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An Analysis of Sign Language Group Communication and Support of Such Communication by Projecting the Upper Body of the Signer

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Abstract. Effective sign language communication requires not only seeing the signer's hand, but also seeing facial expressions and body position, especially when communicating in groups. Here, we address the needs of those who use sign language in group settings. First, to better understand issues surrounding sign language group communication, we interviewed sign language users and performed in-loco observations of group communication. Then, we devised a support system projecting the signer's upper body onto a screen and compared group communication with and without the support system. The results revealed that participants found it difficult to see signers sitting adjacent to them, to follow quick turns in conversation, and to identify the next signer in time. Although signers preferred not to employ our system as their principal communication tool, they found it useful to identify the current signer.

Keywords: Sign Language · Group Communication. · Turn-Taking

1 Introduction

Effective sign language communication requires a clear view of the signer's hands, face, and body orientation [9]. This can be easily achieved in one-to-one settings by having signers stand face-to-face, but it is not as easy in groups. The traditional approach to group sign language communication is that participants should form a circle, affording clear views of everyone. Although this is effective for small groups of four or five people, in larger groups individuals find it increasingly difficult to see each other well and identify the signer-in-turn at a given moment.

Of course, those who use spoken languages face the same problems in larger settings; individuals may find it difficult to speak loudly enough so that everyone in a large audience can hear, so microphones may be used. If there is only one main speaker, one microphone may be adequate, but at large conferences several microphones may be passed around, or microphones may be attached to all seats, allowing all speakers to project their voices when needed. The same approach could be used when communicating in sign language; all participants could be recorded using individual cameras and the images projected onto a large screen. However, this would be costly and the necessary infrastructure may be lacking.

Given the relatively few studies on sign language group communication [7] and possible video supports, it remains unclear how such approaches might affect communication and what types of problems could arise. For example, a signer who is required to face a device or screen might find the lack of feedback from others problematic. Also, research has revealed [1] that signers tend not to take turns until they establish a mutual gaze; turn-taking would be compromised if all participants are expected to look at a screen instead of at each other. Because both space and viewpoint play important roles in sign languages [3], compressing an essentially tridimensional language onto a bidimensional screen might cause information loss and reduce overall comprehension.

Here, we sought to support in-person sign language group communication. First, to identify problems sign language communicators face in large groups, we conducted interviews and performed observations in-loco. Then, we explored the possible effects of mobile cameras combined with screen projection on communication. Although we worked with only a small group, we tried to reproduce problems encountered by larger groups. Here, we describe how technology can aid sign language group communication.

2 Related Work

Several studies have focused on support technologies enhancing sign language communication.

Yonehara and Nagashima [19] found that fluent signers read non-manual signs such as facial expressions using central vision, and capture manual signs with peripheral vision. However, while native signers may spend 80% to 90% of their time looking at the other signer's face, non-native signers tend to look more at the hands than the face while communicating. The amount of time spent looking at the signer's face tends to increase as sign language fluency improves. This points to the clear need for views of not only the hands of signers, but their full upper bodies, as the face is the most common gaze target when signing, and the gaze per se imparts information relevant to communication.

Of special interest in this context are studies on sign language that used a conversation analysis approach. Coates and Sutton-Spence [4] suggested that instead of the 'one-at-a-time' type of system such as that described by Sacks et al. [15] for those using spoken languages, signed languages might be more permissive of overlaps, and signers might orient to a 'collaborative floor.' In such an environment, any approach seeking to identify and display only one signer at a time might be flawed; several concomitant signers might be more acceptable. However, although several studies [11] have suggested that overlap is acceptable, recent research [2, 5, 7, 12] on sign language turn-taking has revealed one-at-a-time behavior closer to that suggested by Sacks et al. [15], and that signers deploy several strategies to solve overlap problems. If this is indeed the case, projecting only the main speaker might be of value.

The spread of 4G technology and the development of increasingly powerful smartphones render virtually any device capable of real-time video transmission of a quality adequate for sign language communication. Currently, the deaf community [6] uses several video chat applications including Glide [8] and Skype [16] to engage in remote sign language communication. Several studies have explored how the deaf employ

mobile technologies; long before real-time video transmission enabled remote sign language communication, the hearing-impaired enthusiastically adopted mobile devices, recognizing the possibilities afforded by visual media, texting, and picture-sending and display [17].

Kikuchi and Bono [10] investigated telecommunication between two mixed groups of signing and non-signing (deaf and hearing) individuals. The groups were remotely located and relied on screens for communication of sign language in groups concomitant with spoken communication; some participants encountered delay issues.

3 Methods

3.1 Interviews and in-loco observations

Interviews with two sign language users explored their experiences in group settings, challenges faced, and possible supports they would like when using sign language in groups. Both interview subjects were male college students in their early twenties, one of whom was deaf and the other was hearing.

In-loco observations were conducted by the author at the University of Tsukuba Sign Language Circle. This circle is composed of both hearing and hearing-impaired students, enrolled not only at the University of Tsukuba but also at the Tsukuba University of Technology, which supports hearing- impaired students, and thus has a large number of such students. In terms of sign language skills and background, members of the circle were very diverse, reflecting the entire spectrum from deaf students who used Japanese Sign Language as their first language to hearing students who had just started learning sign language and were still unable to effectively communicate without the support of spoken Japanese. The meetings thus featured a mix of spoken Japanese, Japanese Sign Language (JSL), and Signed Japanese[3]; when members who could not fully express themselves in sign language were communicating, others performed simultaneous translation. Additionally, when profoundly deaf members who did not have fully functional oral abilities were signing, hearing members with good sign language skills spoke aloud any words they thought some members might not understand when following the signs alone. We sought to better understand the dynamics of group communication in an environment where a sign language served as a common language. We observed seating arrangements, gazing, turn-taking, motion, and conversation strategies.

3.2 Experiment

We performed an experiment to better understand the dynamics of sign language group communication and the possible effects of mobile cameras and screen projection on such communication. A group of sign language speakers discussed certain topics over two 15-min periods, first without any aid and then with the support of mobile devices serving as individual cameras and a screen projecting the speaker-in-turn. The topics were chosen by participants from a list of topics provided at the beginning of the

[3] Signed Japanese is a manually coded form of Japanese that uses signs of Japanese Sign Language [20]

experiment. Participants first discussed the creation of a new holiday in Japan, and then discussed a subject they would remove from the Japanese middle-school curriculum.

Because the number of participants was small (five), they were asked to sit in a row to simulate the seating arrangement of a group with more participants. The room arrangement is shown in Figure 1

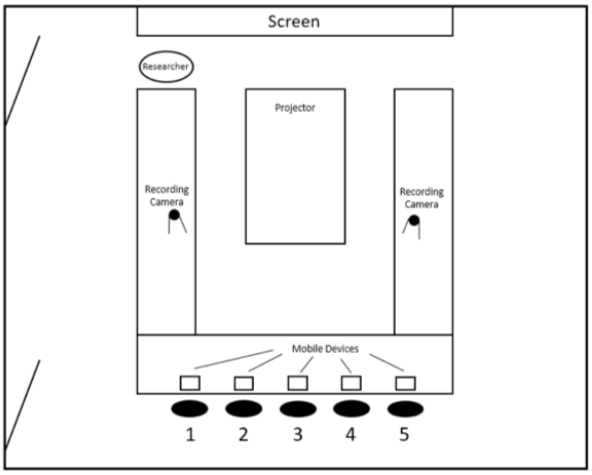

Fig. 1. Experiment arrangement

During the second 15-min session, a smartphone or a tablet was placed in front of each participant, on a stand, to ensure that the upper body was adequately captured by the front camera. Each device was connected via a videoconferencing application to the researcher's computer, which thus displayed all transmitted images. The screen of each mobile device displayed its own front camera image; participants could thus see how they were being captured.

The researcher's computer displayed the image of the signer-in-turn in real time. The mobile device source displayed was manually controlled, thus changing as the conversation proceeded and different participants took their turns signing. The entire conversation was recorded by two cameras placed as shown in Figure 1.

After both 15-min sessions had concluded, participants were asked to answer a questionnaire (free description) and underwent individual 5-min interviews exploring their views of the experiment and their experience with sign language group communication involving support technologies.

The entire experiment, including questionnaires, explanations, and interviews, was conducted in the Japanese language with Signed Japanese translation as needed. All English text presented here has been translated from the original Japanese.

We explored participant age, sign language background, and hearing condition, and then proceeded as follows:

1. In terms of the first 15-min session (without any form of support):

- 1.1 Was it easy to talk? (1–7)
- 1.2 Could you participate adequately? (1–7)
- 1.3 Could you understand other members' views? (1–7)
- 1.4 How visible was each person? (1–7 for each seat)
- 1.5 What was your extent of participation? (1–7)
- 1.6 If you felt any problem or difficulty during conversation, please describe the issue (free description).

2. In terms of the second 15-min session (with support):
   - 2.1–2.5 : The same as questions 1.1 to 1.5
   - 2.6 Was the image quality adequate to allow you to understand the sign language? (1–7)
   - 2.7 Was the support useful? (1–7)
   - 2.8 Please explain why the support was or was not useful (free description).
   - 2.9 If you encountered any problem or difficulty during conversation, please describe that issue (free description).
3. In terms of sign language group communication:
   - 3.1 Do you ever use sign language in groups? In what kinds of situations? (free description).
   - 3.2 Do you encounter any problem or difficulty when using sign language in groups? If yes, please describe the issue (free description).
   - 3.3 If there a support that you would like when using sign language, please describe it. Please do not concern yourself as to whether the support is or is not feasible (free description).

In the visibility questions (1.4 and 2.4), the score 1–7 corresponds to 0% to 100%. In other questions, the score 1–7 corresponds to 'Strongly Disagree' to 'Strongly Agree'.

We recruited five participants, all of whom were undergraduate students and aged 20–26 years (four males and one female). Three were hearing-impaired; all considered themselves to be fluent in sign language and were able to communicate without the aid of spoken Japanese throughout the entire experiment. All provided written informed consent prior to enrolment.

4 Results

4.1 Interviews and in-loco observations

In the preparatory interviews, both subjects described difficulties in seeing everyone simultaneously, and noted that this might be why some participants do not receive all information being exchanged. They identified two different sources of such difficulty. The first was simple sight obstruction, and the second was not knowing where to look; one interviewee commented that participants could "lose some of the conversation when the signer changes and I have not yet figured out who is now signing."

When asked about the strategies used to deal with these problems, both subjects stated that their favored approach to sight obstruction was to ensure the group was as circular as possible. Although this sometimes worked, *it may be difficult to achieve, depending on the number of people involved, the size of the room, and the types of tables and*

chairs available. The choice of long tables for three people, or small individual tables, is relevant when choosing a room for Sign Language Circle activities; individual tables are better. However, when a presentation requires the use of a screen, the need to open one side of the room means that the circle changes to a V- or U-shaped arrangement, forcing participants to sit side-by-side, rendering it more difficult to obtain mutually clear views.

In terms of the second issue, interviewees noted that when turn changes are extremely hard to follow, they might (in the worst-case scenario) "ask members to raise their hands and wait for other participants to turn toward them before they start to sign." They noted that sometimes, *when participants start signing in what might be considered a natural flow, either two people start signing at the same time without realizing it, or part of the group does not realize that someone has started signing, and thus keeps the conversation going in another direction.*

When specific content is considered important, and the group wants to ensure that everyone is following the topic, the interviewees stated that they usually have the signer in question stand and move to the front of the group, where s/he is visible to everyone and can lead the talk. Although this is effective, both interviewees noted that *it is time-consuming waiting for the person to move, and that while this technique may work for specific relevant announcements, it is impossible to use when the group needs to decide something collectively, such as the date or content of the next meeting.*

In-loco observations revealed that, apart from the problems described above, meetings were characterized by a great deal of moving of tables and chairs around the room, reflecting both dissatisfaction with the view of the signer-in-turn, and also individual clearing of a position when it was that individual's turn to communicate.

In terms of possible support technologies, both interviewees expressed desire for a feature that would render them easily visible to other participants without the need to move around the room; this would both improve overall understanding and reduce the time used to wait or to move furniture.

Finally, both interviewees noted that although Sign Language Circle activities usually involve 10–20 people, who can thus sit in a circle, conferences or lectures requiring people to sit in rows would particularly benefit from such support; in such cases, clear views of all speakers are impossible.

4.2 Experiment

Questionnaire answers Table 1 and Table 2 shows the questionnaire answers after both of the turns[4].

In the first 15-min session, the participant in position 2 found it necessary to constantly change the view-point to the right and left, and thus lost parts of the conversation. Another participant who scored a maximum for all questions found communication easy, because all participants well-understood hearing impairment, but noted that it was rather difficult to see everyone.

In the second 15-min session, the participant in position 2 noted the same problems as in the first session; the constant directional changes caused loss of parts of the

[4] The answers given to the free writing questions are omitted due to space limitation.

conversation. Another participant referred to feeling confused when having to wait for the screen to change before beginning to sign.

In terms of whether the support was useful or not, one participant referred to becoming more aware of his/her own speech, noting that this was good. The same participant noted that when sitting in a line, it is sometimes difficult to know who is signing at a given moment, and found the support useful in this context, in addition to making signing easier to see in general. In terms of negative aspects, two participants stated that the screen change times were too slow; they lost the beginning of the sign and often preferred to look at the signer directly. One participant complained about the delay between a sign and its display on the screen. Another participant referred to wanting to look directly at the person signing, noting that the screen was unsatisfactory. Finally, one participant observed that the screen was not necessary due to the small number of participants, but commented that it would be useful in a larger setting with more than 20 people.

	questions								
	1.1	1.2	1.3	1.4					1.5
				1	2	3	4	5	
p1	6	7	7	-	5	6	5	6	5.5
p2	4	3	5	4	-	5	5	5	2
p3	7	7	7	-	7	-	7	7	7
p4	7	7	7	7	7	7	-	7	5
p5	6	6	7	7	7	7	6	-	5

Table 1. Participants' answers regarding group talking without support

	questions										
	2.1	2.2	2.3	2.4					2.5	2.6	2.7
				1	2	3	4	5			
p1	3.5	5	5	-	5	6	5	6	5.5	4.5	1
p2	4	4	5	4	-	5	5	5	3	4	2
p3	7	7	7	7	7	-	7	7	7	5	7
p4	7	7	7	7	7	7	-	7	4	7	5
p5	6	6	7	7	7	7	7	-	6	6	5

Table 2. Participants' answers regarding group talking with support

Conversation analysis

First session — without support During the first 15-min session, it was apparent that signers accustomed to group communication had already developed favored strategies, including actions respectful of other members; there was no need to ask them to do this.

For example, at the exact moment conversation started, all three participants in the middle (positions 2, 3, and 4) pushed themselves backwards even when not requested to. It was not possible to retreat far from the original straight-line arrangement, but even a 30-cm backward push was crucial to afford clear views of participants in positions 1 and 5. These participants also gradually rotated toward the group, until they faced almost completely sideways.

Nonetheless, some participants struggled at several times during conversation, leaning forward to see a member who was more than two positions away. Also, the neutral positions adopted during conversation were usually inadequate to allow conversation with adjacent members. When the signer-in-turn was the person immediately next to them, all participants turned their chairs a few degrees toward him/her, to see the signing better.

Participants at the ends (positions 1 and 5) pushed their chairs forward to see signing from an angle rather than from the side. Signers in the other positions, however, did not exhibit the same behavior, perhaps aware that if they did so they would most likely obstruct the views of the more outside members; they limited themselves to turning in their places without horizontal movement.

A pattern that was observed many times was that when conversation was led principally by the two most distant participants (1 and 5), all other participants alternated their head and eye directions from right to left and vice versa. Participants were accustomed to this style of conversation and quickly adapted, moving their heads to the opposite direction as soon as a sentence concluded, knowing that an answer would most likely be forthcoming from the opposite direction. Although this allowed participants to follow all sentences completely, it meant that when conversation took an unexpected turn, the participants would be facing the wrong way. This is illustrated in Figure 2; when conversation was led by 1 and 5 for some time (Figure 2(a) and (b)), 2, 3, and 4 would turn their heads in the opposite direction as soon as any sentence finished, here marked by 1 lowering his/her arms (Figure 2(c)). However, just after doing so, 1 unexpectedly continued; 2 and 3 were facing the wrong direction for a period and thus lost the beginning of 1's continued signing (Figure 2(d)).

Appropriately seeing the person right next to oneself was an issue for some participants. On more than one occasion, participants failed to take the turn from participants sitting by their sides. In some cases, participants would tap the shoulders of persons whom they wished to take the turn, as a last resort.

Second session — with support Participants had mixed reactions toward the mobile devices and the main screen. Participants in positions 1 and 5, who previously ended up sideways to better see the group, did not turn in as much as before, probably because they knew that if they did so the cameras would not catch their signing.

Although some participants used the screen to see signing by other participants, they faced each other directly most of the time, ignoring the screen and the devices. However, participants did refer to the screen on several occasions.

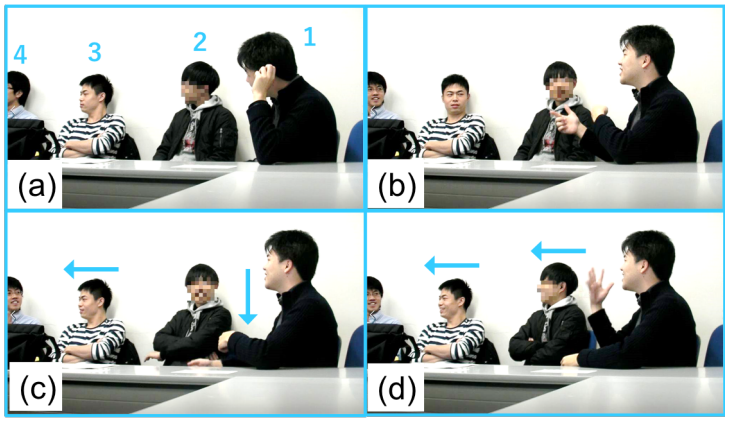

Fig. 2. Unexpected turn-taking causes participants to lose signing signals

When participants failed to correctly predict where the next signing would come from, and ended up facing in a direction from where no-one was signing, they would sometimes use the screen to recognize the signer-in-turn and then face in the correct direction. Also, participants located between two signers who were alternating turns, and who thus needed to constantly turn their heads, decided to look at the screen for as long as that conversation continued.

Usually, participants opted for direct conversation without using the screen; most problems evident in the first session remained evident, including the difficulty of seeing adjacent participants. As shown in Figure 3, on one occasion, the participant in position 1 was unable to see the signs by the participant in position 2 (Figure 3(a)), who had turned to better face the rest of the group. Because one comment was funny and made all other participants laugh, the participant in position 1 stopped the conversation and asked the participant in position 2 to repeat it (Figure 3(b)); participant 2 then turned to a more neutral angle where signing would be visible from position 1 and repeated the comment (Figure 3(c)). Interestingly, the next time the participant in position 2 became the focus of conversation, participant number 1 opted to use the screen, instead of looking at participant 2 directly (Figure 3(d)), perhaps as a reaction to the previous failure. Although this allowed participant 1 to correctly understand participant 2, participant 2 turned in the direction of participant number 1 when signing, probably expecting visual feedback, but participant 1 was looking at the screen and thus did not give such feedback, as shown in Figure 3(d). Participant 2 was somewhat distressed, but due to his desire for anonymity, we cannot show the expression of participant 2.

Interviews after the experiment With regard to using sign language in groups, most participants noted that they find it difficult to see signers well when a group contains 10 or more people. One participant noted that “the problem usually involves people sitting close, not those further away.” When features of a space force some signers to sit in a

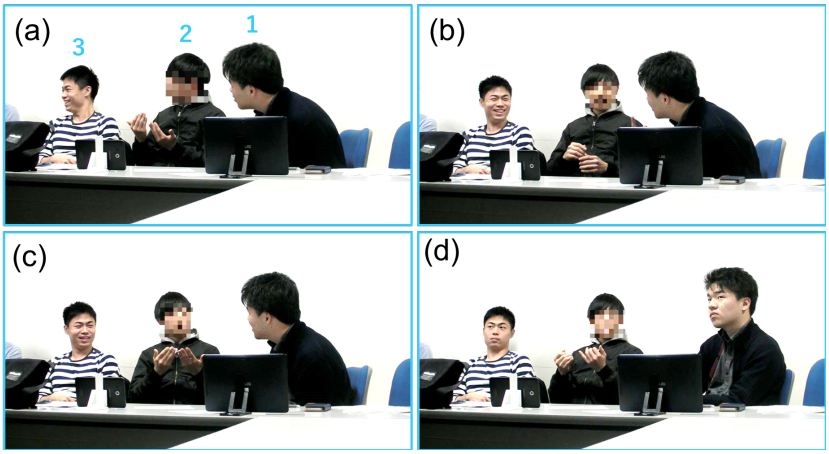

Fig. 3. Repetition of signing, and subsequent use of the screen

straight line, the mutual views of all such signers are obstructed. Another participant mentioned the need to "constantly move the gaze around the group."

With regard to participation in the experiment, participant 5 expressed difficulty seeing what participant 4 was signing, because participant 4 would turn to the left. Participant 2 also referred to having "difficulty managing my gaze, as it was necessary to go back and forth between participant number 1, on the left, and participants 3, 4, and 5, on the right." Although able to follow the conversation most of the time, participant 2 noted that "there were moments when parts of the conversation were lost because of that [head-turning]."

Participants had mixed reactions to the offered support. Two commented that it was useful and would be especially good on occasions where there are more than 20 participants, but others said the system was almost useless. Two participants stated that screen-changing was too slow; they lost the beginnings of signings if they followed conversations on the screen. One participant complained of the time delay between signing beginning and appearing on the screen. Two of the participants referred to preferring direct views, with one commenting "even if a screen was available, in a conversation, I would like to face the signer directly, so I would opt for a direct view over a screen even if the direct view was somewhat obstructed and the screen not." One participant who did not use the screen for most of the time commented that "the screen changes disturbed me, because they intruded into my peripheral vision and distracted me." Two participants referred to wanting to see reactions, with one noting the need to "see other participants' reactions while they talk; this would be impossible if staring at a screen."

On the positive side, almost all participants commented that although they would not use the screen as the principal means of following the conversation, quick glances at the screen were useful to see who was signing at any given moment. Also, two of the participants stated that it was useful for seeing signing when they could not obtain a clear view.

5 Discussion

5.1 Sign Language Group Communication Issues

We observed several patterns of sign language group communication. Signers were very aware of the obstacles they faced and adopted various strategies to benefit both them and other members, such as pushing backwards when sitting in a straight line or avoiding moving forward when they believed this would obstruct the view of others.

Although these strategies were successful to some extent, limitations were apparent. Group communication can be unsatisfactory if a circular arrangement is impossible due to the room size, type of furniture, or number of participants. Also, some strategies cannot be used by all participants. Body rotation was common to improve the views of others, but served to worsen the views of some participants, as the signer tended to turn in the direction in which most participants are located.

A need for rapid head and eye movement was evident, and some signers considered this difficult. The experiment revealed that the usual strategy was to move the gaze as soon as possible in the direction of the next expected signer. Overall, this strategy reduced missed signing, but failed when unexpected turn-taking occurred.

In general, both the questionnaire responses and interviews revealed that signers experienced most difficulties understanding adjacent signers. This may be attributed to two factors. First, sign language is usually viewed from the front; a side view is associated with significant information loss, especially that imparted by facial expressions and other non-manual messages. The other factor, evident in the experiment and expressed by two participants, is that when participants turn their bodies to be better seen by group members, some members actually have a poorer view than before. Rotation of distant participants does not have a strong effect, but even minor rotation of an adjacent participant may render it very difficult to see the hands and face of that person.

Such difficulties not only render signing comprehension difficult, but also compromise turn-taking. The experiment revealed that when participants wanted to take the turn from an adjacent person, they realized that traditional strategies such as a specific gaze or hand movement would not be perceived by the current signer, and were forced to touch the signer.

Although parallel signing was not observed in the experiment, possibly because of the small number of participants, the subjects mentioned that it is sometimes difficult to prevent it; two participants might start signing at the same time while not realizing it. As discussed in Section 2, overlap is a recurrent issue [2, 4, 5, 7, 11, 12] in the sign language literature. Although some recent studies [2, 5, 7, 12] have suggested that a one-at-a-time turn-taking is favored during sign language conversations, all of these studies evaluated groups of fewer than five speakers. In larger settings, overlaps may be more difficult to prevent, even if conscious efforts are made by the participants.

Compared with spoken languages, in which messages are by default broadcast, and two simultaneous utterances invariably disturb each other, simultaneous sign language comments might not necessarily constitute an overlap in the sense that multi-party attention is required to detect the situation; some instances might even be unobserved by the speakers. McIlvenny [13] found that maintaining a shared floor must be continually

addressed by employing conscious and explicit efforts, including actions such as tapping and waving.

In large settings, such strategies may be insufficient, which explains participants' comments that when content is considered important to the entire group, the signer moves to a spot where a clear view is possible for all group members. Although this approach is effective, it slows conversation and renders group interaction even more difficult, as all signers are forced to face the same direction rather than each other. Several participants noted that dealing with situations where many signers are present is complex, and some sort of support would be appreciated.

5.2 Signer, Upper Body Screen Projection as a Support

Projecting the signer-in-turn in an effort to facilitate group conversation led to diverse reactions. Although all participants remained in conversation principally by looking directly at the other members of the group, the screen was not useless, as revealed by some answers to the questionnaire.

Even if the screen did not control the conversation, it was useful to identify the signer-in-turn. No participant viewed the screen continuously, but several participants took quick glances to verify who was signing. One participant commented that the screen was useful both to understand signing per se and to identify the signer-in-turn.

All participants commented that they did not use the screen as the principal conversational tool because of the lack of visual feedback from other participants. Looking at the screen prevented participants from seeing the reactions of other signers, and was of particular concern to the signer-in-turn, who would see only him/herself. Simultaneous screening of all participant images was suggested, but attracted mixed reactions. One participant said this would not be helpful, because s/he would try to see everything that was happening at the same time and would become lost. Another stated that even if all participants were on the screen, s/he would still prefer to look directly at the signer. Some participants commented that such an approach was reasonable and that they would like to try it. However, although the approach may work for groups of up to 10 people, such groups might be able to communicate effectively even without support. With larger groups of 20 or more, it is hard to imagine how showing all members at the same time on a screen would be either feasible or desirable.

Although concern with the lack of reactions from others when signing was expected, failure to use the screen had an unexpected effect. During the experiment, participant 1, who had previously failed to see the signing of participant 2, decided to look at the screen to improve understanding of the conversation, but when participant 2 was signing again, s/he turned toward participant 1, who was now looking at the screen instead, creating discomfort for participant 2.

In terms of the technical features of the support, two participants felt that screen changes between signers were too slow. This could possibly be addressed via automatic signer recognition followed by a rapid screen change; however, it is not clear how an automatic recognition algorithm would deal with overlap. Also, sign language users deliver confirmatory and feedback signs in the same manner as spoken language users; avoiding erroneous recognition of such signs may be problematic.

Also, one participant was bothered by the time delay of signing. Previous research [14] has shown that the delay usually tolerated by signers is about 150 ms, considerably more than the 45 ms tolerated by spoken language users. However, the experimental time delay was less than 150 ms, perhaps explaining why only one of the five participants considered it problematic. During the interview, the participant stated that seeing signing on the screen after performing signing or directly seeing signing made him/her uncomfortable. Thus, although the time delay tolerated by sign language users is about 150 ms, this may be reduced when signers are exposed to both original and delayed sources simultaneously, creating discomfort that is absent when the signer has access to only the delayed source.

Overall, signers desired support when communicating in groups. Simple signer upper-body projection onto a screen facilitated signer viewing and recognition, but signers were very concerned about the lack of feedback (the inability to see the reactions of non-signing members). The participants agreed that the screen would be useful in settings with 20 or more people, such as lectures. Also, regardless of whether the screen helped make signing more visible to participants, it was helpful to identify the signer.

6 Conclusion

When in large groups, signers find it difficult to obtain clear views of all participants, and may struggle to correctly recognize who is the principal signer at any moment; fast head and eye movements are used to understand the content being shared in conversation. Also, simultaneous sign language utterances may break the turn-taking mechanism, creating parallel conversations.

Signers find it especially difficult to see adjacent signers because of poor visualization angles, leading to loss of information (such as facial expressions). The views of aligned participants are also obstructed. When participants sit in rows facing the same direction (as during lectures), it is impossible to obtain clear views of some signers.

Projecting the signer's upper body onto the screen facilitated signing visualization, and also indicated who was the speaker-in-turn, allowing participants to face the correct direction rapidly. However, several obstacles in terms of feedback and the reactions of others remain.

The lack of feedback was perceived as negative by all participants. Participants could not see the reactions of others on the screen, and those who were not using the screen experienced negative emotions when they tried to look at another member who was staring at the screen. However, the participants acknowledged that in larger settings, such effects are unavoidable and must be endured to some extent.

To address the remaining issues, it will be necessary to ensure that participants looking at a signer on a screen impart and receive feedback to/from the signer and others. Automatic signer recognition is desirable. Finally, even if the signer-in-turn is not projected, there is a clear need for a form of support allowing participants to correctly recognize the signer-in-turn faster.

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