EmojiFan: Designing A Social Interface Supporting Facial Expression Interaction for Blind and Low Vision People in Party Settings

Jinlin Miao*
China Academy of Art
Hangzhou, China
miaojinlinchloe@gmail.com

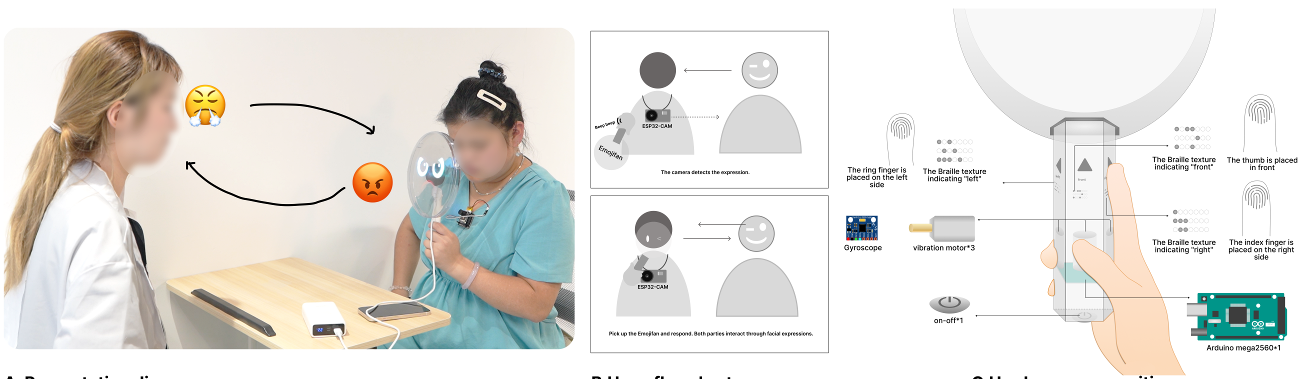
Shan Luo*
China Academy of Art
Hangzhou, China
luoshan3398@qq.com

Yue Chen
China Academy of Art
Hangzhou, China
1533314274@qq.com

Hongyue Wang
Exertion Games Lab, Human-Centred Computing
Monash University
Melbourne, Victoria, Australia
hongyue@exertiongameslab.org

Zhejun Zhang
China Academy of Art
Hangzhou, China
ezrealzhang1030@gmail.com

Rina R. Wehbe†
HCI4Good, Faculty of Computer Science
Dalhousie University
Halifax, Nova Scotia, Canada
Rina.wehbe@dal.ca



A. Presentation diagram. B.User flowchart. C.Hardware composition.

Figure 1: (A) A user employs EmojiFan to identify a social partner's facial expressions and respond with corresponding digital facial expressions; (B) The user's process of using EmojiFan; (C) EmojiFan system hardware components.

Abstract

Facial expression interactions play a crucial role in fostering social bonds and expressing emotions. However, in the dynamic, fast-paced, and noisy environments of parties, various factors hinder blind and low-vision (BLV) individuals from engaging fully in facial expression interactions. While previous research has explored how BLV users can convey emotions through non-verbal visual cues, it has largely overlooked the challenges they face in engaging with facial expressions after perceiving these cues. To address this gap, we conducted a formative study with 10 BLV users to identify their challenges and expectations regarding facial expression interactions in party settings. Guided by these insights, we developed *EmojiFan*, an AI-powered smart fan designed to offer a personalized representation of facial expressions through dynamic, expressive emojis. Finally, we carried out an in-the-field study with 6 BLV participants and 8 sighted social partners to examine the effectiveness of *EmojiFan* in enhancing facial-expression interactions during parties. Overall, our goal is to empower BLV individuals' autonomy to actively participate in social interactions through digital facial expression, thereby contributing new insights for the accessibility community on designing expressive, socially responsive assistive technologies.

*Both authors contributed equally to this research.
†Corresponding authors

CHI '26, Barcelona, Spain

ACM ISBN 979-8-4007-2278-3/26/04
https://doi.org/10.1145/3772318.3790944

CCS Concepts

• **Human-centered computing** → **Interaction devices**; *User interface design*; *Interface design prototyping*; *Scenario-based design*; **Accessibility systems and tools**.

Keywords

Blind People, Facial expression, Social assistance, Social Ice-breaking, AI-assisted Wearable Devices, Personalized Feedback, Offline Social Accessibility, Emotion Recognition

ACM Reference Format:
Jinlin Miao, Shan Luo, Yue Chen, Hongyue Wang, Zhejun Zhang, and Rina R. Wehbe. 2026. EmojiFan: Designing A Social Interface Supporting Facial Expression Interaction for Blind and Low Vision People in Party Settings. In *Proceedings of the 2026 CHI Conference on Human Factors in Computing Systems (CHI '26), April 13–17, 2026, Barcelona, Spain.* ACM, New York, NY, USA, 21 pages. https://doi.org/10.1145/3772318.3790944

1 Introduction

Imagine stepping into a lively party: music is playing, laughter echoes across the room, and conversations overlap in every direction. You can sense the vibrant energy in the air—but you cannot see who is speaking, where they are, or what their expressions look like. For blind and low vision (BLV) individuals, this is a common experience at parties. In urban culture, parties, defined as social gatherings in which multiple people engage within the same venue to build social connections, serve as key sites for fostering interpersonal relationships[27, 67, 80, 85]. However, research illustrates that due to communication barriers[29] and social anxiety[46], BLV individuals often experience reduced participation in social events or intentionally withdraw from social activities[59]; moreover, this trend is reflected in population-level data: the prevalence of moderate and severe loneliness among BLV individuals is 28.7% and 19.7% , respectively[12]. Hence, party settings constitute a socially significant but accessibility-limited environment for BLV individuals, highlighting the need to address the barriers that hinder their active engagement.

Party environments often involve large groups, creating noisy, spontaneous settings with rapid conversational turn-taking. In such settings, people rely heavily on rapid nonverbal cues (e.g., tone, body language, posture)[5], with facial expressions being the most significant for inferring intentions, emotions, and engagement and for conveying agreement[33, 48, 70]. Conversational cues are closely related to the expression of interpersonal attitudes and the development of mutual trust, and deeper relationships[6]. However, due to limited opportunities for visual learning (e.g., observing others' facial expressions)[86], BLV people often struggle to engage effectively in facial-expression interaction, which can hinder conversation initiation and expressive participation, particularly in party social settings.

Prior work has focused on developing interactive technologies leverage nonverbal cues to facilitate facial expression among BLV individuals. For example, early versions of Google Glass[4] captured a partner's emotion via an onboard camera and relayed it to BLV users through audio during conversation. Similarly, recent VR headsets[38] and AI-assisted devices[82] detect nonverbal signals and provide voice prompts, helping BLV users produce facial expressions intentionally or subconsciously. Interactive systems like these overlook how technology can support them in engaging in facial-expression interaction after perceiving such cues—especially in party settings. Recognizing BLV individuals' difficulties with eye contact[66], Jun et al.[65] designed smart glasses with eye-tracking capability that simulate eye-related expressions, helping BLV users engage in more natural eye contact. However, beyond eye expressions, little is known about how interactive technologies can help BLV individuals express the entire facial expressions socially, especially in party settings.

To address this gap, we conducted a formative study with 10 BLV individuals. The study explores the challenges BLV users experience in facial expression communication in party settings. Combined with previous literature and the formative study, the results revealed that: 1) **Richer Expression Cues are Needed:** Beyond eye contact, BLV users hope to have complete facial-expression interactions; 2) **Responding with Facial Cues is Desired:** after receiving nonverbal cues, BLV users often cannot respond with facial expressions in a timely and natural way; 3) **BLV user are Early Adopters:** BLV users look forward to using a social interface that is more in line with the party scene.

Drawing on these findings, we further distilled key design goals that guided the development of *EmojiFan*—an AI-assisted smart fan equipped with a controllable facial expression display. *EmojiFan* supports BLV individuals in socializing during parties through the following features: 1) **Unobtrusive Hints:** Use haptic feedback to unobtrusively help BLV individuals perceive social cues and orientation themselves in party settings; 2) **Personalization of Expression:** Enable AI-based personalization of facial-expression preferences according to BLV user-defined settings, so as to better convey their individuality and personality; 3) **Instant Display:** Employ AI as a proxy for automatic facial expressions to ensure the timeliness of interactions; 4) **Social Affordance:** Integrate the social interface into a handheld fan, where combining the cultural and social attributes of fans as a medium for social expression in party social settings, raising the fan naturally triggers interaction—making it both familiar to use and enjoyable to engage with.

In a controlled party simulation, we conducted an in-the-field study involved multi-person, where BLV individuals engaged in face-to-face social activities with and without the use of *EmojiFan*. Through user experiments, we collected data from various dimensions for thematic analysis to respond with our research question. The results of the user study verified that BLV individuals were able to communicate more effectively when using *EmojiFan*. Additionally, we documented the challenges faced by BLV user when using *EmojiFan*, as well as the impact *EmojiFan* had on their social interactions.

The contributions of this work are as follows: 1) *EmojiFan*, an AI assistive social interaction system that provides automatic emoji-based expression support for BLV users. 2) We further investigated the difficulties that BLV users face in facial expression interaction after receiving nonverbal cues. 3) This work present design insights and considerations, offering guidance for future interactive systems aimed at supporting facial expression interaction for BLV users, thus contributing new design insights for accessible and affective human–AI interaction.

2 Related Works

Our research builds upon previous studies, which include: 1) Socially assistive tools for BLV People; 2) Support systems in perceiving social cues; and 3) Support systems in social expressive interfaces.

2.1 Socially Assistive Tools for BLV People

Early social assistive tools for BLV individuals primarily focused on online social platforms[15, 83, 87]. These interactive systems provided convenient recognition of text[52], images[73], and emojis[38], facilitating BLV individuals' online communication[16, 38, 83]. Other research have also developed interactive systems for various offline social scenarios[69], enabling BLV and sighted individuals to participate together in social activities including partner dancing[76], archery[53], card games[9, 36], and children's education[37, 55]. These systems provided rich scenarios and opportunities for building friendly relationships between BLV and sighted people. However, when BLV individuals engage in face-to-face communication and dialogue with sighted people to establish closer relationships, much nonverbal information[48] still cannot be effectively conveyed during their interactions. Such information is essential for promoting mutual understanding and empathy, establishing trust[20], and facilitating relationship building between BLV and sighted individuals[6].

Thus, our research aims to further focus on the barriers that BLV individuals face in social expression with others. Our research project will incorporate party scenarios to design and develop specific interactive systems, including how BLV people can capture nonverbal cues and naturally express their social intentions with others. In the following sections, we will discuss existing interactive systems about perceiving social cues and social expressive interfaces in detail.

2.2 Support Systems in Perceiving Social Cues

Interactive systems that support BLV individuals in capturing nonverbal social cues exist primarily in virtual social environments[17, 38, 72] and face-to-face social environment[41, 82, 83]. In virtual environments, many interactive systems convert captured nonverbal cues into diverse feedback modalities, including tactile prompts[72], text prompts[42, 90], audio prompts[38], multimodal sensory feedback[38], and even visual prompts with magnified images for individuals with low vision[60, 90]. However, these systems are limited by their reliance on virtual online platforms. Consequently, some research projects have developed interactive devices for face-to-face communication, such as smart glasses[4, 38], haptic vibration gloves[78], and others[28]. These systems use cameras to capture real-world nonverbal social cues and convert them into text descriptions[1, 26, 41], tactile vibrations[13, 35, 62], simple melodies[50], helping BLV individuals better understand the intentions and interaction content of their social partners in face-to-face settings.

However, BLV individuals still face subtle difficulties in responding to these social cues, including challenges in making eye contact[13], which further affects their overall facial expression and interaction[13, 34]. Therefore, our research aims not only to learn from prior work on capturing social cues but also to address the difficulties BLV individuals experience in social expression and interaction. More specifically, considering the noisy party environment where audio and visual modalities are challenging to employ, we will adopt vibrotactile feedback to help BLV individuals perceive surrounding social cues.

2.3 Support Systems in Social Expressive Interfaces

In the domain of supporting social expressive interfaces for BLV people, a small number of researchers have focused on enabling eye contact interactions. Morrison et al. developed PeopleLens[56], an interface that guides BLV people to direct their gaze toward conversation partners, helping them adjust their conversational orientation. Building on this foundation, Osawa[61] and Qiu et al.[63, 65] expanded beyond mere directional guidance to emphasize the importance of dynamic eye contact. Their system uses the Eye Tribe Tracker to monitor eye movements and generate fundamental gaze patterns, such as "look at" and "look away," enabling BLV people to simulate natural eye contact during conversations. This approach enhances communication quality between BLV people and sighted individuals by creating more natural gaze-based interactions.

However, these existing systems have some key limitations: (1) they offer a limited repertoire of gaze number patterns; (2) they lack personalization capabilities, preventing BLV people from responding to social cues according to their own preferences in real-time; (3) they focus exclusively on eye contact rather than supporting full facial expressions. To address these gaps, our research aims to develop a personalized expressive interaction system for BLV people. We leverage AI technology to generate a richer range of facial expressions that respond to conversation partners' social signals based on individual user preferences. Furthermore, in complex social contexts such as parties, interfaces supporting social expression for BLV people must be flexible and culturally appropriate[22]. Specifically, BLV people should be able to use the social expressive interface freely[88], which is not defined as stigmatizing[19], without being constrained by head-mounted devices or adhesives attached to facial skin[75]. These design considerations will be elaborated in subsequent sections.

2.4 Summary

Building upon prior research on social assistance for BLV individuals, our work primarily focuses on the difficulties they face in expressing social facial expressions. Our interactive system leverages AI-powered personalization capabilities to generate diverse facial expressions based on user-defined preferences, responding to different social cues in real face-to-face social scenarios. Also, our system extends beyond the limited prior work on eye contact to encompass full facial expressions, while also emphasizing the social and natural qualities of the interaction interface. We aim to advance the relationship, trust, and rapport between blind and sighted individuals during social interactions, and enable possibilities for proactive social engagement.

3 Formative Study

In the related works section, we identified that our research centers on supporting facial expression interaction for BLV individuals. To expand on this, in this section, we further explored the design considerations related to both the functionality and appearance of the system, aiming to ensure that it better fits social contexts and meets the needs of BLV individuals in party environments.

The formative study[45] had two primary objectives: (1) to understand the challenges BLV individuals face in social expression during the party contexts; (2) to derive design goals and principles based on these insights, ensuring the proposed design aligns with the needs of BLV users in the party settings.

3.1 Methods

3.1.1 Participants. We recruited 10 participants (P1-P10; 4 females and 6 males), aged between 19 and 30 years (mean age = 23.91, standard deviation = 5.42). The vision conditions of BLV users are shown in Table 1. During the recruitment process, we selected young BLV users who rated their offline social frequency between 3 and 5 on a Likert scale (ranging from 1 to 5, where 5 indicates a very high frequency of offline social interactions). The majority (63.64%) rated their social frequency as 4-5, while the remaining participants rated it as 3, which was considered to indicate sufficient social experience. Their social experiences primarily focused on gatherings between BLV users and sighted people. These selection criteria were beneficial for our interviews, as they allowed us to review the specific difficulties and experiences these BLV users encountered in past social gatherings and encouraged active participation in discussions about design functions and requirements. We recruited BLV users through the student organizations of a special education university in Hangzhou. Each BLV user received a compensation of 200 RMB after the activity. This study has been approved by our university's Institutional Review Board (IRB). Additionally, during the later discussions regarding design goals and principles, we had six researchers with a design background, who were collaborators on this research project.

3.1.2 Procedure. As shown in Figure 2, our entire formative study consisted of two tasks.

The first task involved interviews with 10 BLV user. The steps of the interview process were as follows: 1) Introduction of the overall project and experimental background; 2) A conversation with each participant based on a fixed interview themes (The detailed of interview themes can be found in the Appendix A.1), including what kind of interactions they had at the party, which of those were unpleasant, and how BLV user respond to those unpleasant interactions. These interview themes helping them recall the difficulties and challenges they faced when initiating conversations with others at offline social gatherings; 3) Asking the BLV users to provide ideal suggestions and solutions for addressing these challenges (specific interview themes can be found in the Appendix A.2). Each interview lasted about 40 minutes, and 6 researchers spent one week collecting audio data from the 10 BLV users. We recorded the interview data and analyzed it with the permission of all the BLV users.

The second task involved interviews with 6 researchers with a design background. We discussed the challenges and ideal suggestions raised by the BLV users, further refine the issues faced by BLV users and the important design goals from a design perspective and the discussion was held online via Zoom for 40 minutes. The goal was to propose design goals and principles corresponding to the difficulties faced by BLV users. After the meeting, three researchers used an automated transcription tool to summarize the recorded data.

3.2 Analysis

Both of our tasks utilized Zoom's automatic transcription tool and AI data summarization tools for analysis and summarization (the use of AI tools to process data was conducted with the consent of BLV users and approved by the university's IRB). Based on this, three researchers independently reviewed and manually checked the transcribed texts to correct any transcription errors. We applied thematic analysis[84] to the transcribed texts of the 10 BLV user from Task 1 and the transcriptions of the discussions among design researchers in Task 2. The three researchers independently conducted open coding on the two sets of transcribed data and collaboratively developed a coding manual to resolve any discrepancies through discussion. We then clustered the relevant codes using axial coding and affinity diagrams, extracting themes and sub-themes from the codes. Once the initial themes and sub-themes were determined, the researchers cross-referenced the original data, the coding manual, and the themes for final adjustments, ensuring that all codes were accurately categorized. The full thematic analysis for both tasks was completed in two weeks.

3.3 Finding: Challenges

3.3.1 Difficulties of Accessing Nonverbal Cues in Party Setting. Most nonverbal cues are visual signals, and BLV users have indicated that they usually cannot receive such signals, which makes them very passive in parties. P1 noted: *"I have no idea whether they included me in the conversation or not. Am I actually part of it, or am I just an outsider? Should I leave the group now? Staying feels awkward, but leaving feels just as awkward."* During parties, the noisy environment makes it difficult to receive auditory signals. As P2 said: *"Not knowing the other person's state… puts you in an awkward situation."* P9 shared: *"I'm 50% sure they were calling me, but I still wouldn't respond… I'd rather just pretend I didn't hear it."* Because they cannot receive accurate social intentions or emotional signals, BLV users are unable to engage in facial interactions in party settings or initiate ice-breaking behaviors. This is because such ice-breaking usually requires seeing the other person's situational awareness.

3.3.2 Difficulties in Emotional Interaction. Most BLV users have difficulty making eye contact, this will hinder them from engaging in rich emotional interactions with their social partners. P5 said: *"I've read in novels about people making eye contact during face-to-face conversations, but we blind people can't make eye contact. That's something I see as a communication barrier, though there's nothing we can really do about it."* P6, who became blind later in life, said: *"I feel it's currently very difficult for me to express my thoughts to my friends through facial expressions or eye contact. This kind of communication is very one-way and lonely."* There are also BLV users who express

Table 1: Participant Information

Serial number	Gender	Age	Occupation	Visual Ability	Social Frequency (1-5)[1]
P1	M	30	IT	Totally Blind	3
P2	M	23	Student	Totally Blind	4
P3	F	21	Massage Therapist	Totally Blind	4
P4	M	20	Student	Low Vision	4
P5	F	20	Student	Totally Blind	4
P6	M	19	Student	Low Vision	5
P7	F	26	Customer Service	Amblyopia	3
P8	M	20	Student	Light Perception Only	3
P9	F	24	Student	Low Vision	4
P10	M	22	Student	Low Vision	4

[1] Self-rated on a Likert scale where 1 = very rarely socialize, 5 = very frequently socialize.

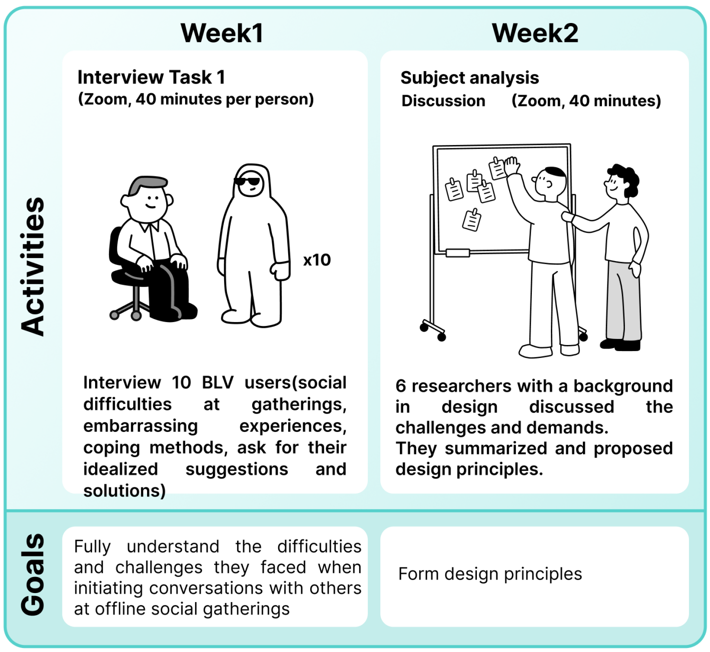


Figure 2: The process of formative study.

a desire to enhance the quality of their communication through facial expressions: P9 said, *"It's a bit difficult because I don't know other people's facial expressions, and even if I did, it would be hard for me to respond. I worry that my smile looks stiff and unattractive."* P3 said: *"When I'm listening to someone speak, I usually tilt my head to listen with one ear. They often can't see my facial expressions, and I prefer online communication. Offline, when people stare at my face, I feel a bit inferior."*

In summary, there are various reasons, both physiological and psychological, that make it difficult for BLV users to express their facial emotions. We want to position this emotional expression as a right. BLV users should have the right to choose whether to convey emotions, rather than doing so to serve the needs of their communication partners.

3.3.3 Social Discomfort, Stigma, and Lack of Socially Acceptable Assistive Tools. Many BLV users expressed concerns that using current assistive technologies in party settings may draw unwanted attention, appear socially stigmatizing, or require assistance from others, making them feel embarrassed or dependent. Some BLV users mentioned that they avoid using mobile apps or visual recognition tools because the act of aiming a device at someone's face may be interpreted as impolite or intrusive. As P1 said: *"I know there are some AI chatbots now that can recognize a lot of objects, but I definitely wouldn't hold my phone up to someone's face to see what their expression is like. That would be very impolite."* P7: *"I feel* *like wearing these assistive tools in social settings makes me stand out in an awkward way. I once went out with a camera—it was quite big—and people kept asking What are you doing?"*

Beyond this, BLV users also worried about being over-observed or perceived as different when using devices that visibly signal disability, which can disrupt their social confidence. P4 noted: *"At a party, it's too complicated, and I would give up on communicating."* Some participants expressed frustration that certain assistive tools require help from others to properly aim or operate, reducing their autonomy. P5:*"I usually wear headphones to listen to text prompts from apps. One time, the audio played out loud on the subway, and I must have seemed really odd. It felt like the noisy surroundings suddenly went quiet... In that moment, I felt like I'd been exposed as someone strange."*

BLV users also expressed a desire for assistive tools that more convenient, without requiring users to learn a lot of complicated features. P3:*" I once tried on a VR headset, and they had to help me set it up. If I were to use something like that in a real social situation, I wouldn't want someone standing next to me to guide me. I'd prefer something convenient—something that doesn't take a lot of time to put on, take off, or adjust. Otherwise, it just feels like I'm constantly bothering others, and that's awkward."* Some also mentioned that if it's for social settings like parties, the tool should be more fun and entertaining. Socially engaging—something that could blend into party culture rather than look like a medical or assistive device. As P7 asked: *"Could it be installed on a more natural tool so that it doesn't stand out in a party setting? Something more natural."*

These concerns reveal that BLV users expect assistive tool doesn't carry an overt label of disability, socially acceptable, easy to use without assistance, and ideally designed in the form of familiar or fun social props to reduce stigma and encourage more positive interaction experiences.

3.4 Finding: Design Considerations

Based on the difficulties and challenges that BLV users face in the party setting, Task 2 of our formative study proposed the following three design principles, providing design goals for the development of future interactive systems.

3.4.1 Design Consideration 1: Capturing Timely Nonverbal Visual Cues through Haptic Feedback. In describing their challenges, many BLV user expressed a desire to better perceive nonverbal cues whether before, during, or at the end of a conversation. Being able to detect these subtle social cues is crucial for them to respond appropriately. In the context of a party, providing vibration feedback and effective directional cues is considered especially important. This is particularly suitable for noisy party settings and can help some BLV user broadly understand the social intentions expressed by others. (1) Real-Time Detection: The system should detect facial expressions and direction (e.g., smiles, gaze direction) in real time to support social awareness. (2) Haptic Feedback: Considering that auditory channels are often overloaded in party-like environments, we use vibration motors to deliver intuitive and non-intrusive feedback.

3.4.2 Design Consideration 2: Initiating Automatic Emotional Interactions Based on the Preferences of BLV Users. While this kind of vibration feedback can help BLV user generally understand that someone has expressed social intentions, emotional interactions, and other social signals to them, it is difficult to know the specific content. In combination with the challenges described, BLV user have expectations for the interaction system and would like to have richer expressions of eye contact and emotional interaction. In addition, some BLV users may struggle to express emotions accurately and are often misunderstood[86]. We aim to use AI proxy to express the emotions of BLV user automatically, and at the same time, it should be expressed according to the personalized preferences of BLV users. (1) Personalized Presets: Everyone responds differently to various social signals, and diverse feedback is needed to express one's personality. This approach helps foster a stronger sense of trust. We will consider using AI proxy technology to better assist BLV users in personalizing their social interactions. (2) Automatically: Considering real social interactions, these fleeting emotional exchanges are immediate, including responses to and changes in expressions. Therefore, our emotional output should be automated.

3.4.3 Design Consideration 3: A Wearable Form and Interaction Method that Fits the Party Setting. Many BLV users mentioned in their challenges that they worry about drawing too much attention, some products carry stigmatizing labels[19], or some products needing assistance from others to use devices creates inconvenience and trouble, and they hope products used in social settings would be more engaging and natural. Meanwhile, in Task 2, designers emphasized that to enhance everyday usability and social acceptability, some studies have shown that hand movements or "fidgeting" behaviors are frequently observed in BLV users with social anxiety[32]. To meet these needs, the role of the form of social assistive devices in social contexts is crucial[14, 39]. As a physical object, the fan has evolved into a signaling tool across different cultures. Thus, the fan serves as an ideal form for this interactive device. At the same time, choosing the right object as a social artifact is important. Previous studies[22, 88] have shown that social objects can help shift people's attention from one another to the object itself, reducing social pressure, while also facilitating social comfort. A suitable social object should have the right appearance and visibility to subtly signal the user's presence and social intentions, thereby enhancing interaction opportunities. Compared to previous assistive devices, the fan offers modern aesthetics with no obvious "disability" markers[22], while maintaining appropriate visibility. Moreover, the fan is held in the hand, and holding onto an object can be seen as a "physical anchor" that provides a sense of security, making it a perfect social interface.

In summary, based on previous studies and the challenges mentioned by BLV users in the formative study—including the inability to capture others' social cues, the inability to engage in timely facial expression interaction and communication with others, and feedback on existing assistive social tools—we have incorporated three design considerations in the design process of the interactive system. These include: using vibration feedback to provide recognition of nonverbal social cues; enabling AI-generated automatic expressions for facial expression interaction through personalized preference settings; and finally, combining the cultural and social attributes of fans as a medium for social expression in party social settings.

4 Design

We present *EmojiFan*, a novel AI-assisted wearable prototype designed to support BLV users in facial expression communication within party settings. By capturing others' nonverbal cues and enabling users to define expressive feedback personally through a fan-shaped display. BLV users using this prototype can not only receive social cues during the party settings, but also express them emotion quickly and in a personalized way.

Furthermore, to make it more natural, socially culturally appropriate, and comfortable for BLV users to use our interactive system in party settings, our interactive system interface employs an electronic fan that allows BLV users to freely pick up and put down at parties. The fan interface further empowers BLV users with control over social expression while serving as an engaging social tool.

In the following sections, we will elaborate on the design highlights of our prototype system, user workflow, and detailed software and hardware interactive system components.

4.1 Core Design Features

4.1.1 Using Fan as a Social Interface: Cultural Symbolism and Unobtrusive Social Interaction Considerations. In response to Design Consideration 3, *EmojiFan* allows users to respond to social cues by choosing whether to raise the fan. This design was influenced by the cultural symbolism of fans as nonverbal communication tools, where raising a fan has historically signified engagement and positive social signals such as "Desirous of acquaintance"[2, 18, 57]. Integrating this behavior into the interaction of *EmojiFan* ensures that they maintain a sense of autonomy in the party setting[40, 44]. Meanwhile, the action is subtle and natural[88], avoiding unnecessary attention from others and minimizing the negative symbolic load[19], which helps users engage in social interactions without feeling self-conscious or stigmatized and add to social comfort[22].

4.1.2 User-Defined Personalized Emotional Responses. According to design consideration 2, *EmojiFan* enables users to define their desired emotional responses to various social cues. For example, a user might specify, "When someone smiles at me, I want to respond with a smile." This customization feature allows users to have control over how *EmojiFan* responds to the social signals they encounter.

To ensure that the system aligns with the user's intentions, we designed a configuration process to map the user's emotional response preferences to the corresponding responses from *EmojiFan* to the social counterpart. The details of the configuration process are provided in the Appendix B.1.

4.2 User Flow

Before using *EmojiFan*, each user is asked ten questions about how they would like to respond to different social situations, such as "What expression would you like to show when someone smiles at you?". (The details are concluded in the Appendix B.2.5.) The user provides their preferences, which are then used to customize *EmojiFan*'s response settings. Once the preferences are set, the system generates a table of emotional responses tailored to the user's needs. The user is then shown these responses and asked if they align with their preferences. If any responses don't match, the process is repeated until the settings fully reflect the user's desired emotional reactions (as illustrated in Figure 5).

When using *EmojiFan*, the user wears a camera on their neck that detects the facial expressions of others. If a social cue is recognized, the system determines the direction of the person and activates the corresponding motor in the *EmojiFan* handle. There are three motors in the handle (left, middle, and right) that vibrate to indicate the direction of the social cue. The user can then turn towards the person. If the user chooses to respond, they can simply raise *EmojiFan*, and it will automatically display the predefined emotional response, allowing users to participate naturally in the interaction (as illustrated in Figure B1).

4.3 Hardware Implementation and Software Implementation

The software and hardware workflow of the entire system is illustrated in Figure 3. A detailed part of these issues is provided in Appendix B.1 and B.2. During the preset phase, we used a LoRA fine-tuned ChatGPT-4o to assist in analyzing users' natural language preferences and generating initial emoji tags. These were then used by Jimeng AI to create dynamic emoji animations, forming a personalized response mapping for each user.In the real-time recognition and feedback phase, an ESP32-CAM module, worn on the user's chest, captured a front-facing video stream and transmitted it to a computer via Wi-Fi. The video was processed using OpenCV and fed into our fine-tuned DeepFace model to recognize facial expressions in the social environment.Once a socially meaningful expression was detected, the system sent a feedback signal via Bluetooth to an Arduino MEGA2560 embedded in the fan handle. The MEGA2560, equipped with a vibration motor and gyroscope, first activated the motor to notify the user of a potential social cue. If the user chose to respond, raising the fan would be interpreted as a reply gesture. This movement was detected by the gyroscope and sent back to the computer. Upon receiving the signal, the Python program triggered the fan to display the corresponding emoji animation via Wi-Fi.

4.4 Ethical and Privacy Considerations

This subsection addresses ethical considerations in two areas, including (1) ethical and privacy considerations, (2) privacy and transparency concerns, a detailed part of these issues is provided in Appendix B.3.

5 User Study

As shown in Figure 6,in order to understand what challenges do BLV users face when using *EmojiFan* during the party settings, we conducted users experiment in party settings. Our party experiment included the following components: 1) Allowing BLV users to freely interact and communicate with sighted partners without using *EmojiFan*; 2) Allowing BLV users to interact freely with sighted partners while using *EmojiFan*; 3) Conducting semi-structured interviews with both BLV users and sighted partners on-site; 4) Having three researchers discuss observational data before and after the use of *EmojiFan*; 5) Conducting follow-up interviews with BLV users and sighted participants after the party experiment; 6) Organizing all collected data and conducting thematic analysis.

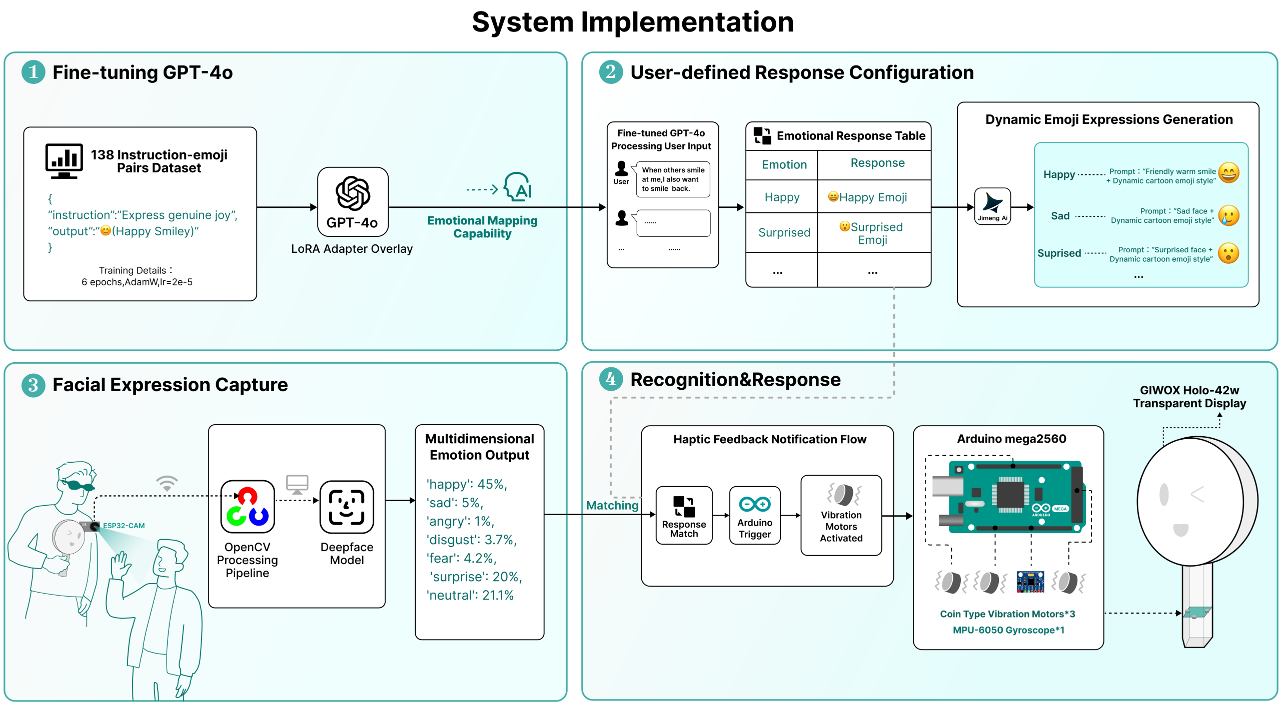


Figure 3: The system implementation.

5.1 Participants

5.1.1 BLV Users. In the formative study's user experiment on social software groups for BLV users, we continued to recruit BLV users for the user study. Due to voluntary participation and time constraints, six BLV users (P1-P6, 4 females and 2 males) participated in the study, aged between 18 and 39 years (mean age = 24.0, standard deviation = 6.88). The visual conditions and offline social frequency of the BLV participants are shown in Table 2. All BLV users received a 200 RMB reward after the activity. The user data involved in the experimental process and the content of the interviews have been permitted by the users and can be analyzed and applied. This study has been approved by our university's Institutional Review Board (IRB).

5.1.2 Sighted Partners. Additionally, we recruited eight sighted partners (S1-S8, 6 females and 2 males), aged between 18 and 40 years (mean age = 27.26, standard deviation = 6.74), to ensure our experiment closely mirrors a real party setting scenario. The details of the sighted participants are shown in Table 3. To maintain the social atmosphere of the gathering, we screened sighted partners to ensure they were socially active and outgoing. They also expressed curiosity about the lives of BLV users. Two sighted partners had previous experience interacting with individuals with BLV users. Recruitment was conducted through online university communities, and all participants clearly stated in the questionnaire (Appendix C.2) that they had no discriminatory attitudes toward individuals with disabilities. The user data involved in the experimental process and the content of the interviews have been permitted by the users and can be analyzed and applied. All sighted partners received a 200 RMB reward after the activity. This study has been approved by our university's Institutional Review Board (IRB).

5.1.3 Empirical Environment. To ensure ecological validity, the experiment simulated a social setting with six confederate researchers acting as partners and observers. (Full details are in the Appendix C.3.) Six observational researchers recorded interactions between six BLV users and sighted partners, both with and without *EmojiFan*. One staff member managed the experiment, adjusting camera angles, playing music, and providing refreshments, while another assisted with food, beverages, and safety. Later, three researchers with design backgrounds analyzed the recorded interactions, focusing on *EmojiFan* usage.

5.2 Study Procedure

In order to better understand what impact BLV users use the *EmojiFan* interactive system in the party setting, our experiment drew on the theory of bodystorming[71] and incorporated elements from previous research[83], with sighted partners acting as potential social partners. In the party setting, BLV users and sighted partners engaged in interactions both with and without the *EmojiFan* interaction system. The group with *EmojiFan* interactions required researchers to set up personalized emoji preferences for the BLV users in advance (details are provided in the Appendix C.1.) We conducted observational recordings and interviews to gather feedback

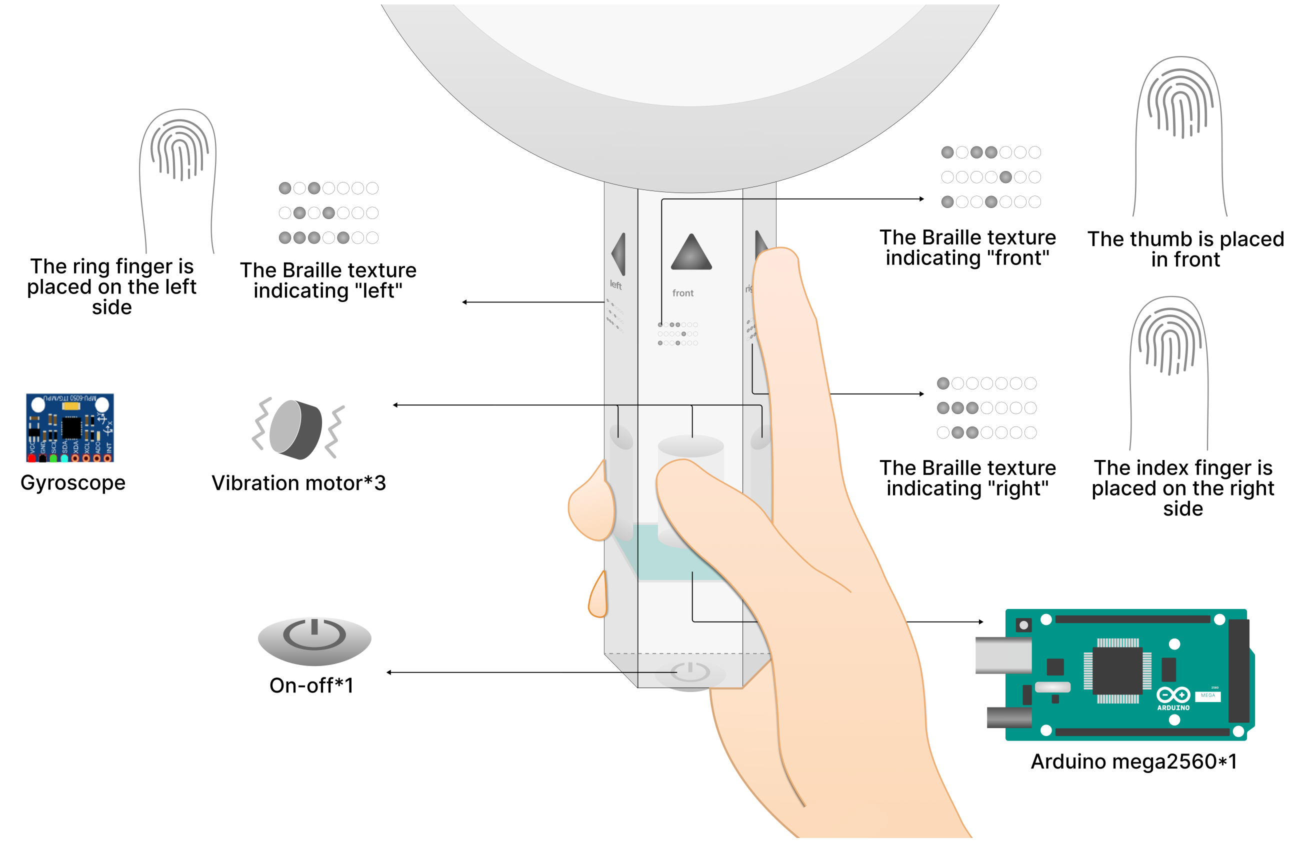


Figure 4: Hardware Implementation of the *EmojiFan* System.

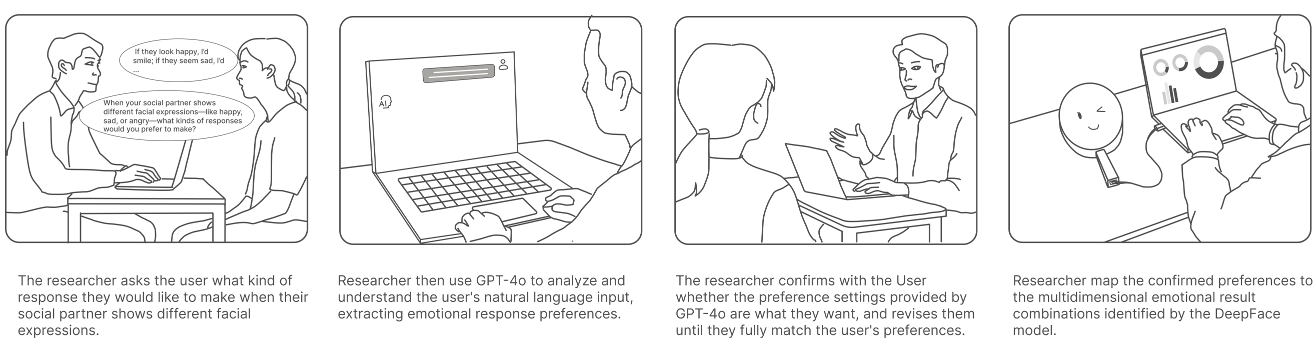


Figure 5: Process for mapping users’ emotional response preferences.

from all participants about their experiences with *EmojiFan*. After the party experiment, three researchers discussed the interaction videos recorded before and after the use of *EmojiFan* in the party scenario. After the experiment was concluded, we conducted follow-up interviews with the BLV users and sighted partners to further explore their feelings about *EmojiFan*. (The detailed procedure of the entire study is provided in the Appendix C.3.)

5.3 Data Collection and Analysis of Sighted Partners

Our primary data sets include: 1) Video data of interactions between BLV users and sighted partners, both with and without using *EmojiFan*; 2) Discussion video data from three researchers regarding the interaction videos; 3) Audio data from semi-structured interviews conducted with 6 BLV users and 8 sighted partners after the party experiment; 4) Audio data from follow-up phone interviews with

ID	Gender	Age	Occupation	Visual Impairment
P1	Female	22	Student	Congenitally Blind
P2	Male	21	Student	Blind
P3	Male	18	Student	Semi-Blind
P4	Female	23	Student	Light Perception
P5	Male	39	Professional Massage Therapist	Light Perception
P6	Female	21	Student	Blind

Table 2: User study 2: BLV Individuals' Information

ID	Gender	Age	Occupation
S1	Female	21	Student
S2	Female	27	Engineer
S3	Male	22	Student
S4	Female	26	Teacher
S5	Male	18	Student
S6	Female	40	Customer Service
S7	Female	33	Designer
S8	Male	31	Artist

Table 3: User study 2: Sighted People Participant Information

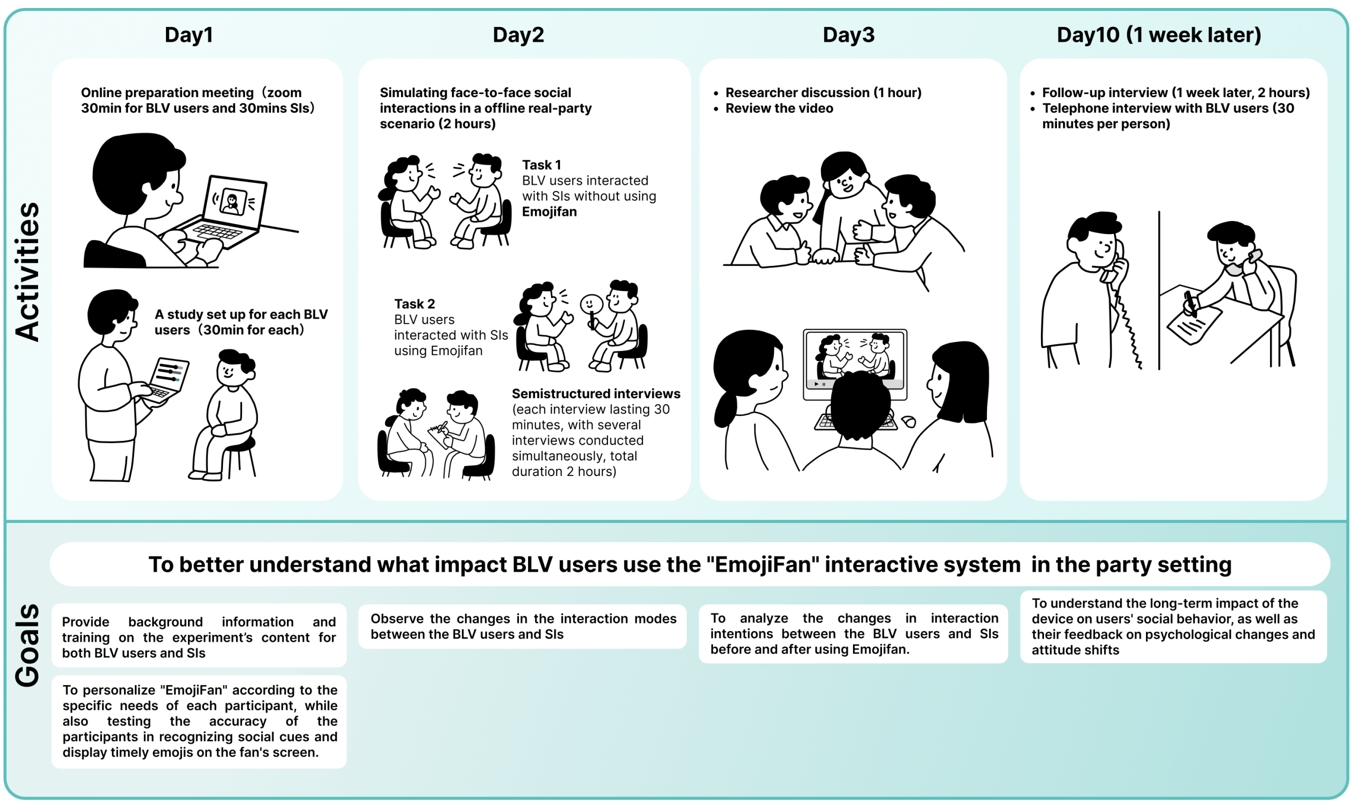


Figure 6: The process of user study.

BLV users and sighted partners later. (The detailed procedure of data collection and analysis part is provided in the Appendix C.4).

5.4 Results

5.4.1 Theme 1: EmojiFan Can Facilitate Ice-Breaking and Further Interaction for BLV Users. Our data analysis shows that when people with BLV users use *EmojiFan* for ice-breaking interactions, the emoji proxy function generated emojis are very interesting and attract social attention. As a result, sighted people are drawn to *EmojiFan* and use the emojis displayed on the fan as a topic to start a conversation. P1: *"Even if someone wants to talk to me, they might hesitate about how to start... but if I'm holding EmojiFan, they'll find it fun because I've responded with an emoji, and this makes it easier for us to start a conversation."* S6: *"When I looked at him, I saw that he was holding EmojiFan towards me with a cute wink emoji. I thought it was funny, and then we started talking. Later, I learned that this emoji was one that he (the BLV user) had set, so I asked him why he chose it, and he said he hoped it would attract me."*

In addition to ice-breaking time, the emoji proxy function also plays a role in conversations. Some BLV users see the *EmojiFan* emojis as a way to display their social status, emphasizing the dynamic and developmental changes during their social interactions rather than just instant attraction. For example, P6 said: *"Besides the playful emojis attracting others, I would always hold it near my chest. This way, during conversations, the other person can also see my emotional changes."* Similarly, our researchers found that these dynamic emoji changes also catch the attention of sighted people, further increasing physical contact and gestural expressions during conversation. This makes sighted people constantly focus on the emoji changes on the *EmojiFan*, linking them to the BLV person's emotions and thoughts. S4: *"Sometimes, I even ask him (the BLV person) why he's holding a crying emoji. I'm curious to know if the emoji reflects what he's thinking."*

The *EmojiFan* fan interface itself also facilitates interaction between both parties. Some BLV users have stated that using the fan as a social medium reduces the awkwardness of identity in party settings because the electronic fan feels particularly natural in this context. P3: *"I think your product (EmojiFan) is quite suitable because the fan can cover my face, and I can hold it beside me. I can place it sideways to help me express myself, and I can also use it to fan myself. People won't find it awkward; they will just find it interesting."*

Finally, our follow-up interviews further show BLV users have expressed a desire to continue using *EmojiFan* for ice-breaking in the future, indicating that it has a positive effect on interactions between BLV and sighted people. P3 expressed excitement about using *EmojiFan*'s emoji proxy function in other scenarios: *"I was on a plane going home, and someone started talking to me. But because I couldn't see, I wasn't sure if they were talking to me. At that moment, I thought, 'It would be great if I had an EmojiFan.'"* Some BLV users also mentioned that in travel situations, they would prefer the emojis to be displayed on a smaller interface. P4: *"If I could express my emotions on a small necklace, it might be more suitable for everyday scenarios, not just parties."*

In conclusion, *EmojiFan*, as an effective ice-breaking tool, whether through the emoji proxy function or using the fan as an interface, allows BLV users to naturally and comfortably express their facial expressions in party settings. It promotes interaction and communication between BLV and sighted people.

5.4.2 Theme 2: BLV Users Can Take the Initiative in Social Interactions when Using EmojiFan.

Our findings show that many BLV users actively take control of interactions when using *EmojiFan*. For example, some BLV users will raise the fan after receiving nonverbal cues to signal their intention to lead the conversation. P5: *"When everyone was laughing, I thought about drawing their attention, so I picked up the fan again. I felt this way everyone would listen to me."* Similarly, when BLV users are faced with topics they are not interested in, they will put the fan down as a way to signal their lack of desire to respond. P6: *"They were talking about anime characters for a long time, which I don't really like. After a while, I didn't want to continue, so putting down the fan became a way to signal that I wanted to end the conversation. It felt very good, much smoother than before, because sighted people usually don't know whether I want to keep talking."* Sighted people can also pick up on these signals of rejection through the fan. S4: *"I noticed that when I looked at him, his fan vibrated but he didn't raise it. I understood that he didn't want to talk to me."*

Indeed, this proactive control is expressed through the interaction with the fan itself. Similarly, BLV users can also use *EmojiFan*'s vibration feedback feature to gain awareness of their surrounding environment. P5: *"I will keep using it during the conversation. I need to get more information about the other person's facial expressions. For example, it would be better if it could tell me about the changes in the other person's expressions through different frequencies."* This information allows them to actively control the atmosphere of the conversation, such as creating humor, preventing awkward silences, and better expressing their own personality. P4: *"I noticed there hadn't been any vibrations for a while, and he wasn't talking, so I picked up the fan and told him a funny joke. This made me feel like a real participant, not just a passive person talking to someone else."*

In summary, BLV users have the right to access more nonverbal information from their surroundings through the fan during interactions, as well as the freedom to choose whether or not to respond with facial emojis.

5.4.3 Theme 3: EmojiFan can Enhance the Empathy of Sighted Individuals towards BLV Individuals.

Our *EmojiFan* system indirectly enhanced sighted people's ability to empathize with BLV individuals during the experiment. Almost all sighted participants were able to understand the current emotions of BLV users by observing the changes in the *EmojiFan*'s expressions. S5 said, *"I saw her fan change from happy to crying, and when I asked her about it, she quickly hid the EmojiFan, as if she had exposed her feelings."* When unsure whether the emotion displayed was accurate, sighted people would further communicate with the BLV users. S2 *"Sometimes I would ask a BLV person why they were showing a crying emoji. He humorously responded that he didn't know either, so when I couldn't distinguish his true thoughts, I would double-check."* These behaviors helped sighted people begin to notice the emotional and mental changes in the BLV users during the conversation, reducing subtle barriers.

Additionally, our researchers observed that sighted people reacted differently before and after using *EmojiFan*. Before using *EmojiFan*, sighted people were reluctant to communicate with BLV users. They avoided eye contact and appeared awkward and insecure during interactions. Researcher 1 noted, *"I sensed a sense of inequality. It seemed like the sighted people didn't really want to talk to them or didn't know how to start the conversation."* The sighted people had many unnatural gestures. They kept touching their hair and looking around at other people. When the BLV users tried to initiate social interactions, misunderstandings often led to awkward situations. Researcher 2 noted *"One BLV user mustered the courage to talk to a sighted person, but the sighted person was busy with something else and could only awkwardly ask them to move aside. If they had received a signal from the other person about the intention to socialize, this rejection wouldn't have happened."*

However, when using *EmojiFan*, communication became much smoother for sighted people. The feedback from facial expressions allowed them to engage in continuous conversation. Researchers observed that sighted people were more focused when communicating with BLV users who used *EmojiFan*. They made fewer hand gestures and provided more nods and eye contact. S1 said, *"For someone like me who is used to looking directly at the other person's face during a conversation, this is a great medium. At first, the BLV user faced me with their ears, which made it hard for me to focus and quickly ended the conversation."* S3 added, *"For someone who is more introverted, the fan is a great solution. It doesn't require me to look directly into the other person's eyes and avoids the tension of face-to-face communication, while still allowing me to face the other person and talk. This helps me focus and engage in the conversation more naturally."*

In conclusion, our *EmojiFan* system not only helps sighted people better understand the emotions of BLV users, but also makes conversations between BLV and sighted individuals smoother, with more topics to discuss, creating a more intimate and comfortable interaction.

5.4.4 Theme 4: The EmojiFan Interaction System is Better Suited For Party Settings. Party settings often involve noisy, brief, and impromptu conversations. In this particular environment, many BLV users are willing to use the personalized emojis generated by *EmojiFan* to break the ice. P1: *"It (EmojiFan) allows me to be more proactive, and it's easy to attract others. It's very popular at parties. For example, I might hold up a fan and ask people around me what emotion the AI has generated, then strike up a conversation."* However, during interviews, some BLV users also expressed a desire to better understand the real-time facial expressions conveyed by the *EmojiFan* interaction system, rather than the unknown. *P4: "But I feel like long conversations make me anxious. It's good for breaking the ice at a party, but I don't know what expression it's showing. I would put it down and wait for the right moment to use it."*

Some BLV users also suggested that in more serious settings, they would prefer the interface to be less noticeable. They hope that the automatic emoji proxy interface could be adapted to different contexts. P6: *"I was on a plane going home, and someone started talking to me. But because I couldn't see, I wasn't sure if they were talking to me. At that moment, I thought, 'It would be great if I had EmojiFan, but it should be small, like a necklace, so others can see it without it being too obvious. Even if the expression is wrong, it wouldn't matter.'"*

Additionally, some BLV users expressed a desire to receive more information about the other person, not just emotional cues through vibration. P2: *"I hope that in the future, the device can provide more information through earphone feedback, such as recognizing whether the person approaching is a man, woman, or child, instead of just giving a social signal or the other person's expression."*

As a special scenario, party settings play a significant role in using *EmojiFan*'s emoji proxy for ice-breaking. BLV users have offered more expectations and suggestions for future scenarios where *EmojiFan* could be adapted.

6 Discussion

The paper reveals central challenges to BLV users include a need for expression cues, richer facial cues, and a willingness to engage with technology. The results lead to the creation of *EmojiFan*, which allowed for unobtrustive hints, personalized expressions, timely feedback, using AI-based personalization and built-in social aforadances. Further, results highlight the need for social autonomy, equitable conversation, augmentation of sighted participants, respect for the complexities of eye contact and visual conversation cues, visual conversational presence, and natural interaction avoiding awkwardness. Each of these themes are discussed alongside design implications to build upon in future work.

6.1 *EmojiFan* Empowers BLV Individuals' Social Comfort to Establish Social Connections

Social Comfort refers to the ease with which people engage in social interactions[54, 81]. *EmojiFan* addresses this challenge by adopting the fan as a tangible interaction modality, thereby granting BLV individuals greater social agency: (1) Enhancing social presence. By embedding digital expressive capabilities into this familiar object, as mentioned in Theme 1 5.4.1, *EmojiFan* enables BLV users to engage in social signaling. When displaying dynamic emojis, the fan can attract the attention of social partners, increasing BLV users' visibility and allowing them to express aspects of their social identity, such as emotions and intentions. (2) Enhancing social confidence. As mentioned in Theme 2 5.4.2. By utilizing a handheld fan, *EmojiFan* avoids design features typically associated with disability, thereby reducing stigma and enabling the device to integrate seamlessly into social contexts. Its form aligns with the cultural tradition of objects as communicative devices, carrying connotations of status, gender, and etiquette[18, 57]. Moreover, because the fan is held in the hand, this tangible artifact functions as a "physical anchor" that offers a sense of security. This grounding effect makes the fan an effective social interface, thereby promoting comfort during interpersonal interactions. Importantly, *EmojiFan* provides subtle vibration feedback that allows users to engage naturally in social situations without drawing unwanted attention. In this way, these several thoughtful design considerations empathically support social autonomy, allowing BLV individuals to engage in social activities with greater confidence and independence. In party settings, these points enhance visibility through dynamic emojis, promote comfort with subtle feedback and a physical anchor, and help users express their social identity, making interactions feel natural and contextually appropriate.

6.1.1 Design implications 1: Incorporating Unobtrusive Interaction into Accessibility Interface Design. Technology for accessibility should minimize disruption to natural behavior during social interactions[30, 43, 51]. During our study, BLV users could naturally perceive nonverbal cues in their surroundings through vibration feedback. Moreover, the fan can serve as a medium for a social assistance interface. This illustrates how unobtrusive interaction can enhance autonomy for BLV individuals in social settings. We recommend that designers adopt unobtrusive interaction strategies when creating tangible interfaces for BLV users in social contexts. This may include employing subtle interaction modalities, leveraging everyday objects as interaction carriers, and considering the cultural attributes embedded in these social interfaces. Prior work has shown that unobtrusive sensing can reduce the social stigma commonly associated with assistive devices[51]. Over time, such design strategies may enable a new class of social accessibility artifacts that are seamlessly integrated into everyday cultural practices—shifting assistive tools from markers of difference to enablers of participation. Conversely, neglecting unobtrusiveness risks producing designs that remain cumbersome, conspicuous, and ultimately marginalizing.

6.2 *EmojiFan* Facilitates BLV Individuals' Social Autonomy to Establish Social Connections

Autonomy is central to social connectedness, as individuals experience greater confidence and interpersonal satisfaction when they can freely initiate, regulate, and terminate social interactions[47, 91]. Our formative study showed that BLV individuals often assume a passive social role in party settings because they have limited access to the rich non-verbal signals that typically guide interpersonal engagement. To address this challenge, *EmojiFan* is designed to capture, interpret, and translate social signals in ways that help shift BLV individuals from passive responders to active participants who can influence the rhythm and flow of conversation. First, *EmojiFan* performs facial-expression recognition in social settings and provides immediate haptic feedback, enhancing users' ability to engage with others on equal footing. Second, beyond simply augmenting gaze perception, *EmojiFan* broadens access to a wider spectrum of facial expressions, enabling BLV users to actively respond to nuanced social cues. Therefore, *EmojiFan* enables BLV individuals to both increase their interactions with sighted people (e.g., Theme 1: drawing others in, allowing them to read the emoji, empathize, and initiate conversation) and exercise social agency (e.g., Theme 2: freely choosing when to "pick up" or "put down" the fan to respond to others or express their viewpoints).

6.2.1 Design implications 2: Consider Harnessing Perception and Response to Social Cues When Designing Social Assistive Systems. We recommend that designers create systems that not only help BLV users perceive social cues but also support real-time responses to these cues, thereby enhancing their ability to actively participate in social interactions. Prior assistive technologies for BLV individuals often focus solely on compensating for sensory deficits, overlooking the challenges users face in proactively engaging in conversations[13, 34]. Enabling BLV users to respond quickly and naturally to social cues can transform passive interactions into more dynamic and empowering social experiences (e.g., Theme 2: By displaying the emoji on the fan, BLV users can catch people's attention and spark them to speak up first.). This shift from passive reception to active engagement can increase users' confidence and autonomy in social settings, fostering deeper involvement and greater participation in social activities. By prioritizing both the perception and the response to social signals, designers can develop more inclusive, empowering communication tools that better support BLV individuals in navigating social environments.

6.3 AI Proxies Facilitates Rapid, Dynamic Social Experiences in Party Scenarios

In party-like social settings, interactions between people are typically rapid and dynamic[10]. Social interactions often rely on rapid exchanges of non-verbal cues such as eye contact, nodding, and smiling. For BLV individuals, the inability to perceive these cues can hinder their participation and sense of inclusion in social settings. Prior research has shown that AI proxies can assist BLV individuals in navigating social activities more effectively[58, 64]. In our study, we found that *EmojiFan* supports BLV users in two complementary ways. First, it enables users to personalize their responses to social cues. To reduce risks of interpreter bias or AI bias, we incorporated cartoon-style emojis as the expressive medium, providing a neutral and culturally inclusive form of communication that minimizes misinterpretation and promotes clearer social interaction. Second, *EmojiFan* automatically adjusts its digital expressions based on the facial changes of social partners in real time. Our findings further validate and extend existing work by demonstrating that the ambiguity inherent in AI proxies, when strategically leveraged, can enhance the diversity and flexibility of user experiences. This productive ambiguity allows interactions to remain open-ended and adaptable, offering BLV individuals more engaged social experience in fast-paced environments.

6.3.1 Design implications 3: Incorporating Ambiguity in Digital Proxies to Facilitate Social Ice-Breaking in Accessibility Interface Design. The ambiguity of AI proxies has been recognized in prior work as an unavoidable and often productive aspect of mediated interaction[77]. In *EmojiFan*, we did not attempt to eliminate this ambiguity; instead, we embraced it as part of the social interaction experience. During the study, we observed that in certain situations, ambiguous social feedback helped break social barriers and initiate conversations (e.g., Theme 3: When sighted partners notice the emoji on the fan change during chat, they often ask the BLV user about the mood shift, or the emoji draws them into deeper conversation.). Based on this insight, we recommend that designers consider ambiguity as a design resource when developing social assistive devices. In dynamic and rapidly changing social environments such as parties, well-managed ambiguity can make interactions more playful and effectively facilitate social ice-breaking.

The theory of uncertainty reduction suggests that appropriately calibrated ambiguity in communication can foster curiosity, prompt engagement, and deepen interaction when managed creatively[49]. In social settings, this implies that designers can move beyond using AI proxies as purely accurate or deterministic representations. Instead, they can strategically adjust the level of ambiguity in AI-generated feedback—whether through unexpected sounds, vibrations, or expressive cues—to blur the boundaries between social interaction and self-expression, thereby fostering more engaging and inviting interaction experiences (As the BLV participants envisioned in Theme 4 for future AI-generated feedback for function and interface).

6.4 *EmojiFan* Augments Sighted Individuals' Attention to the Social Needs of BLV Individuals

When designing social assistive systems, attention should be given to visibility and attention. Previous research has suggested that systems that make participants and their activities visible to one another can help users maintain group collaboration[25]. Our findings confirm this idea and, further, we extend it to facilitate the attention of social participants. *EmojiFan* was found to enhance the attentional focus of sighted participants during interactions. In typical conversations, sighted individuals often reported being easily distracted—looking away, fidgeting with their hands, or shifting their gaze (Theme 3). With *EmojiFan*, however, they could continuously observe a stream of dynamic facial expressions, which provided a clear visual target, made conversations more interactive, and encouraged them to respond more attentively.

6.4.1 Design implications 4: Consider Enhancing Social Connectedness Between BLV and Sighted Individuals Through Attention Augmentation. Assistive systems should not only empower BLV individuals but also provide resources that anchor the attention of sighted participants. Prior work on interactional synchrony[31] suggests that conversational partners typically coordinate their body postures and attentional orientations unconsciously. When one party's body orientation deviates from expectations (e.g., Theme 4: when a BLV user faces the speaker with their ear, breaking the expected nonverbal interaction pattern), this may cause interactional asynchrony, making it difficult for the speaker to maintain focus. Thus, by offering a shared expressive focus, systems like *EmojiFan* can reduce distraction, support more sustained engagement, and encourage equitable contributions from both sides. Promoting this approach can foster deeper empathy, reducing social anxiety, and enhancing engagement in conversations, particularly in scenarios where direct eye contact can be difficult or uncomfortable. On the other hand, the cons of not considering such a design could perpetuate awkward, passive interactions, limiting BLV users' social participation and self-expression.

6.5 Limitation and Future Work

Our discussion addresses multiple aspects, including the unobtrusive interaction between BLV individuals and sighted people, the unique characteristics of party settings match *EmojiFan* system, the agency that BLV users gain through *EmojiFan*, and the impact of *EmojiFan* on communication from the perspective of sighted individuals. However, further considerations can be made.

First, BLV users cannot know what emoji expression is displayed on the fan in real time. In Theme 4 of the results, some BLV participants mentioned these concerns and indicated that such concerns would be amplified outside of the party context. Particularly when BLV users envisioned future usage scenarios for *EmojiFan*, they expressed a desire to learn the content of the emoji on the fan through alternative means, including text prompts and richer haptic cues, and design and develop appropriate interfaces tailored to different usage scenarios. Finally, future work will explore the portability of the system and robustness in other social areas outside the party scenario including, but not limited to, public transit, hallway interactions, and outdoor events.

Second, there are potential ambiguities in information transmission within our interactive system, as well as AI biases and privacy concerns arising from data training. Regarding ambiguous information transmission, this includes ambiguities in the AI-generated emoji workflow and individual differences in emoji interpretation when emojis are conveyed to sighted individuals. Our interactive system optimizes these potential ambiguity issues as much as possible through design strategies such as using a cute animated style to enhance emoji interpretability and allowing users to freely control whether emojis are transmitted via the fan interface. Regarding issues with AI data training—such as facial analysis errors when the DeepFace component of the *EmojiFan* software recognizes social partners, and errors in emoji generation—we have optimized the software system as much as possible and increased the number of robust personalized fine-tuning iterations for BLV users, and ensured data privacy of BLV users as outlined in the Appendix B.3. However, potential ambiguities in information transmission and AI biases from data training remain unavoidable. In the future, we will further optimize the biases present in the system by employing better design strategies to reduce information bias through interactive approaches, adding more training data, and refining the model architecture.

Finally, our entire experiment was conducted in a simulated party environment, which ensured experimental safety, privacy, and controllability. However, this also means that we did not fully replicate the complex phenomena of an actual party environment, which may have limited the final results and reduced the richness of the findings. In future work, we will consider using comprehensive tracking methods to document how BLV users use the prototype in real party settings, thereby obtaining more diverse and varied results and increasing the contribution of the research.

7 Conclusion

In this paper, we conducted a formative study with 10 BLV users to explore their challenges and expectations regarding facial expression interaction in party settings. Guided by these insights, we designed *EmojiFan*, an AI-assisted smart fan that provides a personalized proxy of facial expressions and conveys them through dynamic, expressive emojis. We further evaluated *EmojiFan* with six BLV users in a user study, demonstrating its effectiveness in facilitating facial expression interaction in party settings and discussing broader implications for using AI proxy of facial expressions communication.

8 Acknowledgments of the Use of AI

We extend our heartfelt gratitude to all participants who took part in this research, sharing their time and insights. We also thank reviewers for their time and effort in fostering a better version of this paper. We would like to thank National Science Engineering Research Council of Canada NSERC R36100 for their support of HCI4Good Research. We used AI for the following: prototypes, manuscript shortening, grammar correction, and transcription of audio recordings into text. Details can be found in the relevant sections.

These prompts include: "Please help me translate this text," "Please help me check the grammar issues in this text," and "Please help me check if the sizes on this page are written incorrectly." "Translate this audio file into text for me, and extract the key themes." The authors take full responsibility for the output and use of AI in this paper.

References

[1] 2024. OrCam MyEye 3 Pro - Revolutionize Your Vision with Cutting-Edge AI Technology. https://www.orcam.com/en-us/orcam-myeye-3-pro?srsltid=AfmBOoqnQ-i2-4NqwQ2bGAxpM-8h2tUF81G3_2k9xjMun69F2DNdfxQ3

[2] 2024. The language of the fan. https://alwaysausten.com/2024/09/24/the-language-of-the-fan/?utm_source=chatgpt.com

[3] Taslima Akter. 2020. Privacy considerations of the visually impaired with camera based assistive tools. In *Companion Publication of the 2020 Conference on Computer Supported Cooperative Work and Social Computing*. 69–74.

[4] ASM Iftekhar Anam, Shahinur Alam, and Mohammed Yeasin. 2014. Expression: A dyadic conversation aid using Google Glass for people who are blind or visually impaired. In *6th International Conference on Mobile Computing, Applications and Services*. IEEE, 57–64.

[5] Dane Archer and Robin M Akert. 1977. Words and everything else: Verbal and nonverbal cues in social interpretation. *Journal of personality and social psychology* 35, 6 (1977), 443.

[6] Michael Argyle, Mark Cook, and Duncan Cramer. 1994. Gaze and mutual gaze. *The British Journal of Psychiatry* 165, 6 (1994), 848–850.

[7] Qiyu Bai, Qi Dan, Zhe Mu, and Maokun Yang. 2019. A systematic review of emoji: Current research and future perspectives. *Frontiers in psychology* 10 (2019), 476737.

[8] Darlene Barker, Mukesh Kumar Reddy Tippireddy, Ali Farhan, and Bilal Ahmed. 2025. Ethical Considerations in Emotion Recognition Research. *Psychology International* 7, 2 (2025). doi:10.3390/psycholint7020043

[9] Adrian Bolesnikov, Jin Kang, and Audrey Girouard. 2022. Understanding Tabletop Games Accessibility: Exploring Board and Card Gaming Experiences of People who are Blind and Low Vision. In *Proceedings of the Sixteenth International Conference on Tangible, Embedded, and Embodied Interaction* (Daejeon, Republic of Korea) *(TEI '22)*. Association for Computing Machinery, New York, NY, USA, Article 21, 17 pages. doi:10.1145/3490149.3501327

[10] Simone Boogaarts-de Bruin. 2011. *Something for everyone?: Changes and choices in the ethno-party scene in urban nightlife.* Amsterdam University Press.

[11] Isabelle Boutet, Megan LeBlanc, Justin A Chamberland, and Charles A Collin. 2021. Emojis influence emotional communication, social attributions, and information processing. *Computers in Human Behavior* 119 (2021), 106722.

[12] Audun Brunes, Marianne B. Hansen, and Trond Heir. 2019. Loneliness among adults with visual impairment: prevalence, associated factors, and relationship to life satisfaction. *Health and quality of life outcomes* 17, 1 (2019), 24.

[13] Hendrik P Buimer, Marian Bittner, Tjerk Kostelijk, Thea M Van Der Geest, Abdellatif Nemri, Richard JA Van Wezel, and Yan Zhao. 2018. Conveying facial expressions to blind and visually impaired persons through a wearable vibrotactile device. *PloS one* 13, 3 (2018), e0194737.

[14] Andreas Butz. 2010. User interfaces and HCI for ambient intelligence and smart environments. In *Handbook of ambient intelligence and smart environments*. Springer, 535–558.

[15] Maria Claudia Buzzi, Marina Buzzi, Barbara Leporini, and Fahim Akhter. 2010. Is Facebook really "open" to all?. In *2010 IEEE International Symposium on Technology and Society*. 327–336. doi:10.1109/ISTAS.2010.5514621

[16] Jazmin Collins, Crescentia Jung, Yeonju Jang, Danielle Montour, Andrea Stevenson Won, and Shiri Azenkot. 2023. "The Guide Has Your Back": Exploring How Sighted Guides Can Enhance Accessibility in Social Virtual Reality for Blind and Low Vision People. In *Proceedings of the 25th International ACM SIGACCESS Conference on Computers and Accessibility* (New York, NY, USA) *(ASSETS '23)*. Association for Computing Machinery, New York, NY, USA, Article 38, 14 pages. doi:10.1145/3597638.3608386

[17] Jazmin Collins, Kaylah Myranda Nicholson, Yusuf Khadir, Andrea Stevenson Won, and Shiri Azenkot. 2024. An AI Guide to Enhance Accessibility of Social Virtual Reality for Blind People. In *Proceedings of the 26th International ACM SIGACCESS Conference on Computers and Accessibility* (St. John's, NL, Canada) *(ASSETS '24)*. Association for Computing Machinery, New York, NY, USA, Article 130, 5 pages. doi:10.1145/3663548.3688498

[18] Hugh Davies. 2019. Fanology: Hand-fans in the prehistory of mobile devices. *Mobile Media & Communication* 7, 3 (2019), 303–321.

[19] Aline Darc Piculo Dos Santos, Ana Lya Moya Ferrari, Fausto Orsi Medola, and Frode Eika Sandnes. 2022. Aesthetics and the perceived stigma of assistive technology for visual impairment. *Disability and Rehabilitation: Assistive Technology* 17, 2 (2022), 152–158.

[20] Paul Dumouchel. 2005. Trust as an action. *European Journal of Sociology/Archives européennes de sociologie* 46, 3 (2005), 417–428.

[21] Joanna C Dunlap, Devshikha Bose, Patrick R Lowenthal, Cindy S York, Michael Atkinson, and Jim Murtagh. 2016. What sunshine is to flowers: A literature review on the use of emoticons to support online learning. *Emotions, technology, design, and learning* (2016), 163–182.

[22] Vernandi Dyzel, Rony Oosterom-Calo, Mijkje Worm, and Paula S Sterkenburg. 2020. Assistive technology to promote communication and social interaction for people with deafblindness: a systematic review. In *Frontiers in Education*, Vol. 5. Frontiers Media SA, 578389.

[23] Paul Ekman. 1992. Are there basic emotions? (1992).

[24] Paul Ekman, Tim Dalgleish, and M Power. 1999. Basic emotions. *San Francisco, USA* (1999).

[25] Thomas Erickson and Wendy A Kellogg. 2000. Social translucence: an approach to designing systems that support social processes. *ACM transactions on computer-human interaction (TOCHI)* 7, 1 (2000), 59–83.

[26] Be My Eyes. 2024. Introducing: Be My AI.

[27] David Grazian. 2009. Urban nightlife, social capital, and the public life of cities 1. In *Sociological Forum*, Vol. 24. Wiley Online Library, 908–917.

[28] Chitralekha Gupta, Ashwin Ram, Shreyas Sridhar, Christophe Jouffrais, and Suranga Nanayakkara. 2025. Scene-to-Audio: Distant Scene Sonification for Blind and Low Vision People. In *Proceedings of the Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '25)*. Association for Computing Machinery, New York, NY, USA, Article 471, 9 pages. doi:10.1145/3706599.3719849

[29] Nikki Heinze and Lee Jones. 2024. Social functioning in adults with visual impairment from minority ethnic communities in the United Kingdom. *Frontiers in public health* 12 (2024), 1277472.

[30] Linda Hirsch, Christina Schneegass, Robin Welsch, and Andreas Butz. 2021. To See or Not to See: Exploring Inattentional Blindness for the Design of Unobtrusive Interfaces in Shared Public Places. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 5, 1 (2021), 1–25.

[31] Stefanie Hoehl, Merle Fairhurst, and Annett Schirmer. 2021. Interactional synchrony: signals, mechanisms and benefits. *Social cognitive and affective neuroscience* 16, 1-2 (2021), 5–18.

[32] Stefan G Hofmann and Stella Bitran. 2007. Sensory-processing sensitivity in social anxiety disorder: Relationship to harm avoidance and diagnostic subtypes. *Journal of anxiety disorders* 21, 7 (2007), 944–954.

[33] Hyukjae Jang, Sungwon P Choe, Simon NB Gunkel, Seungwoo Kang, and Junehwa Song. 2016. A system to analyze group socializing behaviors in social parties. *IEEE Transactions on Human-Machine Systems* 47, 6 (2016), 801–813.

[34] Divya Jindal-Snape. 2004. Generalization and maintenance of social skills of children with visual impairments: Self-evaluation and the role of feedback. *Journal of Visual Impairment & Blindness* 98, 8 (2004), 470–483.

[35] Ómar I Jóhannesson, Oana Balan, Runar Unnthorsson, Alin Moldoveanu, and Árni Kristjánsson. 2016. The sound of vision project: on the feasibility of an audio-haptic representation of the environment, for the visually impaired. *Brain sciences* 6, 3 (2016), 20.

[36] Gabriella M. Johnson and Shaun K. Kane. 2020. Game changer: accessible audio and tactile guidance for board and card games. In *Proceedings of the 17th International Web for All Conference* (Taipei, Taiwan) *(W4A '20)*. Association for Computing Machinery, New York, NY, USA, Article 9, 12 pages. doi:10.1145/3371300.3383347

[37] Katherine Jones, Martin Grayson, Cecily Morrison, Ute Leonards, and Oussama Metatla. 2025. "Put Your Hands Up": How Joint Attention Is Initiated Between Blind Children And Their Sighted Peers. In *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems (CHI '25)*. Association for Computing Machinery, New York, NY, USA, Article 555, 18 pages. doi:10.1145/3706598.3714005

[38] Crescentia Jung, Jazmin Collins, Ricardo E. Gonzalez Penuela, Jonathan Isaac Segal, Andrea Stevenson Won, and Shiri Azenkot. 2024. Accessible Nonverbal Cues to Support Conversations in VR for Blind and Low Vision People. In *Proceedings of the 26th International ACM SIGACCESS Conference on Computers and Accessibility* (St. John's, NL, Canada) *(ASSETS '24)*. Association for Computing Machinery, New York, NY, USA, Article 20, 13 pages. doi:10.1145/3663548.3675663

[39] Heekyoung Jung and Erik Stolterman. 2011. Form and materiality in interaction design: a new approach to HCI. In *CHI'11 Extended Abstracts on Human Factors in Computing Systems*. 399–408.

[40] Antti Kauppinen. 2011. The social dimension of autonomy. *Axel Honneth: Critical Essays* (2011), 255–302.

[41] Daniel Killough, Justin Feng, Zheng Xue Ching, Daniel Wang, Rithvik Dyava, Yapeng Tian, and Yuhang Zhao. 2025. VRSight: An AI-Driven Scene Description System to Improve Virtual Reality Accessibility for Blind People. In *Proceedings of the 38th Annual ACM Symposium on User Interface Software and Technology (UIST '25)*. Association for Computing Machinery, New York, NY, USA, Article 49, 17 pages. doi:10.1145/3746059.3747641

[42] Daniel Killough, Justin Feng, Rithvik Dyava, Zheng Xue "ZX" Ching, Daniel Wang, Yapeng Tian, and Yuhang Zhao. 2025. Demonstration of VRSight: AI-Driven Real-Time Descriptions to Enhance VR Accessibility for Blind People. In *Proceedings of the Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '25)*. Association for Computing Machinery, New York, NY, USA, Article 724, 5 pages. doi:10.1145/3706599.3721194

[43] Hyunjung Kim and Woohun Lee. 2009. Designing unobtrusive interfaces with minimal presence. In *CHI'09 Extended Abstracts on Human Factors in Computing Systems*. 3673–3678.

[44] Jinho Kim, Gum-Ryeong Park, and Eun Ha Namkung. 2024. The link between disability and social participation revisited: heterogeneity by type of social participation and by socioeconomic status. *Disability and Health Journal* 17, 2 (2024), 101543.

[45] Neal Kingston and Brooke Nash. 2011. Formative assessment: A meta-analysis and a call for research. *Educational measurement: Issues and practice* 30, 4 (2011), 28–37.

[46] Susanne Klauke, Chloe Sondocie, and Ione Fine. 2023. The impact of low vision on social function: The potential importance of lost visual social cues. *Journal of Optometry* 16, 1 (2023), 3–11.

[47] Esther S Kluwer, Johan C Karremans, Larisa Riedijk, and C Raymond Knee. 2020. Autonomy in relatedness: How need fulfillment interacts in close relationships. *Personality and Social Psychology Bulletin* 46, 4 (2020), 603–616.

[48] Mark L Knapp, Judith A Hall, and Terrence G Horgan. 1978. *Nonverbal communication in human interaction*. Vol. 1. Holt, Rinehart and Winston New York.

[49] Leanne K Knobloch. 2008. Uncertainty reduction theory. *Engaging theories in interpersonal communication* (2008), 133–144.

[50] Takayuki Komoda, Hisham Elser Bilal Salih, Tadashi Ebihara, Naoto Wakatsuki, and Keiichi Zempo. 2024. Auditory Interface for Empathetic Synchronization of Facial Expressions between People with Visual Impairment and the Interlocutors. In *Proceedings of the Augmented Humans International Conference 2024*. ACM, Melbourne VIC Australia, 138–147. doi:10.1145/3652920.3652937

[51] Tiffany CK Kwok, Peter Kiefer, and Martin Raubal. 2024. Unobtrusive interaction: a systematic literature review and expert survey. *Human–Computer Interaction* 39, 5-6 (2024), 380–416.

[52] Hae-Na Lee and Vikas Ashok. 2022. Impact of Out-of-Vocabulary Words on the Twitter Experience of Blind Users. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (New Orleans, LA, USA) *(CHI '22)*. Association for Computing Machinery, New York, NY, USA, Article 608, 20 pages. doi:10.1145/3491102.3501958

[53] Shan Luo, Jianan Johanna Liu, and Botao Amber Hu. 2024. Designing a Safe Auditory-Cued Archery Exertion Game for the Visually Impaired and Sighted to Enjoy Together. In *Proceedings of the 26th International ACM SIGACCESS Conference on Computers and Accessibility* (St. John's, NL, Canada) *(ASSETS '24)*. Association for Computing Machinery, New York, NY, USA, Article 102, 6 pages. doi:10.1145/3663548.3688510

[54] Daniel Miller. 2017. *The comfort of people*. John Wiley & Sons.

[55] Lauren R. Milne, Cynthia L. Bennett, Richard E. Ladner, and Shiri Azenkot. 2014. BraillePlay: educational smartphone games for blind children. In *Proceedings of the 16th International ACM SIGACCESS Conference on Computers & Accessibility* (Rochester, New York, USA) *(ASSETS '14)*. Association for Computing Machinery, New York, NY, USA, 137–144. doi:10.1145/2661334.2661377

[56] Cecily Morrison, Ed Cutrell, Martin Grayson, Geert Roumen, Rita Faia Marques, Anja Thieme, Alex Taylor, and Abigail Sellen. 2021. PeopleLens. *Interactions* 28, 3 (April 2021), 10–13. doi:10.1145/3460116

[57] Anna Myers. 2025. 'Gestures Proper to Each of Them': Shakespeare and the Mediation of Gendered Social Exchange in Eighteenth-Century England. *Journal for Eighteenth-Century Studies* 48, 3 (2025), 327–353.

[58] Prudhvi Naayini, Praveen Kumar Myakala, Chiranjeevi Bura, Anil Kumar Jonnalagadda, and Srikanth Kamatala. 2025. AI-Powered Assistive Technologies for Visual Impairment. arXiv:2503.15494 [cs.HC] https://arxiv.org/abs/2503.15494

[59] Mala D Naraine and Peter H Lindsay. 2011. Social inclusion of employees who are blind or low vision. *Disability & Society* 26, 4 (2011), 389–403.

[60] Tetsuya Oda, Hiroaki Shirai, Kyohei Toyoshima, Masaharu Hirota, Ryo Ozaki, and Kengo Katayama. 2020. VR Application for Supporting Object Recognition Considering Eye in Low Vision. In *Proceedings of the 2020 8th International Conference on Information and Education Technology* (Okayama, Japan) *(ICIET 2020)*. Association for Computing Machinery, New York, NY, USA, 295–299. doi:10.1145/3395245.3396232

[61] Hirotaka Osawa, Takeomi Goto, and Bohao Wang. 2017. Wearable social prosthetics: supporting joint attention during communication with artificial eyes. In *Proceedings of the 2017 ACM International Symposium on Wearable Computers* (Maui, Hawaii) *(ISWC '17)*. Association for Computing Machinery, New York, NY, USA, 168–169. doi:10.1145/3123021.3123036

[62] Oliver Ozioko, William Navaraj, Marion Hersh, and Ravinder Dahiya. 2020. Tacsac: A Wearable Haptic Device with Capacitive Touch-Sensing Capability for Tactile Display. *Sensors* 20, 17 (8 2020), 4780. doi:10.3390/s20174780

[63] Shi Qiu. 2017. Designing Gaze Simulation for People with Visual Disability. In *Proceedings of the Eleventh International Conference on Tangible, Embedded, and Embodied Interaction* (Yokohama, Japan) *(TEI '17)*. Association for Computing Machinery, New York, NY, USA, 685–688. doi:10.1145/3024969.3025034

[64] Shi Qiu, Pengcheng An, Kai Kang, Jun Hu, Ting Han, and Matthias Rauterberg. 2023. Investigating socially assistive systems from system design and evaluation: A systematic review. *Universal Access in the Information Society* 22, 2 (2023), 609–633.

[65] Shi Qiu, Siti Aisyah Anas, Hirotaka Osawa, Matthias Rauterberg, and Jun Hu. 2016. E-Gaze Glasses: Simulating Natural Gazes for Blind People. In *Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction* (Eindhoven, Netherlands) *(TEI '16)*. Association for Computing Machinery, New York, NY, USA, 563–569. doi:10.1145/2839462.2856518

[66] Shi Qiu, Jun Hu, and Matthias Rauterberg. 2015. Nonverbal signals for face-to-face communication between the blind and the sighted. In *Proceedings of international conference on enabling access for persons with visual impairment*. 157–165.

[67] Bernadette Quinn and Theresa Ryan. 2019. Events, social connections, place identities and extended families. *Journal of Policy Research in Tourism, Leisure and Events* 11, 1 (2019), 54–69.

[68] Chirag Raman, Navin Raj Prabhu, and Hayley Hung. 2023. Perceived conversation quality in spontaneous interactions. *IEEE Transactions on Affective Computing* 14, 4 (2023), 2901–2912.

[69] Matt Ratto, Isaac Record, Ginger Coons, and Max Julien. 2014. Blind tennis: extreme users and participatory design. In *Proceedings of the 13th Participatory Design Conference: Short Papers, Industry Cases, Workshop Descriptions, Doctoral Consortium Papers, and Keynote Abstracts - Volume 2* (Windhoek, Namibia) *(PDC '14)*. Association for Computing Machinery, New York, NY, USA, 41–44. doi:10.1145/2662155.2662199

[70] Vasudevi Reddy. 2016. Prelinguistic communication. In *The development of language*. Psychology Press, 25–50.

[71] Dennis Schleicher, Peter Jones, and Oksana Kachur. 2010. Bodystorming as embodied designing. *Interactions* 17, 6 (Nov. 2010), 47–51. doi:10.1145/1865245.1865256

[72] Jonathan Isaac Segal, Samuel Rodriguez, Akshaya Raghavan, Heysil Baez, Crescentia Jung, Jazmin Collins, Shiri Azenkot, and Andrea Stevenson Won. 2024. SocialCueSwitch: Towards Customizable Accessibility by Representing Social Cues in Multiple Senses. In *Extended Abstracts of the CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) *(CHI EA '24)*. Association for Computing Machinery, New York, NY, USA, Article 295, 7 pages. doi:10.1145/3613905.3651109

[73] Letícia Seixas Pereira, José Coelho, André Rodrigues, João Guerreiro, Tiago Guerreiro, and Carlos Duarte. 2022. Authoring accessible media content on social networks. In *Proceedings of the 24th International ACM SIGACCESS Conference on Computers and Accessibility* (Athens, Greece) *(ASSETS '22)*. Association for Computing Machinery, New York, NY, USA, Article 28, 11 pages. doi:10.1145/3517428.3544882

[74] Serengil. [n. d.]. GitHub - serengil/deepface: A Lightweight Face Recognition and Facial Attribute Analysis (Age, Gender, Emotion and Race) Library for Python. https://github.com/serengil/deepface

[75] Kristen Shinohara and Jacob O Wobbrock. 2011. In the shadow of misperception: assistive technology use and social interactions. In *Proceedings of the SIGCHI conference on human factors in computing systems*. 705–714.

[76] Yoonji Song and Jiye Kim. 2015. Mingle: Wearable Devices for Enhancing Communications and Activities between the Blind and Ordinary People through a Waltz. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems* (Seoul, Republic of Korea) *(CHI EA '15)*. Association for Computing Machinery, New York, NY, USA, 367–370. doi:10.1145/2702613.2725435

[77] Belona Sonna and Alban Grastien. 2025. *On Explaining Proxy Discrimination and Unfairness in Individual Decisions Made by AI Systems*. Springer Nature Singapore, 260–273. doi:10.1007/978-981-95-4969-6_20

[78] Andrii Soviak, Anatoliy Borodin, Vikas Ashok, Yevgen Borodin, Yury Puzis, and I.V. Ramakrishnan. 2016. Tactile Accessibility: Does Anyone Need a Haptic Glove?. In *Proceedings of the 18th International ACM SIGACCESS Conference on Computers and Accessibility* (Reno, Nevada, USA) *(ASSETS '16)*. Association for Computing Machinery, New York, NY, USA, 101–109. doi:10.1145/2982142.2982175

[79] Abigale Stangl, Emma Sadjo, Pardis Emami-Naeini, Yang Wang, Danna Gurari, and Leah Findlater. 2023. "Dump it, Destroy it, Send it to Data Heaven": Blind People's Expectations for Visual Privacy in Visual Assistance Technologies. In *Proceedings of the 20th International Web for All Conference*. 134–147.

[80] Quentin Stevens and HaeRan Shin. 2014. Urban festivals and local social space. *Planning Practice and Research* 29, 1 (2014), 1–20.

[81] Cindy Ycaza Stroschein. 2006. *Social comfort and Internet use*. Capella University.

[82] Xinru Tang, Ali Abdolrahmani, Darren Gergle, and Anne Marie Piper. 2025. Everyday Uncertainty: How Blind People Use GenAI Tools for Information Access. In *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems (CHI '25)*. Association for Computing Machinery, New York, NY, USA, Article 63, 17 pages. doi:10.1145/3706598.3713433

[83] Yuanyang Teng, Connor Courtien, David Angel Rios, Yves M Tseng, Jacqueline Gibson, Maryam Aziz, Avery Reyna, Rajan Vaish, and Brian A. Smith. 2024. Help

Supporters: Exploring the Design Space of Assistive Technologies to Support Face-to-Face Help Between Blind and Sighted Strangers. In *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) *(CHI '24)*. Association for Computing Machinery, New York, NY, USA, Article 40, 24 pages. doi:10.1145/3613904.3642816

[84] Gareth Terry, Nikki Hayfield, Victoria Clarke, Virginia Braun, et al. 2017. Thematic analysis. *The SAGE handbook of qualitative research in psychology* 2, 17-37 (2017), 25.

[85] Norsidah Ujang, Marek Kozlowski, and Suhardi Maulan. 2018. Linking place attachment and social interaction: towards meaningful public places. *Journal of Place Management and Development* 11, 1 (2018), 115–129.

[86] Dannyelle Valente, Anne Theurel, and Edouard Gentaz. 2018. The role of visual experience in the production of emotional facial expressions by blind people: A review. *Psychonomic bulletin & review* 25, 2 (2018), 483–497.

[87] Aditya Vashistha, Edward Cutrell, Nicola Dell, and Richard Anderson. 2015. Social Media Platforms for Low-Income Blind People in India. In *Proceedings of the 17th International ACM SIGACCESS Conference on Computers & Accessibility* (Lisbon, Portugal) *(ASSETS '15)*. Association for Computing Machinery, New York, NY, USA, 259–272. doi:10.1145/2700648.2809858

[88] Ramiro Velázquez. 2010. Wearable assistive devices for the blind. In *Wearable and Autonomous Biomedical Devices and Systems for Smart Environment: Issues and Characterization*. Springer, 331–349.

[89] Alessandro Vinciarelli, Maja Pantic, Hervé Bourlard, and Alex Pentland. 2008. Social signals, their function, and automatic analysis: a survey. In *Proceedings of the 10th International Conference on Multimodal Interfaces* (Chania, Crete, Greece) *(ICMI '08)*. Association for Computing Machinery, New York, NY, USA, 61–68. doi:10.1145/1452392.1452405

[90] Ru Wang, Ruijia Chen, Anqiao Erica Cai, Zhiyuan Li, Sanbrita Mondal, and Yuhang Zhao. 2025. Characterizing Visual Intents for People with Low Vision through Eye Tracking. In *Proceedings of the 27th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '25)*. Association for Computing Machinery, New York, NY, USA, Article 65, 18 pages. doi:10.1145/3663547.3746391

[91] Ying YANG and Yu KOU. 2015. Individuals' well-being in prosocial interaction: The role of autonomy. *Advances in Psychological Science* 23, 7 (2015), 1226.

A Formative Study

A.1 Formative Study Question 1

- What kind of interactions did you have at the party?
- Have you ever encountered barriers in nonverbal communication, including difficulties in initiating greetings or responding to facial expressions?
- How do you respond to those interactions?
- Can you recall some specific experiences to describe these issues?
- What were your happiest and most awkward moments involving nonverbal communication? Can you describe them?

A.2 Formative Study Question 2

- Have you ever used any assistive social tools to address these issues?
- What barriers or limitations did you encounter while using them?
- If we could leverage technologies such as AI or other tools, how would you hope to solve these problems?
- What would you not want these assistive technologies to do during social interactions?

B Design

B.1 Hardware Implementation

As shown in Figure 1(C) and Figure 4, our hardware prototype consists of a camera worn around the neck as a pendant and a handheld fan device. The camera module is an ESP32-CAM, positioned on the user's chest to capture non-verbal cues. The fan is composed of a transparent holographic display and a handle, where the display is a GIWOX Holo-42W model that supports Wi-Fi data transmission. The handle is 3D-printed in white PLA and designed with an isosceles trapezoid cross-section, narrower at the top and wider at the bottom. Braille-inspired tactile textures are placed along the two slanted sides and the top edge to represent left, center, and right, helping users identify the spatial orientation of potential social partners. Inside the handle, an Arduino Mega 2560 controls three coin-type vibration motors, a power switch, an MPU-6050 gyroscope, and a 5V battery. The vibration motors (Leader LCM0827A3038F) are mounted beneath the corresponding tactile regions on the two sides and top, providing directional haptic feedback to indicate left, center, or right social cues.

B.2 Software Implementation

B.2.1 Fine-Tuning GPT-4o. During the personalization stage, we used ChatGPT-4o to interpret each BLV user's natural-language descriptions of their social and emotional interaction preferences and automatically generate a set of personalized emoji expression tags. To improve the consistency and semantic alignment of this mapping process, we applied parameter-efficient fine-tuning (PEFT) to GPT-4o using a LoRA-based adapter. The fine-tuning dataset consisted of 138 instruction–emoji pairs, created from interview transcripts with 15 BLV participants. Each sample contained a user-defined social response description and its corresponding designer-validated emoji representation, stored in a JSON structure:"instruction": "<user preference text>", "output": "<emoji tag>" We trained the LoRA adapter for 6 epochs using AdamW (learning rate = 2e—5) with an 80/20 train–validation split, resulting in a lightweight personalized layer (~1.3M parameters) while keeping the base language model weights frozen. After this process, our fine-tuned GPT-4o is able to analyze and understand the user's natural language input, extracting emotional response preferences and mapping them to the multidimensional emotional result combinations identified by the DeepFace model.

B.2.2 User-Defined Response Configuration. Based on user inputs, our fine-tuned GPT4-o generates an emotional response table for each user, which includes the corresponding responses from *EmojiFan* to the social counterpart when DeepFace recognizes the face and analyzes the combination of different emotional values. Subsequently, we used Jimeng AI to generate a set of dynamic emoji expressions that match the user's expected responses. To reduce potential AI-generated bias as much as possible, the text prompts used for creating the dynamic emoji animations were composed only of: (1) the user's own description of the expression + (2) a style keyword (e.g., emoji, cartoon, dynamic) without additional interpretation or refinement. An example prompt is: "A friendly, warm smile showing that I am happy to talk with you, style: dynamic cartoon emoji."(As illustrated in Figure 5 and Figure 3)

B.2.3 Facial Expression Capture. Social signals include phenomena such as attention, empathy, politeness, flirting, and (dis)agreement, and are conveyed through multiple behavioral cues including posture, facial expression, voice quality, gestures, etc.[89] Among these, facial expressions play a central role in transmitting social signals, as they, along with eye contact, are the most reliable cues. Therefore, in our system design, we focus exclusively on detecting and analyzing the facial expressions of the social counterparts.

B.2.4 Recognition of Potential Social Signals and Personalized Response. In the real-time interaction stage, the ESP32-CAM worn around the user's neck transmitted front-facing video via Wi-Fi to a local computer. Each frame was processed using OpenCV and analyzed by the DeepFace affect recognition model to obtain a multidimensional emotional result (e.g., 'happy': 45%, 'sad': 5%, 'angry': 1%, 'disgust': 3.7%, 'fear': 4.2%, 'surprise': 20%, 'neutral': 21.1%). When an expression indicating potential social engagement was detected, the system compared the multidimensional emotional result with the user-specific emotional response table generated in the personalization stage, identified the emoji expression that aligns with the user's preference, and then sent a Bluetooth command to the Arduino Mega 2560 in the fan handle. Based on left/center/right orientation, the Arduino activated one of the three embedded coin-type vibration motors, enabling discreet haptic notification to the BLV user. If the user chose to respond, raising the fan—detected by the MPU-6050 gyroscope—triggered the retrieval of the personalized emoji mapping and initiated Wi-Fi transmission of the corresponding animation to the GIWOX Holo-42W transparent display. The fan then presented an animated emoji as the user's expressive feedback within the social interaction.

B.2.5 Questions During the Configuration Phase.

- When someone smiles at you, how would you like to respond emotionally?
- When someone looks surprised or shocked (eyes wide, mouth slightly open), what expression would you like to show?
- When someone looks sad (eyes downcast, lips turned down), how would you like to respond emotionally?
- When someone looks angry (furrowed brows, clenched jaw), what expression would you prefer to show?
- When someone looks disgusted (wrinkled nose, raised upper lip), how would you like to respond?
- When someone looks fearful (wide eyes, slightly raised eyebrows), what kind of facial expression would you like to make?
- When someone looks happy (eyes squinted, wide smile), how would you like to respond emotionally?
- When someone looks neutral (no clear expression, relaxed face), what expression would you like to show?
- When someone looks confused (furrowed brows, eyes darting), how would you like to react emotionally?
- When someone looks surprised but also slightly annoyed (wide eyes, slight frown), what expression would you prefer to show?

B.3 Ethical and Privacy Considerations

Our methodology considers the ethical and privacy concerns of the study and has been approved by our university's Institutional Review Board (IRB).

B.3.1 For Potential Interpreter Bias and Algorithmic Error Concerns. Our design follows the ethical framework proposed by[8], allowing users to decide whether to respond whenever a social signal is detected, putting control in the hands of participant. When selecting the emotion recognition model, we referred to the cross-cultural six basic emotion categories proposed by Ekman & Friesen (Happy, Sad, Anger, Fear, Disgust, Surprise)[23, 24], and therefore adopted DeepFace[74], which is grounded in the same theoretical framework. Since DeepFace[74] may not reliably recognize non-typical expressions and emotional meanings may vary culturally, these potential algorithmic and cultural biases were addressed by using cartoon-style emoji representations, which can improve the efficiency of communication[21], and are less likely to cause interpersonal misunderstandings in social contexts[7, 11].

We treat algorithm-controlled ambiguity as a design resource. Ambiguity can make interactions more playful and effectively facilitate social ice-breaking. To minimize interpreter bias, no predefined constraints were imposed on users' personalized response configurations.

Our camera-based sensing approach builds upon prior work[79], and to ensure acceptability for BLV users, we designed the system to receive information from both sighted and extended fields of view (FoVs). We also design the system to allow access to extended FoV information, as previous literature has indicated that BLV users feel it is equalizing, since sighted individuals have effortless access to wider PoV via head-turning, and thereby can perceive a greater ranger of social cues[3].

B.3.2 For Privacy and Transparency Concerns. : Given that *EmojiFan* captures and processes facial expressions, we incorporated privacy-preserving and ethical design principles throughout system development. The system minimizes data exposure by (1) processing video on-device or on a password-protected trusted local computer within a restricted-access space, (2) retaining no raw image frames after inference, and (3) communicating only abstract, non-identifying affect signals (e.g., directional vibration) to the user. Prior to all study sessions, participants were briefed on their rights to withdraw or pause recording at any time. Further, signage was posted to indicate the perimeter of the recorded space. Both the verbal brief and the signage informed of the purpose of data collection, the functions of the camera, what data the system captures, how facial expressions are analyzed, the limitations of automated affect inference, how feedback is generated, and their right to request that the system be paused at any time.

C User Study

C.1 Customization of the Fan per User

We held two online meetings before the experiment, each lasting 30 minutes. These meetings provided background information and training on the experiment's content for both BLV users and sighted partners. After the online meeting, we had information needed for the study set up (30 minutes) for each BLV user. The goal of pre-study protocol is to personalize *EmojiFan* according to the specific needs of each participant, while also testing the accuracy of recognized social cues and to ensure a timely display emojis on the fan's screen. These configurations will be used during the experiment.

(1) Meeting for BLV users: The online training for BLV users included details about their tasks, the experiment process, and the timeline. The task for BLV users was to attempt to make a conversation with pre-arranged sighted actors. BLV users can end a conversation at any time or join a new conversation group. At the same time, considering the complexity of the experimental process, we informed the BLV users about the presence of sighted actors and asked them to replicate their real reactions as accurately as possible.
(2) Meeting for sighted partners: The online training for sighted partners focused on introducing the project background and guide them on how to communicate naturally with BLV users, including appropriate facial expressions and how to effectively portray the roles they were assigned.
(3) Set up a personalized emoji output AI agent: Use a large language model to help BLV users users configure a text-based emoji AI agent. We gave six BLV users a complete introduction to the interactive system. With the assistance of staff, each participant tried out all of the available personalized preference settings, These settings include the text prompts we provided to the large language model and the list of questions for BLV users, such as: how the BLV users would like to respond when someone smiles at them, or how they would like to respond when someone expresses sadness. We prepared ten questions for all the BLV users to answer and their responses were then used to fine-tune a large language model to personalize the automatic emoji text output system. To ensure accurate representation, we repeat the process three times with user feedback. Our method ensures that the automatically generated emojis accurately reflected the expressions the user intended to convey. Following. texts are converted into emoji images by a text-to-image generative model and displayed on the fan's screen.

C.1.1 System Robustness. We tested the fault tolerance and robustness of the system by conducting a total of 50 recognition attempts, during which network latency or stuttering occurred 3 times. Considering that this is not yet a fully developed product, such a fault tolerance rate is acceptable. Finally, each BLV users configured a personalized *EmojiFan* system to act as their emoji output proxy.

C.2 Questionnaire for Sighted Participants

Our screening questionnaire for sighted participants included the following items:

- Have you had prior contact with visually impaired individuals?
- Are you willing to socialize with visually impaired individuals?
- Have you ever had experiences of discriminating against people with disabilities?
- Do you consider yourself to have positive social interaction skills?

C.3 Procedure

C.3.1 Simulating Face-to-face Social Interactions in a Real-party Scenario (2 hours). All Participants were asked to engage in face-to-face social interactions. The predefined interaction method was set as 1-on-1 social interaction, with a total of six groups. To replicate a real gathering scenario, two sighted partners from the eight sighted partners could randomly join any of the six groups for interaction. This ensured that random events, such as switching conversation partners or ending interactions early, were allowed to occur during the experiment, and these events were documented. To facilitate conversation, both sighted partners and BLV users were provided with reference conversation topics, this process include task 1 (no using *EmojiFan*) and task 2 (using *EmojiFan*).

In the first phase of task 1 (controlled condition without *EmojiFan*), BLV users interacted with sighted partners without using *EmojiFan*, with each interaction lasting about 6 minutes. The BLV users could interact with different sighted partners, but we only recorded 6-minute segments of their interactions. During this phase, 6 researchers were responsible for recording the interactions of the 6 sighted partners with BLV users, while 2 researchers (including the facilitator) observed the interaction modes between the BLV users and sighted partners.

In the second phase of the task 2 (using *EmojiFan*), the BLV users were guided to use *EmojiFan* for a second round of social interactions. The previous groupings were randomized, and the 6 BLV users switched conversation partners. Each interaction again lasted about 6 minutes. The BLV users could interact with different sighted partners, but we only recorded 6-minute segments of their interactions. Our goal was to observe the changes in social interaction between the BLV users and sighted partners after using *EmojiFan*. During this phase, 6 researchers recorded the interactions, while 2 researchers (including the facilitator) observed the changes in interaction modes, particularly in terms of emotional expression and non-verbal communication.

C.3.2 Semi-Structured Interviews (2 hours). After finished party interaction activity, researchers conducted semi-structured interviews with both the BLV users and sighted partners. Each group consisted of one researcher and one participant, with each interview lasting approximately 30 minutes. The main purpose of the interviews was to understand the challenges faced by BLV users when using the system in real-life social scenarios, as well as the impact of *EmojiFan* on their social interactions. During the interviews, one researcher was responsible for audio recording and note-taking to ensure that all feedback was accurately documented.

(1) Experience of the BLV users: The researcher asked the BLV users about their feelings when using and not using *EmojiFan*, including whether it was easier to perceive social signals from others, whether they could express their emotions and needs more clearly, and whether they felt their social interactions were more natural or confident.
(2) Feedback from sighted partners: The researcher also asked the sighted partners about their experiences, particularly whether they found it easier to understand the emotional changes of the BLV users, and if there were any barriers or inconveniences.

C.3.3 Discussion on Interaction Intentions Before and After Using EmojiFan Based on Observed Videos(1 hours). One week later, three researchers with a design background discussed the videos observed during the experiment to analyze the changes in interaction intentions between the BLV users and sighted partners before and after using *EmojiFan*. Our discussing referenced the interaction effectiveness research by C. Raman et al.[68], and discussing the changes in interaction intentions, emotional expression, and social performance between the BLV users and sighted partners. The research team specifically focused on the behavioral differences between BLV users when using and not using *EmojiFan*, and how these differences influenced their interactions with sighted partners.

C.3.4 Follow-up Interviews to Inquire About BLV users' Feelings (2 hours). In the second week after the experiment, the research team conducted phone follow-up interviews with 6 BLV users to understand the long-term impact of the device on users' social behavior, as well as their feedback on psychological changes and attitude shifts. Each interview lasted about 30 minutes, with 8 researchers involved in the process. The interviews were recorded with the participants' consent. The follow-up focused on the following: First, the researchers explored whether the participants experienced a shift in their social attitudes, such as whether they began to engage more actively in social interactions or adopted a more open and proactive social attitude. Secondly, the follow-up also examined whether the BLV users' self-awareness had changed after using the device, particularly in terms of social confidence and emotional expression. Additionally, we explored whether users would be willing to spontaneously participate in social interactions without relying on the device. This part of the follow-up assessed whether users felt that the presence of the device made them more willing to step out of their comfort zone and initiate interactions with others. Finally, the research team asked about users' impressions and expectations regarding the device after the usage period, including its potential value in daily life and whether they expected further optimizations to enhance the quality of social interactions. The themes for the follow-up interview are provided below.

C.3.5 The Themes for the Follow-up Interview. **Impact of Devices on Continued Social Interaction**

- After the party, do you feel more comfortable taking the first step to contact others?
- If you were asked to use a device to attend a party again, would you be more proactive?
- Does the device help you build longer-term "social confidence"? Why?

Psychological Changes and Attitude Changes Purpose: To understand whether users have changed their social concepts and self-perception

- Did you feel more willing to take the initiative to talk to strangers this week?
- Do you think this social experience has increased your confidence in future interactions?
- If there is a similar gathering next time, will you be looking forward to it? Nervous? Okay?
- Have any friends or acquaintances asked you about your experience that day? How did you share it?

User Spontaneous Behavior and Sense of Belonging Purpose: To explore whether users are willing to participate in social activities spontaneously, rather than relying solely on device push

- Have you initiated a social behavior on your own initiative this week? For example, inviting someone to chat or greet someone?
- Have friends at the party sent you new invitations (for meetings, activities, joining groups, etc.)?
- Do you feel like "I am a real participant" rather than a passive participant?

The Lasting Impact and Expectations of the Device Purpose: To observe the user's impression and expectations of the "post-use period" of the device

- After the party, did you think: "I hope this device can be used for a long time"? Why?
- Is there a time when you suddenly wish the device was still around to help you?
- Is there any social situation that you encountered this week, but you think the device can help you break through?

C.4 Data Collection and Analysis

We segmented and analyzed the before-and-after videos of interactions between BLV users and sighted partners. In the comparison videos before and after using *EmojiFan*, we first divided the group conversations into several segments. Based on the distribution of group interaction durations, the median duration of group conversations was 1.10 minutes, and the average duration was 1.91 minutes. To make a fair comparison with approximately 1-minute conversations, longer conversations were split into independent 1-minute segments. For conversations longer than 2 minutes, they were divided into multiple 1-minute segments. Then, we performed preliminary quantitative analysis. To evaluate the quality of the interactions, we designed a rating scale based on the *Perceived Conversation Quality in Spontaneous Interactions* scale proposed by C. Raman et al. and used a Likert scale (1-5). Three researchers independently observed the segmented videos and rated each social interaction segment to assess its quality. The rating criteria included emotional expression, the effectiveness of verbal and nonverbal feedback, and the naturalness of the interaction[68]. Finally, we summarized the average scores of all the researchers for the interaction videos before and after using *EmojiFan*. The results are shown in Figure 3. We compared the average scores before and after using *EmojiFan* for all six groups, and the interaction changes were displayed in a bar chart (Figure 4). The results showed that interactions using *EmojiFan* were more effective than those without. Subsequently, we transcribed the discussion videos from the three researchers, the semi-structured interview audio data from 6 BLV users and 8 sighted partners after the party experiment, and the follow-up phone interview recordings of the BLV users. We used AI tools for transcription and summary. We conducted inductive thematic analysis[84], using an open coding process to identify relevant concepts and themes. Each data unit included a coded excerpt, and the coding process was "data-driven" to minimize bias[84]. Initially, two coders familiarized themselves with the entire dataset before coding it independently. They then conducted three rounds of coding. In the first round, 50 code labels were generated. In the second round, the coders met to integrate consistent high-level labels into broader themes, resolving differences through additional coding. In the third round, under the guidance of a senior researcher, these labels were iteratively grouped into four overarching themes, covering 391 data units out of the total 832.