting their physical position, for example, by continuously turning toward the speaker or taking on a strategic position within the group from the start. Some participants also reported pretending to understand peers when they didn't, for example, laughing along, to maintain a sense of inclusion and avoid standing out.

Most participants used their CIs and assistive technologies strategically without having to disrupt an interaction, though there was a high level of diversity in the technologies (CI versions and accessories) they used and were satisfied with. One participant attempted using hand-held microphones provided for the classroom during breaks with friends to pass around and enhance speech clarity, but this was uncommon, inconvenient, and only feasible when interactions happened near the classroom. Small, portable accessories, such as Bluetooth-connected microphones, or more advanced versions of CI speech processors with situation-specific settings could be helpful in noisy spaces such as cafeterias, though not all participants were satisfied with such programs, preferring to only use default programs and regulate loudness. While one participant entirely stopped using remote microphones with their CIs even in class, another participant extended their use of a remote microphone from classroom to social interactions in the cafeteria, experimenting with different directions and settings to support better communication within their peer group. However, such portable, discreet (e.g., clip-on) microphones suitable for informal conversations were not always covered by insurance, highlighting practical and financial limitations.

Finally, most participants reported switching communication modes, such as using occasional signs, sign-supported speech, or phones. Even when participants were not fluent in sign language, a few basic signs learned by peers could have a meaningful impact, signaling a willingness to connect or offering a simple way to exchange messages (e.g., "let's get coffee") when auditory communication was difficult. Participants sometimes also developed their own nonverbal signals to manage expectations, such as placing the external part of their CI in front of them to indicate they were taking a listening break or asking a peer to tap their shoulder to get their attention.

Differences in experiences before and after CI

Some participants received their first CI later in life (between 6 and 25 years, rather than as an infant/toddler), resulting in reflective accounts of how implantation shifted their social experiences. This included greater access to spoken conversation, not only in one-on-one interactions but also in small groups or classroom settings, particularly under favorable acoustic and social conditions. While the CI provided new opportunities for social engagement, it did not eliminate all barriers; large-group conversations, noisy environments, and fast-paced exchanges often remained difficult. Participants also encountered increased expectations from others, rooted in the assumption that the CI had fully "fixed" their hearing.

With the CI, people thought I'd be able to hear again. Like, with the hearing aid before, it was more like, "Okay, he's hearing impaired, that's just how it is"… But when I said, "Hey, I'm getting surgery because I need to improve my hearing comprehension", they automatically assumed: "Ah, now he's got better tech, so now it'll all work". And . . . no. (P13)

Receiving a CI could also affect confidence in navigating social situations or requesting support, especially after rehabilitation.

I'd say that in school, I was mostly someone who just followed what the others were doing… I thought, OK, I can't take part in the conversation, but I'm sitting together with the people. That was kind of the point for me. Now, I'd say, especially after I was in rehab… I've become more aware of what I need and how I can express what I need. (P11)

Still, the mental and sometimes emotional effort of social participation and a sense of partial exclusion often persisted. Rather than describing the CI as a cure, participants framed it as a tool that expanded access while requiring ongoing effort and adaptation.

Discussion

Extending prior research on CI users' communication and social challenges, this qualitative study uniquely focused on unstructured peer interactions beyond the classroom, revealing how specific situational, spatial, and social environments in mainstream school shape social participation, coping strategies, and belonging from

Table 3 Take-home message: towards inclusive (not deficit-oriented) school design, architecture, & practices, with focus on nonclassroom social participation.

Key takeaways:

- Social difficulty is not an individual problem. Social barriers for DHH/CI students arise from environments and norms. School design should reduce the urge, often put on the DHH students, to constantly compensate or "try harder."
- Accessibility should not come at a personal cost. Inclusion should not require trading comfort, energy, or social safety. Fatigue, stress, and stigma are design failures, not inevitable consequences of deafness.

Recommendations for built/social spaces:

- Design usable social spaces, not just formally accessible ones. Support social life where it naturally occurs (not in separate segregated areas), with good acoustics, lighting, seating, and open access. For recess, lunch, and transitional areas: check noise, reduce chaos, ensure visual contact, and ensure practical accessibility. Quiet rooms or libraries cannot replace acoustically treated social spaces.
- Build autonomy into space use. Students should access quieter, safer, or better-lit areas independently, without special permissions or rules. Allow spontaneous small-group or solo use; remove restrictive rules that may prevent DHH students to share suitable spaces with non-DHH friends.

Recommendations for cultural/social practices:

- Support sustainable and flexible participation. Inclusion involves maintaining engagement while managing listening effort and energy. Design spaces and activities to support stepping back and re-engaging without penalty or judgment. Normalize clear options for socializing and energy management.
- Support building new connections after transition periods. Provide structured icebreakers, small-group or one-on-one opportunities during transitions (e.g., new class or university start). Support DHH students to sharing their identity and needs with others on their own terms.
- Treat assistive technologies as basic infrastructure. Multipurpose tools (portable microphones, CI-compatible devices) should be available across classroom and recess settings and supported by norms. Train peers and staff in correct, nonstigmatizing use.
- Design for system-wide awareness and cooperation. Peer and teacher behaviors affect accessibility; inclusive design must account for daily practices. Provide up-to-date, nonstigmatizing information on DHH/CI labels, needs and inclusive practices (e.g., communication behaviors). Normalize and reinforce inclusive language and behavior across all students, so DHH individuals are not singled out; structural supports reduce social risk and protect relatedness. Even without teaching a visual language, students and staff can be encouraged and guided to explore mixed communication styles to overcome auditory barriers flexibly.

adolescence onward. By conceptualizing school not as a generic backdrop but as a set of distinct spatial and social contexts, the study foregrounds CI users' perspectives as actionable insights for inclusive school design, architecture, and support (see Table 3 or supplementary material for key takeaways).

The findings build on existing literature documenting communication barriers, listening fatigue, social isolation, and the challenges and benefits of friendships (Duchesne et al., 2025; Eichengreen et al., 2025; Jepsen & Pedersen, 2025; Punch & Hyde, 2011; Rijke et al., 2022; Zaidman-Zait & Dotan, 2017). It is clear that these themes recur across diverse contexts and are a concern beyond medical and technological advances—CIs or classroom microphones alone do not sufficiently address these issues. This highlights the urgent need to tackle barriers to DHH social inclusion in mainstream educational settings from a more holistic standpoint. This is especially important given that medical approaches do not equally benefit all DHH individuals, as evidenced by CI users' well-known diversity in functioning, which depends on age of implantation, onset of deafness, and many other factors (Pisoni et al., 1999; Stronks et al., 2025) and is also reflected in our sample.

Cochlear implantation alone does not ensure smooth integration into hearing environments and additional support is often necessary. However, the presence of stable friendships and the development and adoption of various adaptation strategies among participants in this study reinforces that positive social experiences in mainstream school are possible when appropriate conditions and support are in place (e.g., Eichengreen et al., 2025). Our work highlights that, as with other marginalized students such as those with other disabilities or neurodiversity (Koller & Stoddart, 2021; Tsou et al., 2024), the burden of adjustment still falls largely on CI users. This underscores the need to critically examine school environments and move toward more holistic approaches to inclusion (see also: work on DHH inclusion informed by affordance theory; Libbi et al., 2026). The present study provides key knowledge to support such holistic interventions by showing how challenges in social participation (theme1) arise from interactions *that are embedded in environments* shaped by overlapping human and nonhuman factors (theme 2 and 3), prompting CI users to adapt to improve outcomes with available resources (theme 4)—adaptations both to the CI users themselves and the surrounding environment; see Figure 1 for a visual overview of the connections between interview themes. Below, we discuss implications for structural and systemic changes in schools, and for psychology theory, research, and practice.

Role of school environments: social spaces and technologies

The negative impact of poor acoustics and background noise on CI users' speech understanding is well documented, but findings are largely drawn from laboratory settings or structured classroom contexts (e.g., Iglehart, 2016; Krijger et al., 2020; Neuman et al., 2012). By contrast, this study explored how external environmental factors influence CI users' social interactions in dynamic, informal settings, an area that has otherwise been examined only tangentially (Duchesne et al., 2025; Punch & Hyde, 2011; Rich et al., 2013; Wheeler et al., 2007; Zaidman-Zait & Dotan, 2017), or within d/Deaf-centric environments such as Gallaudet University (Bauman, 2010; Gallaudet University, n.d.). The present research offers a more fine-grained understanding of the complex and context-dependent challenges faced by CI users

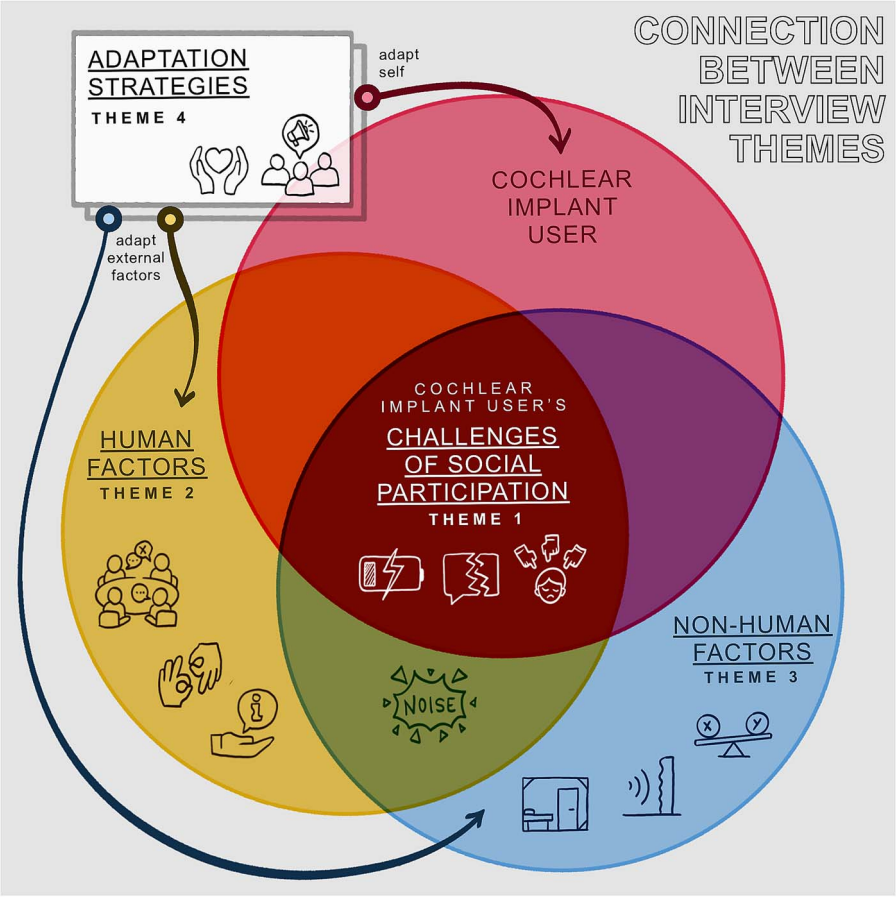

Figure 1 Diagram illustrating the links and overlaps between themes (numbered 1–4, as in Results) emerging from interviews with CI users (picture: ©Claudia A. Libbi (first author)).

in informal peer interactions in predominantly nondeaf, mainstream environments.

Rather than revealing new barriers, our findings show how well-established environmental needs (e.g., nonreverberant spaces with clear visual access) interact with social, institutional, and emotional factors. As key contribution, this research draws attention to the tradeoffs young CI users face in informal educational spaces, where physically suitable environments (if they even exist) are often inaccessible due to competing social demands or restrictive rules. Most participants could not name any space that fully supported socializing without physical, practical, or emotional constraints.

Crucially, the possibility for "feasible" social participation is shaped not just by features of the physical space but by teachers' and peers' awareness and behaviors that affect whether and how spaces or other resources are used, and whether attending to their own needs puts CI users at (social) risk: "Accessibility" is also *social* and *emotional*. This strongly aligns with work on socio-emotional disablism (Drever & Hugill, 2022; Reeve, 2015), which includes not only rejection, exclusion, or physical inaccessibility but also how subtle comments or accommodations may make DHH students stand out and have a hard time. The latter also links to the concept of microaggressions (Sue, 2010), everyday neglects or comments that may seem minor in isolation but can accumulate and affect a student's sense of belonging, which can also be structurally embedded in the design of environments, policies, or available choices that subtly limit DHH students' participation by making it uncomfortable or socially risky to seek optimal conditions.

This study also draws attention to the use of CI accessories such as portable, Bluetooth-connected microphones as tools for social participation outside of the classroom. These devices are typically recommended for formal classroom settings, with limited research on extending their usability for more dynamic environments (e.g., De Ceulaer et al., 2016). This study shows that such tools can support communication in complex contexts like cafeterias, though doing so often required students to creatively adapt them to fit informal interactions. Broader usability for unstructured social settings may depend on reducing this burden of experimentation.

Importantly, the willingness to use visible technological accessories may be limited by social–emotional factors, including discomfort in asking others to cooperate to use microphones correctly, frustration with misuse, stigma, or standing out as different (also noted by, e.g., Krijger et al., 2020; Terlektsi et al., 2020). Some CI users also lacked access to specialized accessories like clip-on microphones altogether due to financial constraints and lack of coverage by insurance. These findings underscore that such technologies should not be treated as optional extras. When designed with young CI users in mind, minimizing stigma, supporting intuitive use, and enabling flexible functionality, they can directly foster social participation and well-being (see also: work on designing technology to support CI

users' social interactions with fewer social–emotional burdens; Libbi et al., 2026). This, in turn, may reduce the need for CI users to choose between inclusion and personal comfort.

Role of school environments for coping & adaptation strategies

The adaptation strategies described by participants extend what is known on coping strategies in DHH populations (e.g., Eichengreen et al., 2025; Hallberg & Carlsson, 1991) by showing how these strategies are shaped by situational and environmental constraints in mainstream settings. Decisions to engage or withdraw depend not only on internal factors like energy and motivation but also on external ones such as accessible spaces, peer behavior, and institutional rules. These external elements can effectively push CI users toward either active or passive coping, with specific strategies shifting depending on whether the environment is completely inaccessible (e.g., even full effort cannot lead to understanding) or functionally inaccessible (e.g., participation is technically possible but too draining or causes social strain). Concurring with recent findings on younger DHH students' coping (Eichengreen et al., 2025), this research also emphasizes the importance of peer support for effective coping when it comes to friends actively providing help in dealing with communication challenges.

Our findings also resonate with broader psychological constructs such as resilience (Eichengreen et al., 2021), individuals' ability to pursue personally meaningful goals within challenging contexts, and capability (Rijke et al., 2022), which concerns the alignment between personal goals, abilities, and the environment (this idea is further developed in an in-depth exploration of DHH affordances for socializing (Libbi et al., 2026). We show that young CI users' approach and attitude to social difficulties may shift, taking pride in "working harder," or ultimately prioritizing their well-being over attempting to join every challenging situation, even if it meant missing out. Both approaches may reflect resilience, show an ongoing process of adaptation and capability to manage socializing with peers. Yet, they also reveal a response to a relatively rigid environment that offers limited support.

Lack of awareness among peers and teachers about the social dimensions of being a CI user, such as social deafness (Punch & Hyde, 2011), cognitive or emotional fatigue (Hornsby et al., 2024; Jepsen & Pedersen, 2025), and common misunderstandings of terms like "deafness" or "hearing loss" reveal a persistent gap in DHH-related knowledge, which places extra burden on CI users to strategically manage labels, challenge stereotypes, and avoid being misunderstood. The level of acoustic, physical, and social challenge can greatly influence the amount of energy and, sometimes, frustration involved in doing so. Several participants found relief in interacting with DHH peers, where mutual understanding and collaborative communication reduced this strain. These insights fit in with prior calls to promote stronger connections to d/Deaf communities in mainstream schools to support DHH students in forming positive self-perceptions and developing adaptive coping mechanisms (Eichengreen et al., 2021), and for deaf awareness training among hearing peers (Terlektsi et al., 2020), especially pointing to the need for further research on how empathy and awareness can be cultivated among non-DHH students (see also Libbi et al., 2026).

Theoretical integration: school environments, adaptations, & basic psychological needs

Although this study was not initially guided by basic psychological needs (BPN) theory (Deci & Ryan, 2000), the findings align closely with its core dimensions and offer a useful lens for interpreting CI users' experiences in mainstream schools. For all students, including those with CIs, the fulfillment of autonomy (agency and self-direction), competence (feeling capable), and relatedness (connection and acceptance) is essential to long term well-being (Deci & Ryan, 2000; Vansteenkiste et al., 2020). Recent work has begun to explore BPNs in DHH populations (Wright, 2025), and this study contributes to that growing discussion.

Our findings suggest that external conditions during informal school interactions may challenge BPN satisfaction. Autonomy may be constrained when students cannot independently access more favorable environments (e.g., quieter, better-lit, or visually open spaces) without requesting special accommodations. At the interaction level, peers' refusal to repeat missed information illustrates another way CI users' perceived control and autonomy may be diminished. In this context, BPN satisfaction seems to depend not just on accessing externally judged "important" content but on feeling an equal opportunity to access the same content as others.

Competence involves not only successful speech perception but also managing energy and effort to stay engaged on one's own terms. Participants often expressed satisfaction in achieving a degree of self-sufficiency and understanding their own needs. Finally, relatedness, while likely strained by communication barriers or perceived differences to hearing peers, may be strengthened when peers and staff supported participation naturally, without overemphasizing the DHH students' needs. For instance, some peers took initiative in choosing accessible locations or learning basic signs, things that made a difference on an emotional, more than practical, communicational level.

These findings suggest that BPN research could be expanded to include specific physical and infrastructural factors, beyond social dynamics, that influence autonomy, competence, and relatedness for CI users. Given the predictive power of BPNs for several important life outcomes across many populations (Vansteenkiste et al., 2020), this perspective may help identify more effective strategies for schools to create inclusive spaces that truly support CI users' well-being and participation.

General implications for practice & research

Hunt (2024) critiques psychology's historical focus on individual deficits, arguing that this perspective obscures the structural and cultural dimensions of disability. This is supported by the present findings, which show how and why CI users' social connection in mainstream schools depends heavily on accessible and inclusive environments. CI users in this study demonstrated a range of skills and social successes, yet not without internal struggles. Hunt's reference to "energy-limiting or less visible conditions" likely resonates with many CI users who appear hearing (or nondeaf) until communication breaks down or they autonomously disclose their needs and identity, often experiencing fatigue from everyday social participation.

These insights point to the need for both educational and clinical practices to move beyond individual coping and toward systemic changes that ease the burden on CI users and other DHH

students. Too often, DHH students are expected to self-manage their well-being while meeting the same performance standards as their hearing peers, despite minimal support. CI users occupy a unique position between medical and disability framings, often integrated in mainstream settings, yet frequently feeling othered or misunderstood. Future research and support systems, including therapeutic approaches, should draw more explicitly on disability-affirmative frameworks (Swain & French, 2000), while recognizing that not all DHH individuals identify as disabled or d/Deaf. Such an approach can go beyond minimizing struggle to strengthen identity, validate difference, and help build environments that genuinely support well-being and inclusion.

Limitations

This study focused primarily on the experiences of DHH students with CIs in mainstream educational settings, but not all mainstreamed DHH students use CIs. While this may appear to limit generalizability, previous research suggests that DHH adolescents with and without CIs often report similar psychosocial outcomes, such as self-esteem, life satisfaction, and loneliness, despite assumptions that the device would significantly alter social development (Leigh et al., 2009). While this study did not directly compare groups, findings suggest some overlap in the experiences of CI users with other DHH students who use hearing aids or no device—for instance, in regard to the use of adaptation strategies (Eichengreen et al., 2025) and difficulties socializing in the presence of noise during breaks (Krijger et al., 2020)—indicating that many of the environmental and social challenges identified here can have broader relevance across the DHH spectrum. Additionally, while the number of participants was relatively small, the study was designed as an in-depth qualitative exploration. Recurring themes across interviews indicate saturation, though further research with larger and more diverse samples is needed to refine and expand on these findings. For example, this might include hearing aid users, people with mild/unilateral hearing loss, Deaf signers, and intersectional populations (ethnic, socio-economic, immigration background, LGBTQ+, etc.).

Furthermore, future studies could extend this work by exploring with more nuance if sub-groups of participants in this sample differ in their perspectives and experiences, for example, looking at unilateral versus bilateral CI users, or comparing different educational settings. The present study was not designed to make such comparisons, but future research could collect data in a targeted way to deepen knowledge on such differences, which can help develop more concrete and context-sensitive support strategies targeting social and built environments.

Conclusion

This study offers a nuanced perspective on the social participation of students with CIs in mainstream educational settings, and its relation to external factors in the environment. While participants generally demonstrated resilience and developed meaningful social relationships, they did so within environments that often came with persistent barriers, both physical and social. The findings underscore the importance of moving beyond individual adaptation and technological fixes, highlighting instead the need for inclusive school environments that support autonomy, competence, and relatedness. By showing how social spaces, institutional norms, and peer understanding shape everyday experiences, the study contributes to growing efforts to design environments that promote genuine inclusion and well-being for DHH students. Importantly, evolving built spaces and socio-cultural practices in response to DHH inclusion is most effective when understood not as optional support or an act of goodwill but as a basic part of equity within the school context, acknowledging students' diverse backgrounds, abilities, and sensory needs. When framed otherwise, even well-intentioned efforts can fall short of meaningful inclusion and may unintentionally reinforce stigma in how DHH students are perceived and in how they come to see themselves. Future work should further explore systemic and cultural shifts, particularly those that recognize diversity within the DHH community and reduce the burden placed on individuals to manage their own participation.

Endnotes

1. Mainstream secondary education is typically part of an academic trajectory that is more closely aligned with progression to higher education (van der Straaten et al., 2021); accordingly, DHH students are represented in higher education, including in the present study.
2. Built features (features of a built environment; Choudhary, 2016; Seyedrezaei et al., 2023) here refer to the physical elements or objects within an environment that have been constructed or affected by humans (for a similar use of the term, cf.: Jabeen et al., 2023; Nordbø et al., 2020).

Supplementary material

Supplementary material is available at *Journal of Deaf Studies and Deaf Education* online.

Author contributions

Claudia Alessandra Libbi (Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing—original draft, Writing—review & editing), Adva Eichengrün (Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Writing—original draft, Writing—review & editing), Josine Buiskool (Conceptualization, Data curation, Formal analysis, Investigation, Methodology), André Götze (Conceptualization, Data curation, Formal analysis, Investigation, Methodology), Karolin Schäfer (Writing—original draft, Writing—review & editing), H. Christiaan Stronks (Project administration, Resources, Supervision, Writing—original draft, Writing—review & editing), Johan Frijns (Funding acquisition, Project administration, Resources, Supervision, Writing—original draft, Writing—review & editing), and Carolien Rieffe (Conceptualization, Project administration, Resources, Supervision, Writing—original draft, Writing—review & editing)

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Conflicts of interest

The authors declare that they have no conflict of interest.

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Appendix A

Semi-Structured Interview Protocol (English translation)

Introduction:

Thank the participant for participating. Ensure accessibility: Check if they can hear/understand interviewer clearly. Researcher introduction & brief explanation of research. Ensure participant understood all aspects of the informed consent leaflet and have no further questions; address any concerns. Repeat interview rules: it's ok to skip a question; participant can interrupt at any time; they can ask for clarification; there are no right or wrong answers. Verify there are no open questions. Ask for consent to record. [Start audio recording.]

Ice breaker

- Which school/university/... do you go to?
- What does a typical school/university/workday look like for you?

Part 1: Daily Sound environment

- Q1: What's a nice place for you to spend your break or free period? (If you have a lunch break, where do you usually go first?) Follow up: Where do you sit? What do you do there? Do you always go to the same place? Where do you go to rest during school hours?
- Q2: Imagine I've never been in a place like that. How would you describe the space to me? Follow-up: What do you experience when you enter the space? Where are you in the space, in relation to others? Is it indoors or outdoors? What do you hear there? How do the sounds affect your listening experience? What is happening around you? Ask about whether space is busy, sound quality, unfamiliar / bothering / distracting sounds. What are places you prefer not to go to and why?

Part 2: Effect of Sound, CI Use, and Identity

- Q3: What does ambient sound do to you? Follow up: Can you describe how it makes you feel? How do you relate to the fact that some people's tiredness / mood is affected by noisy environments? What do you think in such moments? What do you feel (physical / mood)? What do you do then?
- Q4: Can you tell me about the history of your CI(s)? Follow-up: How many, since when, how often/when do you wear them, did you receive instructions on using them, in what way is using CIs comfortable or uncomfortable? Do you adjust settings depending on situation? How do you relate to sign language, in what way do you use it (if at all)?
- Q5: How do you identify yourself in terms of deaf or hard-of-hearing labels? Follow-up: In what situations do you use or feel which label – if it shifts, why? Does the change depend on the situation?
- Q6: How important is hearing to you in your daily life and why?
- Q7: Have you ever tried to explain to a friend or family member what it's like to hear with a CI (if no, why / if yes, how and what was it like)?
- Q8: What do you think you might be better at than hearing people?

Part 3: Daily Social Environment and Activities

- Q9: What do you usually do during breaks? Follow up: spend time with other people, who, one-on-one or groups / how many people? What do you do together? Do you feel like an active part of the interaction, or more passive – explain? How does the communication go? How often do you talk with others?
- Q10: How do you think environment sound affects you during breaks – when you're trying to understand others, or talk with them? Are you satisfied with what you do or don't do during breaks & why? Is your break experience related to fatigue – if you experience that?
- Q11: Can you recall a situation, where connecting with others went really well and you thought: "Wow, this is a great place and I feel involved"? Can you give examples? What made it work well?
- Q12: Can you recall a situation, where the opposite happened – where it was really difficult to connect with others? Can you give examples and explain what made it difficult? How did you deal with it?

Part 4: Advice for a More Inclusive CI Environment

- Q12: Try to remember when you first started secondary school. What was it like to connect with other kids at the school? Where there situations that were especially difficult for you as a CI user? (Follow up:) Now that you're in [class/university/...], what advice would you give another CI user or your younger self based on what you've learned? How have you dealt with challenges, and how did that make you feel?
- Q13: What tips would you give a typically hearing person to help you in a social situation?
- Q14: Imagine an architect is redesigning your school and asks you for advice. What would be on your checklist to have a pleasant break, to feel involved and at ease? Follow-up: Now imagine it's not an architect, but a wizard who asks for your three wishes: They don't have to be realistic; anything is possible. What three things would you wish for, so you can make the best social connections during breaks?

Closing the Interview

- Q15: This is the end of the interview. Is there anything we haven't talked about that you would still like to add? What do you think were the most important points we discussed? How did you experience the interview?
- Inform participant about what will happen next, and how they can contact the researcher (debrief). Address any questions.
- Ask / remind participant to fill out demographics form (or fill it out directly).
- Thank participant again. [End audio recording.]

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