Nonverbal Signals for Face-to-Face Communication between the Blind and the Sighted

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ABSTRACT

Nonverbal communication plays an important role in social interactions. However, most nonverbal communication relies on visual signals such as eye contact, head nods, facial expressions and body gestures. Visual nonverbal signals are inaccessible for the blind and hardly accessible for low vision individuals. In this paper, we present a qualitative study on nonverbal signals for the blind in face-to-face communication and problems they met due to the lack of visual signals. We interviewed 20 blind and low vision participants and collected qualitative data for the further analysis. Our results show that auditory and tactile signals are two major nonverbal signals that blind participants sense in face-to-face communication. They seldom sense positive feelings from visual signals in a conversation and they tend to have an indirect and fuzzy understanding of eyes and eye gestures. Furthermore, we discuss how our findings can be relevant for design: the sighted conversation partner's visual signals with positive meanings need to be detected to help the blind perceive the signal and feel more confident and engaged in face-to-face communication.

1. INTRODUCTION

Human communication contains both verbal and nonverbal information, which interplay in our daily lives. Nearly 65% of all human interpersonal communication happen through nonverbal cues [1], which indicates an crucial role in daily social interactions. Even a small and common conversation could contain a wealth of nonverbal information, which sighed people take for granted in daily routine. For example, a sighted speaker consciously and unconsciously uses eye contacts to convey information with the conversation partner. Through this conversation partner's eyes, she can sense interest, engagement, happiness etc. She naturally uses some hand and body gestures to enhance the effect of the speaking. Meanwhile her conversation partner smiles or frowns, nods or shakes the head to deliver the agreement and disagreement to her wordlessly. In fact, nonverbal signals are more spontaneous and hard to fake than other signals and some sighted people are very proficient at nonverbal deception [1].

Most nonverbal communication relies on the visual signals such as eye contacts, facial expressions, hand and body gestures etc. However, visual signals are inaccessible for the blind and hardly accessible for low vision people, since it is a process through sending and receiving wordless visual messages between people. Gareth R. White et al. [2] interviewed 8 visually impaired expert users and one of them proposed an important communication problem: blind individuals suffered immensely from physical and social isolation and it was very difficult for them to meet people, because they could not see and make eye contacts with sighted people. There are extensive studies concerned about blind people's navigation problems and proposed some technical solutions in Human Computer Interaction (HCI) research field [3] [4], aiming at solving the physical isolation problems of the blind people. However, there are few researches to pay close attention to the blind people's social isolation that mostly results from the lack of visual signals in communication such as eye contacts.

In order to better understand nonverbal signals for face-to-face communication between the blind and sighted as well as problems the blind met due to the lack of visual nonverbal signals, we conducted a qualitative study and interviewed 20 blind and low vision participants over Internet. In the interview, parallel design concepts were also proposed to let the blind participants evaluate for further improvements. In this article, we focus on the qualitative research on nonverbal signals and report the findings, leaving the evaluation of the design concepts for later analysis.

2. RELATED WORK

In literature, we found limited examples related to the purpose of making visual communication accessible to the blind people. Sreekar Krishna et al. developed a wearable Social Interaction Assistant prototype to help the blind and visually impaired individuals to know who is approaching and allow them to choose whether to initiate a conversation [5]. Shafiq ur Rehman et al. developed a haptic chair for providing facial expression information to the blind user. Nine vibrators were located in the back of the chair which indicated some specific facial features [6]. Sreekar Krishna et al. also provided an assistive technology for accessing facial expressions of interaction partners. His research prototype was a

vibrotactile glove wore by the blind individual and it could convey the conversation partner's seven facial expressions (happy, sad, surprise, neutral, angry, fear and disgust) with different vibration patterns[7]. However, it increases the cognitive load for the blind to remember all the meanings of seven vibration patterns. Besides, it does not seem natural to map the conversation partner's facial expressions to a vibrotactile glove. Although the sensory technology is feasible, it still lacks a deep understanding of the blind people's real needs in visual nonverbal communication.

In a prior study [8], we adopted a qualitative research method and interviewed 6 blind participants in Hong Kong about communication problems they met in mobile social media. In this paper, we extended our research to face-to-face communication and also adopted a qualitative study to deep understand blind people's needs in nonverbal communication.

3. USER STUDY

3.1 Participants

Twenty bind participants participated in interviews. Ten were from Yang Zhou Special Education School in Chinese mainland and the other ten were from Hong Kong Blind Union (Table 1). Their age ranged from 16 - 29 (M = 20.30, SD = 2.79) and most of them were high school, college and university students. There were 8 female participants and 12 male participants. Participants were suggested to provide their vision conditions based on the diagnoses from doctors as much as possible. All the participants in Hong Kong clearly knew their vision conditions, which were kept in official medical records. Some participants in Chinese mainland were uncertain about vision conditions, so a teacher in Yang Zhou Special Education School provided vision conditions based on participants' disability certifications from China Disabled Persons' Federation (CDPF).

In Table 1, Y1 to Y10 are participants from Yang Zhou, Chinese mainland. H1 to H10 are participants from Hong Kong. Chinese mainland and Hong Kong have different vision standards in categorizing the visual impairment. Chinese mainland [9]: Blindness 1, Blindness 2, Blindness3, Blindness 4. Hong Kong [10]: Totally blind and Low vision (severe low vision, moderate low vision and mild low vision). In this user study, we standardized different vision conditions in Chinese mainland and Hong Kong, based on the vision conversion standard of the International Classification of Disease (ICD) 10th Revision 1st and 2nd edition [11]. We also used terms: totally blind (Blindness 5, no light perception) and low vision (Blindness 3-5 and Severe visual impairment, with light perception) in this paper.

3.2 Setup

Since all the blind participants were not convenient to be available for face-to-face interview, interviews were conducted over Internet using online audio. In fact, participants could choose either online audio or video communication software and all of them chose audio, which tended to protect more personal privacy. Tencent QQ and Skype were preinstalled in Yang Zhou Special Education School and Hong Kong Blind Union respectively, for the online interviews.

ID	Sex	Age	Vision conditions	Congenital blindness (Y/N)	Sense light (Y/N)
Y1	F	19	Blindness 4	Y	Y
Y2	M	19	Blindness 5	N	N
Y3	M	21	Blindness 5	N	N
Y4	F	21	Blindness 4	Y	Y
Y5	M	18	Blindness 5	Y	N
Y6	M	16	Blindness 4	Y	Y
Y7	F	22	Blindness 5	Y	N
Y8	M	19	Blindness 5	Y	N
Y9	M	19	Blindness 5	Y	N
Y10	M	17	Blindness 5	Y	N
H1	F	21	Blindness 3	Y	Y
H2	M	21	Blindness 5	Y	Y
H3	F	20	Blindness 3	Y	Y
H4	M	18	Blindness 3	Y	Y
H5	M	23	Blindness 3	Y	Y
H6	F	19	Severe visual impairment	Y	Y
H7	F	22	Blindness 3	Y	N
H8	F	23	Blindness 3	Y	Y
H9	M	29	Blindness 5	Y	N
H10	M	19	Blindness 5	N	N

Table 1. Vision conditions of twenty blind participants

3.3 Questionnaire

A questionnaire (see Appendix) was adopted in the semi-structured interview and it included three parts:

1. Vision conditions & basic Information. It included vision conditions of the participants and basic information about their use of electronic equipment.

2. Nonverbal signals in face-to-face communication. This part included the questions like types of nonverbal signals that blind participants could sense in face-to-face communication and which problems they met due to the lack of some visual signals. Since eyes play an important role in visual communication, we are particularly interested in the eyes. Some questions closely related to the perception of the eyes were also proposed in the interview: 1) How do you think of the importance of the eyes in face-to-face communication; 2) Perception of the appearance (shape and color) of the eyes; 2) Understandings of the eye gestures.

3. Evaluations and suggestions of design concepts. We also proposed several design concepts, which aimed at helping the blind perceive the visual signals in face-to-face communication and used a quantitative method to evaluate the concepts. In this article, we leave the evaluation of the design concepts for later analysis.

3.3.1 Procedure

In the interview, the interviewer needed to speak and explain all the questions to the participants and each interview took around one and half hours. English or Chinese Mandarin could be chosen in the interview to ensure all the participants had no language barriers and they could well understand each question.

3.3.2 Analysis

Each interview was recorded and notes were taken. We adopted the software QSR Nvivo [1] to manage and analyze qualitative data of each open question in the questionnaire. In this qualitative content analysis, we followed the approach of conventional content analysis, which coding categories are derived directly from the text data [12].

4. RESULTS

The objective of the user study described in this paper is to understand blind participants' current situation and problems of sensing nonverbal signals in face-to-face communication. More specially, we were interested in blind people's perception towards the eye, which play an important role in the visual nonverbal communication. To gain such knowledge, we selected all 125 quotes from the qualitative data.

4.1 Overview of the Types of Sensing Nonverbal Signals

In total 76 quotes described the types of nonverbal signals in face-to-face communication. We categorized these quotes based on four senses (visual, auditory, tactile and olfactory). Two major types of nonverbal signals were auditory (27 quotes) and tactile perception (18 quotes). Besides, other types of the nonverbal signals that participants mentioned they could sense were: visual perception (14 quotes), mixed perception of visual and auditory signals (8 quotes), mixed perception of auditory and olfactory signals (2 quotes). We also added two types of perceptions which might not be able to exactly belong to any of the five senses: obstacle perception [13] [14] (5 quotes) and airflow perception (2 quotes). Figure 1 provides an overview of the number of the quotes of different types of nonverbal signals that were mentioned by the participants. To gain a better understanding of the each type of the nonverbal signals in face-to-face communication, we summarized the user comments and we were particularly interested in the nonverbal signals, especially the ones included emotional information.

4.1.1 Auditory Perception

Fifteen participants mentioned that they could perceive conversation partners' auditory nonverbal signals. Four of them were low-vision and the other eleven were blind. Seven participants noted that they could sense the conversation partners' body gestures such as leaning forward and backward by auditory perception. One of the example responses was:

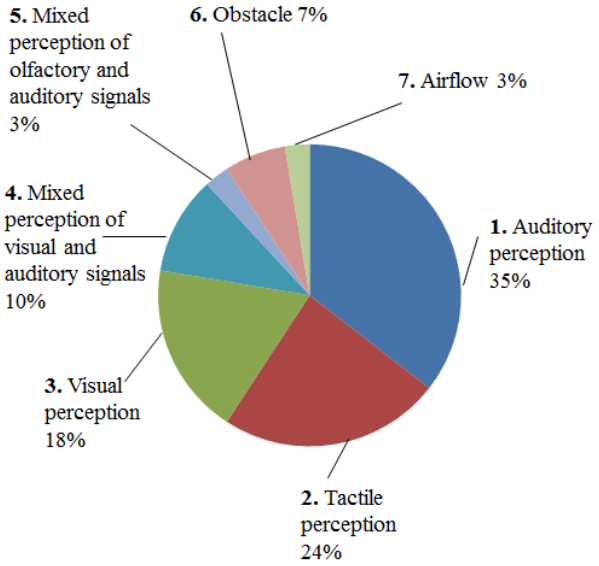

Figure 1. Types of sensing nonverbal signals in face-to-face communication

> *I could feel my conversation partner moving down or up his head when we were talking. [Participant Y7]*

Seven participants described that they sensed conversation partners' facial expressions by hearing them crying or laughing. Participants tended to distinguish and guess conversation partners' emotions from the manners of speaking: if the voice was soft and gentle, the blind tended to believe she was pleasant; if the conversation partner spoke rudely and loudly, the blind probably thought she was angry. In other words, participants in this interview could not directly and exactly sense conversation partners' facial expressions. Instead, they guessed conversation partners' emotions by auditory signals such as laugh, cry, voice and tone.

Ten participants also said they could sense the conversation partners' facial orientation by auditory signals. One participant stated he could perceive conversation partner's facial orientation when they were talking, but if the environment was noisy and it was difficult for him to discern conversation partner's facial orientation. The other participant also mentioned response to the conversation partner's facial orientation:

> *When I distinguished the direction of the conversation partner's facial orientation, I would intentionally turn my head to follow that direction. My head would stay in the direction with the biggest sound (when the conversation partner was talking). [Participant Y6]*

4.1.2 Tactile Perception

Eighteen participants shared their experiences of tactile nonverbal signals in face-to-face communication. Participants expressed positive (3 out of 18 participants), neutral (13 out of 18 participants) and negative (2 out of

[1] http://www.qsrinternational.com/

18 participants) views towards these signals respectively (Table 2).

Types	Attitudes	Understandings
Touch the shoulder	Positive	Friendly signal and feel being encouraged by the friends
Touch the head slightly	Positive	Feel being supported and encouraged
Hold the hand	Neutral	Guide me to one place
Touch the hand	Neutral	Let me know the other one is talking to me or let me do not speak in public place
Touch the body	Negative	An invasion of the privacy

Table 2. Attitude and understanding of different tactile nonverbal signals

4.1.3 Visual Perception

Six low-vision participants stated that they could sense visual signals in face-to-face communication, which included body gestures and facial orientations. All these six participants mentioned they could see some large hand gestures and body gestures such as waving or pointing to one place by using an arm. However, they were not able to sense some subtle finger gestures. Four participants described that they could also see the facial orientations of the nearby conversation partner.

4.1.4 Mixed Perception of Visual and Auditory Signals

Five participants mentioned they could sense body gestures and facial orientations by both visual and auditory perceptions. The example explanation is quoted as following:

> *Basically I could feel a person's body gesture when she was talking, because her voice was shaking along with his body gestures. Sometimes, I could see the conversation partner's body gestures, but not very clear. [Participant H3]*

4.1.5 Mixed Perception of Olfactory and Auditory Signals

Two participants shared their experiences to identify different people via auditory perception and olfaction. One participant mentioned he was able to distinguish the subtle olfactory difference from his close friends. But he also stressed that it would be very complicated to distinguish all the people around. He was not able to recognize a long-time-no-see friend, because he forgot friend's smell or the smell could have been replaced by the other person's. Sometimes he also needed to have a decision by different patterns of footsteps and some special context. He further explained the meaning of the context: smelling one person at school and sensing the similar smell of the person at home. They were considered as different people, because they appeared in two independent contexts. The other participant stated that he could identify a person by both olfactory and auditory signals:

> *I lost my vision by birth. Therefore, ages I distinguished all the people with different genders and by footsteps and smells. The first step was smell, but sometimes it was cheating. So I also used footsteps to help: some walked slowly and some others had heavy footsteps. I could distinguish different people by using signals in combinations with simple patterns of footsteps, the similar as combinations of the different telegraph codes, which finally formed complicated but identical meanings. [Participant Y6]*

4.1.6 Obstacle

Four totally blind participants emphasized they were capable of a particular perception of obstacles [13]. The example answer was quoted as following:

> *When I was walking before hitting an object, I felt something blocked me. I could not clearly explain that sense and it might be called the obstacle sense. [Participant Y2]*

4.1.7 Airflow

Two participants described they sensed some hand gestures by the airflow. One participant mentioned as following:

> *I could not see the hand gesture, but I know if someone is going to hit me. I could sense the subtle airflow caused by the conversation partner's hand gestures. [Participant Y6]*

4.2 Problems Due to a Lack of Visual Signals

Nineteen participants described that they were able to sense conversation partners' feelings by voice tone (13 out of 19 participants) and gestures (10 out of 19 participants). In these ten participants, only two of them stated they could feel positive feelings from conversation partners' gestures while the other eight felt only negative feelings. Furthermore, eight out of twenty participants shared their unhappy experiences due to the lack of perception of the nonverbal signals in face-to-face communication:

> *One person had very funny facial expressions in our conversation, but I could not sense them and naturally did not know why other people laughed. [Participant H2]*

4.2.1 Catch Up with Conversation

Four participants mentioned they could not catch up discussion speed with the sighted due to the lack of nonverbal signals such as hand gestures, nods, eye contacts and facial expressions. For example, one participant complained when several sighted people had a

meeting with him and one of them asked whether they agreed with a thing. Some people nodded and some did not, which he could not know and still thought they were in thinking. The other participant said if the sighted used eye contacts to show who they were talking about, she would be lost in the conversation.

4.2.2 Feel Other People's Feelings

Three participants also mentioned they had difficulties to feel conversation partners' feelings because they were not able to sense their facial expressions. One participant said sometimes he felt sad when he could not exactly feel other people's feelings. For instance, his classmate said "yes" and agreed with him, but actually that classmate was unpleased and disagreed with him. He could not feel his classmate's unhappiness from the tone, which sounded like usual. The other participant stressed he had difficulties to sense conversation partner's positive feelings:

> *When a person felt happy she would smile. But I could not see her smile. Besides, I could not sense nods and facial expressions, so I could only judge some positive feelings by conversation partner's voice tone or the use of languages. [Participant H4]*

4.2.3 Identify Familiar People

One participant described he had problems in identifying a close friend resulted from the changes in nonverbal signals:

> *I could not identify the person even we were familiar with each other in the past. If the feature of his nonverbal signals in my memory changed significantly, I could not identify him. For example: if he liked shaking legs during a conversation and one day he did not shake, I felt he changed. If changes were bigger, I even could not identify him. [Participant Y6]*

4.3 Perception of the Eyes

To gain a further understanding of blind participants' perception of the eyes that play an important role in visual communication, we proposed four relevant questions: 1) Eyes were important or not in the communication; 2) Explanations of the memory of the eyes from childhood; 3) Appearance & functions of the eyes;4) Understandings of "looking at".

The question "Eyes were important or not in the communication" was a basic and warm-up question and it required participants not only answered "Yes" or "No", but also needed to provide reasons. Eleven participants held the view of "eyes were important" explained two types of reasons: 1) Blind people do not have eye contacts and eye contacts could be used to understand other people's emotions and intentions in the communication; 2) Looking at the conversation partner when she was talking indicates respect to her. Most participants tended to hold these views based on their indirect experiences. For example: one participant said she understood the importance of eye contacts from romance novels, which highlighted the description of the eye contacts between lovers. Likewise, nine participants thought eyes were not important in the communication and six of them were totally blind while the other three were low-vision (Table 3). The primary reason of "eyes were not important" was they were not able to get any information when "looked at" the others in face-to-face communication. One participant stressed eyes were significantly important from sighted people's view but actually eyes had no functions for blind people. She thought blind people tend to be more sensitive and they do not need to see. For example, she could be aware of her teacher's feelings, but even the teacher himself did not notice.

Responses	**# Participants**	**Vision conditions**	
		# Totally blind	**# Low vision**
Important	11	5	6
Not important	9	6	3

Table 3. The number of participants held different views towards eyes

Eight participants said they never got explanations particularly about eyes. Twelve participants stated they got the explanations about eyes in childhood from teachers, parents, books etc. One of the example explanations they mentioned was:

> *The eye was a window of the soul, which could provide a person's basic information. When looked at one person, you could understand she was kind-hearted or not. You could also observe this beautiful world and surroundings. [Participant Y5]*

We also asked two open questions: "what do you think of the appearance and functions of the eyes?" and "Can you explain 'look at' based on your understandings?" to gain further information of participants' perception towards eyes. The example descriptions of these two questions from participants are classified in Table 4 and Table 5.

Responses		**# Quotes (N=36)**	**Key words**
Appearance	Shape	16	Round, like a ball, oval, olive shaped
	Color	5	Black center, white surroundings, transparent.
Functions		15	Eye contacts, feelings, be respected; get information, enhance facial expressions

Table 4. Appearances and functions of the eyes]

Responses		# Quotes (N=17)	Key words
Looking at	Eyes	9	Eye contacts, focus, watch
	Face	6	Turn one's face, head orientation, face to face
	Purpose	2	Friendly, blackly, love

Table 5. Understandings of "looking at"

5. DISCUSSION

The research described in this paper is aimed at a better understanding of blind people's need of nonverbal signals in face-to-face communication with sighted people. Since blind and low vision people lost the visual modality completely or largely, we were particularly interested in communication problems due to the lack of visual signals in face-to-face communication. This knowledge is needed for further understandings of blind people's needs of perceiving visual signals in face-to-face communication. We will now discuss our current findings from this qualitative study as well as implications of our research for the design of the assistive device that can help blind people to sense visual signals in face-to-face communication.

5.1 Use of Auditory and Tactile Signals

The two majorities of nonverbal signals that blind participants mentioned that they could sense were auditory (35%) and tactile signals (24%). It indicates that blind people perceive nonverbal signals primarily based on the auditory and tactile modalities. This result is in line with mainstream technology solutions in the HCI field: auditory assistive devices [15] that use auditory signals as a substitute for vision, and also some haptic solutions that use haptic signals as a substitute [16]. We also learned some participants could use olfactory signals to identify different people. However, although a few blind participants demonstrated a better olfactory ability than sighted people due to a result of the sensory substitution, they could not depend on merely olfactory signals to distinguish people. They still needed auditory signals like sound of footsteps as the assistance. There are three key reasons explain this phenomenon: 1) Olfactory signals are very complicated for identifying different people. For example, a blind participant has several friends and it is very difficult for him to remember all the different smells from different friends; 2) Some olfactory nonverbal signals are very similar and sometimes easy to be mixed up; 3) A person's olfactory signal may change after a period of time. It is impossible for a blind person to identify the change, even when it comes from his close friend.

5.2 Problems in Communication Due to the Lack of Visual Signals

Participants mentioned communication problems from inaccessible visual signals in the study. These signals can be categorized as two types: 1) conveying useful information, for example, nodding or shaking the head means agreement or disagreement in discussion; 2) expressing different feelings through smiling or frowning. Some blind participants had difficulties in sensing positive feelings. One possible reason is that they were not able to see facial expressions and subtle finger gestures, which can be used by the sighted people to indicate positive emotions. For example, thumbs-up and smiling of the conversation partner can convey positive feelings and give the speaker more confidence in talking. Blind participants tend to more easily sense some negative feelings from big and sharp hand or body gestures. This could explain why ten participants stated they could sense conversation partners' feelings via gestures in the interview, but only two of them could sense positive feelings and the other eight only sensed negative feelings.

5.3 Indirect and Fuzzy Understanding of Eyes and Eye Gestures

Most participants in the interview gained the understanding of the eyes based on three primary different resources: 1) sighted people tell them (parents, teachers or other people); 2) read novels and other literary works, especially some romance novels described the eye contacts between lovers in details; 3) understand from their own life experiences, which were mostly based on the problems they met due to a lack of visual nonverbal signals. Partially because of using some metaphor and analogy to describe eye gazes or eye contacts in novels and other literary works, participants tend to exaggerate the function of the eyes. For example, one participant stated looking at a person could clearly know he was kind-hearted or not. In fact, it is rather difficult to determine a person's inner character at the first sight even for the sighted people. In the interview, bind participants had clearer understanding or imagination of eyes' shape than the color (Table 4). The reason could be obvious: blind participants can touch their own or other one's eyeballs to recognize the shape of the eyes. Half of them are totally blind and do not have the light sense (Table 1), so it is impossible for them to imagine color. Even for the low vision participants, sensing the eye color is still of a question. Most of them imagine the eye color based on indirect experiences such as from descriptions of a book or by other people telling them. Another interesting point is their understandings of the "look at". We collected 17 quotes from 20 participants of answering this question and 9 quotes considered "looking at" was a behavior triggered by the eyes (Key words: eye contacts, focus, watch etc.). But 6 quotes explained "looking at" was a behavior about the face and head (Key words: turn one's face, head orientation, face to face etc.). One participant stated he could sense his conversation partner looking at him by the facial orientation. In sighted people's eyes,

"looking at" belongs to visual behaviors rather than facial or gestural behaviors. Blind people do not have an explicit concept of "looking at" and it is even a behavior more of the face according to some participants.

5.4 Design Implications

Some design implications are also proposed from the qualitative study: 1) visual signals that convey positive meanings should be sensed by the blind people in face-to-face communication; 2) use facial orientation as a replacement for gaze signal; 3) not only let the blind people perceive visual signals but also help them to give feedback to their sighted conversation partners by using different eye gestures.

From the interview, we found that blind participants received less positive signals in a conversation due to the lack of sensing subtle gestures and facial expressions from the sighted conversation partner. For example: gaze, smile, nod and thumbs up. These positive signals can help them feel more confident in the conversation with the sighted. As for some large hand or body gestures, blind participants can sense some of them from other modalities. For example, some participants could sense conversation partner's facial orientations by auditory signals when the partner was talking. However, all the blind participants cannot sense eye gazes, facial expressions and finger gestures such subtle gestures in the interview.

Another finding related to detecting signals that "looking at" means "facial orientation" according to some blind participants. We can consider using facial orientation as a replacement for gaze signal. In fact, blind participants could not sense subtle gestures such as eye gazes and naturally they had no direct and explicit experiences of eye signals like "looking at". On the other hand, some of them, especially low-vision participants, could sense facial orientations from auditory or weak visual signals. They have a clearer concept about the "face" rather than the "eye".

In our future design, we also consider not only let the blind people perceive visual signals but also help them to give feedback to their sighted conversation partners by using different eye gestures based on the research prototype " wearable eyes" [17]. The "wearable eyes" can display user's eye gestures on the surface of the glasses and produce expressions during user's communication.

5.5 Limitations

This research studied the need of nonverbal signals for the blind in face-to-face communication with the sighted. The study was limited in some perspectives which should take into consideration for improvements in future work: 1) design for face-to-face communication is an interactive process which involves both blind and sighted people and the work presented here lacks a deep understanding of the sighted people's perspectives in communication with the blind; 2) this study adopted online audio interviews, and results may vary if face-to-face interviews were conducted instead; 3) Most interviews (19 out of 20) were conducted in Chinese and only one in English. Translations between English and Chinese may have differences. Especially, in Chinese context, there is no term directly match "nonverbal communication". We needed to explain the meaning of the nonverbal communication to some of the participants; 4) Participants' age ranged from 16-29 and it has its limitations in representing the entire population of the blind.

6. CONCLUSION

This paper described a qualitative study aimed at gaining a better understanding of blind people's need in sensing nonverbal signals in face-to-face communication and which difficulties they have due to the lack of visual signals. We are particularly interested in their understanding of eyes which play an important role in the visual nonverbal communication.

The results show that auditory and tactile signals are two major nonverbal signals that blind participants perceive, but they seldom sense positive feelings from visual signals in face-to-face communication. Furthermore, blind participants tend to have an indirect understanding and fuzzy imagination of eyes and eye gestures. As the next step, the results of this study will be applied to inform the design of an assistive device which helps the blind people in accessing the necessary visual signals in a conversation to enhance communication with the sighted people.

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APPENDIX

Questionnaire of Nonverbal Signals for Face-to-Face Communication between the Blind and the Sighted

Name: _____ Gender: _____
Age: _____ Occupation: _____
Education: _____ Residence: _____

A.1 Vision Condition & Basic Information

1. Describe your vision condition.

_____

(For example: totally blind, visually impaired. Please provide descriptions of the medical diagnosis from the doctor as much as possible.)

2. Which reason caused you became blind or low-vision?

_____

(For example: blind by birth, blind after birth. If blind after birth, need to explain reasons.)

A.2 Use of Electronic Equipment

1. How long have you been using a computer?
○ Never use
○ Less than 5 years
○ 5-10 years
○ 10-15 years
○ More than 15 years

2. How long have you been using a mobile phone?
○ Never use
○ Less than 5 years
○ 5-10 years
○ 10-15 years
○ More than 15 years

3. Which brand of the mobile phone do you use?

_____

4. Which social networking websites as following do you have your own account?

□ Facebook	when_____
□ Twitter	when_____
□ Skype	when_____
□ Path	when_____
□ QQ	when_____
□ Sina Weibo	when_____
□ WeChat	when_____
□ Others	when_____

B. Nonverbal Signals in Face-to-Face Communication

Nonverbal signals include body languages, facial orientation, facial expressions, eye contacts etc.
1. Which nonverbal signal can you sense in face-to-face communication and how do you sense these nonverbal signals? (Please give examples.)

_____

2. Can you sense other one's moods (such as happiness, anger and impatience) by nonverbal signals in face-to-face communication? If yes, how do you sense? (Please give examples.)

_____

3. Which problems have you met in face-to-face communication due to a lack of visual nonverbal signals? (Please give examples.)

_____

4. Do you think eyes are important in face-to-face communication?
○ Yes
○ No

5. Based on question 4, does anyone else tell you or is it your own view?
○ Someone told you
○ My own view
If it is your own view, please explain the reason.

_____

6. How do people (such as your parents and teachers) explain the word "eye" to you in your childhood?

_____

7. What do you think of the appearance of the eyes? What are the functions of the eyes based on your understanding?

_____

8. "One person looks at the other person." Can you explain "look at" based on your understanding?

_____

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