Title	Representation of 'communication atmosphere' for the deaf and hard of hearing
Sub Title	
Author	El Hussein, Mariam(Okawa, Keiko) 大川, 恵子
Publisher	慶應義塾大学大学院メディアデザイン研究科
Publication year	2014
Jtitle	
JaLC DOI	
Abstract	
Notes	修士学位論文. 2014年度メディアデザイン学 第344号
Genre	Thesis or Dissertation
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO40001001-00002014-0344

Master's Thesis
Academic Year 2014

Representation of 'Communication Atmosphere' for the Deaf and Hard of Hearing

Graduate School of Media Design,
Keio University

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A Master's Thesis
submitted to Graduate School of Media Design, Keio University
in partial fulfillment of the requirements for the degree of
MASTER of Media Design

Mariam El Hussein

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Abstract of Master's Thesis of Academic Year 2014

Representation of 'Communication Atmosphere' for the Deaf and Hard of Hearing

Category: Action Research

Summary

Communication is the means in which people exchange and share thoughts, ideas, and feelings. However, deaf and hard of hearing individuals face various difficulties in communicating with others in social and work environments. These struggles hinder collaboration and place great stress on deaf and hard of hearing individuals.

Although universities, research institutes, and companies provide various forms of support, such as note-taking or sign language interpretation, transcription is the main focus. Text-based support often omits important nonverbal information (i.e intonation, facial expression, and body language). The inaccessibility to this information contributes to misunderstandings and impedes communication.

This research proposes a supplementary communication tool, Kooki, to support deaf and hard of hearing students in educational settings through multisensory representation of 'communication atmosphere'. Communication atmosphere is a collection of the nonverbal cues occurring during an interaction between individuals, which guide the two-way nature of a conversation. Unawareness of such cues results in passive participation on the part of the deaf and hard of hearing individual. Kooki provides the missing information necessary for more active participation. This is in the interest of promoting stronger mutual understanding between the deaf and hard of hearing and 'hearing society'.

Keywords:

Deaf and Hard of Hearing, Communication Atmosphere, Face-to-Face Interactions, Communication, Non Verbal Cues

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Chapter 1

Introduction

"The most important thing in communication is hearing what isn't said." [7]

Communication is a ubiquitous part of our everyday life. We communicate while getting our morning coffee, having a meeting at work, attending a lecture at school, or enjoying time with friends. Such routine interactions carry enormous meaning that goes beyond our conscious utterance of spoken words. Albert Mehrabian, a pioneer in the field of understanding communication, indicates that face-to-face communication consists of spoken word, tone of voice, and body language. He established the widely recognized 7 percent, 38 percent, 55 percent communication model. [16] In Mehrania's model, spoken words account for 7%, the way the words are said for 38 %, and body language for 55%. Thus, as much as 93% of communication is non-spoken. The importance of non-spoken communication is undervalued, due to its unconscious nature. On the other hand, individuals with hearing limitations consciously rely on such communication for all interactions, including ones often deemed easy or trivial. People often assume the problem that Deaf and Hard of Hearing (DHH) individuals face in communication is rooted in the fact that they are unable to hear spoken words. Although this is an overgeneralization, DHH individuals also miss important non-spoken information. For instance, tone of voice, pitch, and volume which often express attitudes and emotions. This issue is intensified with the presence of other transcription services. Attention is dedicated to acquiring the transcription of speech, which creates a larger gap of missing information (i.e. non-spoken, such as body

language). This issue has a profound effect on the social inclusion of the DHH in a conversation and educational settings, such as discussions and meetings.

1.1. Background and Motivation

In 2012 there were a reported 3.5 million Canadians experiencing hearing impairment, which is roughly 10% of the total population. Of the 3.5 million, 350,000 (1%) were profoundly deaf and deafened, while 3.15 million (9%) were hard of hearing. The definition of DHH people highly depends on personal identification of the DHH individuals themselves. The most significant difference between 'deaf' and 'hard of hearing' is the degree of severity of hearing loss. Generally, hard of hearing individuals have a mild to moderate level of hearing loss while deaf individuals have severe to profound hearing loss.

There is a misconception that DHH individuals are unable to produce speech. With the support of hearing aids, some DHH individuals are able to communicate verbally. However, the clarity of speech depends on the degree of hearing loss. The most common means of communication amongst DHH individuals is sign language. Sign language is not universal — it differs depending on the national language. For instance, American Sign Language (ASL) is used in the United States and Japanese Sign Language (JSL) is used in Japan. In communication with hearing persons, DHH individuals resort to other methods of communication, as sign language is often not an option. Lipreading, email, virtual notepads, and pen and paper are amongst some of these methods. Such methods are only feasible in one-on-one communication. Interaction in larger groups is more difficult, specifically in the context of discussions or meetings.

As the number of people increases, the difficulty of keeping up with and being included in a conversation also increases. DHH individuals often require additional assistance in order to participate in large groups. Note-taking and sign language translation are among the most common methods of transcription of speech. Note-taking requires either voluntary untrained or paid professional note takers. However, sign language interpretation requires a professional interpreter. Although widely available, the workforce required is often costly. Beyond the issue of cost, DHH individuals need to allocate a large percentage of their attention

to the transcript — whether in the form of notes or sign language. As notes are often viewed on a computer screen, the DHH's attention on the speaker, environment, and others in the room is drastically limited. This limitation causes the DHH to miss certain aspects of communication, which are not available in transcripts. For instance, eye contact when being spoken to, body language, and facial expressions portraying emotions and attitudes. In addition, other information from voice — such as volume and pitch, which carry a lot of meaning — is missing due to the inability to hear. As note takers have a highly demanding task of transcribing speech, it is extremely difficult to include picturesque descriptions of such information. The inaccessibility issue contributes to the DHH being and feeling increasingly excluded in conversations and social interactions.

Feelings of exclusion discourage DHH individuals from entering the conversation and often put them under an immense amount of stress. DHH students, in particular, have difficulties as support is needed for lectures, meetings, discussions, and extracircular social activities. The insufficient support available in larger groups, coupled with the stress it brings about, cause DHH individuals to be more passive participants in a conversation. As DHH individuals, regardless of their impairment, have as much potential as hearing persons, it is necessary to provide new encouraging ways to unlock this potential.

1.2. Research Objective

The lack of non-spoken information is a large contributing factor to DHH individuals' inability to effectively engage in the conversation. As discussed above, non-spoken communication is comprises more than 60% of overall communication. If even a small percentage of this 60% could be made visible to the DHH, their participation in conversations can be facilitated. Thus, this research explores the kind of missing information the DHH can benefit most from. In addition, the optimal representation of such information is tested and considered.

Considering the case of note-taking support, there are various participants in a conversation with different needs. In simple terms, the stakeholders consist of the DHH participant, hearing participants, and a note taker. The DHH participants are often the minority in a large group, such as in discussions and meetings in

educational institutions. The DHH student faces difficulties acquiring and reading the transcript at a speed simultaneous to the current conversation. They are often left with many unanswered questions, which are directed at the only source of information — the note taker. Note takers have a highly demanding position. Note takers must listen to the real time conversation and transcribe, as fast as possible, in order to keep the DHH participant updated. However, there is a certain time lag due to speech being faster than the ability to transcribe it. The time lag is different depending on the skill level of the note taker. In addition, note takers are under an immense amount of stress as they are the point of communication between the DHH participants. As mentioned earlier, DHH individuals often ask note takers for information they are unable to catch or for clarification. Some of these questions may revolve around aspects that are untranscribable, such as tone of voice, body language, and other non-spoken communication. The time lag coupled with lack of information make it difficult for hearing participants to communicate smoothly with DHH participants.

The field this research is mainly focused on is the DHH in educational settings, specifically meetings and discussions. DHH students who are in higher education are required to complete group assignments and work in research projects and laboratories alongside other students, professors, and faculty. Some educational institutes provide support in the form of note-taking or sign language interpretation. However, the access to such resources is not constant and DHH students often resort to asking friends and classmates for assistance. Support from classmates and friends is a great alternative; however, there is a limitation of language and professional skill. It is not guaranteed that colleagues are able to use sign language. In the case of note-taking, the skill is at an amateur level, as other students often have no experience with note-taking. In some cases, the DHH student resorts to their classmates' personal notes or materials presented at the meeting and discussion in order to follow the conversation. This often discourages the DHH student from attending meetings and discussions, contributing to more passive participation, if it is possible to participate at all.

Taking this into consideration, this research thesis explores a possible solution to this communication issue through the proposal of Kooki. Kooki is a supplementary communication tool that aims to provide the DHH with some of the missing

information, in hopes of encouraging more active participation in a conversation and creating smoother communication for all participants. Kooki captures non-spoken information and represents it in a different form, excluding sound. The concept of Kooki is to provide an external multi-sensory device that portrays needed information. The low fidelity prototypes were created and tested both on-screen (alongside note-taking) and off-screen. Furthermore, the prototypes explored various representations, such as visual and tactile, to create feedback that is useful and least distracting. As the focus on the notes and speakers is enough of a demanding task for DHH participants, Kooki strives to provide additional needed information seamlessly. It is important to consider the purpose of this research is not to create the ideal supplementary tool, but rather explore the various possibilities and contribute to the ongoing research by creating guidelines that future works, tackling this issue, can be modeled upon.

The author's experience with a DHH friend during the course of this research inspired the creation of Kooki. The author's goal is to encourage hearing persons to take the chance and try to communicate with DHH individuals. It is a great learning experience for either side and can lead to strong bonds, new friendships and appreciation for the ability to communicate with others regardless of any barriers. Thus, Kooki aims to bridge the communication gap between the DHH and others by bringing them closer together through smoother communication and stronger mutual understanding.

1.3. Thesis Overview

This thesis is comprised of five chapters. The abstract and Chapter 1 outlining the overview of this research and the research problem have been discussed thus far. The remaining portion of this research thesis will cover the following topics:

Chapter 2: Literature Review
Chapter 2 will survey theoretical background and related works, which are important in understanding the inspiration behind and novelty of the proposed concept. It also provides details about the main demographic of the DHH in order to better understand the issues this research discusses and aims to resolve.

Chapter 3: Fieldwork and Concept
Chapter 3 provides details of the fieldwork conducted in order to better understand the issues faced by DHH students when communicating with hearing students. A summary of observational findings and literature findings that influenced the proposed concept will be discussed. An overview of the proposed concept and its details will be introduced.

Chapter 4: Implementation and Evaluation
Chapter 4 discusses the low fidelity prototypes created for the purposes of this research proposal, their implementation in a preliminary and main experiment and the results and feedback from the experiments. The evaluation of the proposed solution was conducted via observations, questionnaires, and interviews, which will be discussed in this chapter.

Chapter 5: Conclusion and Future Work
Chapter 5 will discuss the findings from the experiments and their effect on the communication between DHH and hearing students. In addition, basic guidelines for future development or creation of similar concepts will be discussed. An overview of this research and its contribution as well as what needs to be considered for further development and future work will be discussed.

1.4. Key Terms

1. Verbal Communication: the processes of receiving and sending messages between people through speech cues.

2. Nonverbal Communication: the processes of receiving and sending messages between people through wordless cues (i.e. visual).

3. Note Taking: transcription or recording of information from another source (i.e. video, lecture, conversation).

4. Communication Atmosphere: a collection of non-verbal cues from speech, facial expression and body language that we exhibit while participating in

a conversation.

5. Multi-sensory Representation: the presentation of sensory information in a different form. For example, speech (sound) to vibration (touch).

6. Deaf and Hard of Hearing: the partial or complete inability to hear. This term refers to individuals, communities and hearing impairment.

Chapter 2

Literature Review

This thesis recognizes the importance of taking the plausibility and novelty of the research presented in this thesis into consideration. Insight on the limitations and possibilities of the research and experiments as well as the inspiration behind the proposed concept is vital. Following a brief outline of the scope of this research, selected literature will be reviewed in relation to significant theoretical background and related works pertaining to previous research in the same field. Theoretical background will describe in detail about DHH individuals coupled with communication theories pertaining to the proposed concept Kooki. Related works will discuss pros and cons of previous solutions and their significant influence on the development of the Kooki concept.

The research presented in this thesis was conducted over a period of a two-year Master's Program. In order to maintain the integrity of results and viable contribution to research in the field, within the time limit, this thesis tackled a portion of the overall Kooki concept. With such consideration, the focus is to provide a proof of the proposed concept and its relevance. This is in hope of stimulating further discussion on research in the field and providing recommendations for future improvement and completion of the Kooki concept. Thus, this action research thesis will test and collect a primary set of data, discuss findings, share insights, and offer guidelines as a base for subsequent developments of technological solutions for the DHH.

2.1. The Deaf and Hard of Hearing

The term "deaf and hard of hearing" is commonly used to refer to individuals with a hearing impairment. Barnett (2002) defines hard of hearing people as, "those with hearing loss who can still derive some linguistically useful information from speech [1]. On the other hand, "deaf people receive no useful linguistic information from sound [1]." Hearing loss is classified into six degrees: normal, mild, moderate, moderately severe, severe, and profound. [1] Both DHH individuals are often associated with or actively a part of the Deaf community. The Deaf community is a tightly knit group that share strong connections and pride in their culture [5]. Deaf communities are not exclusive to DHH individuals. Deaf communities often include hearing individuals who interact, support, and work with deaf individuals [5]. DHH individuals are often surrounded by close friends, family, or a community where they are understood and accepted [22]. Social activities are crucial for Deaf communities. Through social gatherings, DHH individuals obtain support and a sense of shared values and common cultural beliefs [30]. This emphasizes their desire to identify as a community, rather than a group of people with a disability [30].

DHH individuals who associate with Deaf culture do not consider themselves as persons with disability [1]. They consider themselves a community with their own unique culture, separate from hearing people, rather than a group of individuals who are simply grouped together on the basis that they experience similar challenges [32]. Furthermore, there is a differentiation between individuals who identify with Deaf culture and others who do not. "Deaf" with a capital "D" is for associates of Deaf culture, whereas "deaf" with a lower case "d" refer to all individuals with hearing impairments [5].

Individuals who are born deaf or hard of hearing learn to communicate differently depending on the type of family they are born into. Those born into a deaf family learn sign language at an early age.[2] Deaf children slowly pick up on signs similar to young hearing children slowly picking up on speech [5]. If a person is born into a deaf family, their English skills often develop later on at school or at home. However, due to the early onset of learning signs, these individuals develop communication skills at an early stage. On the contrary, if a deaf person is born into a hearing family, the environment is not as communication-

rich and their learning is limited. They often use gestures or other methods to communicate with family [5]. They learn signing and other communication skills later on, bringing about slower development of communication.[3] As the development of language is heavily dependent on hearing the spoken words, those who are born deaf are at a significant disadvantage and often have much difficulty learning written and verbal languages [18].

On the other hand, individuals who are born hearing and lose their hearing over time learn to communicate initially through hearing speech. People who lose their hearing over time do not rely heavily on sign language as they have already learned written and spoken language. These individuals compensate for their hearing loss via the use of hearing aids and other types of assistive devices.[4] As has been discussed by the research presented thus far, DHH individuals have a wide range of communication abilities. Thus, the preferred method of communication, type of technology used, and assistance needed varies depending on the communication ability [5].

2.1.1 Deaf and Hard of Hearing Communication

DHH individuals interact with each other and with hearing people using various communication methods. Some of the communication methods include verbal communication, lipreading, sign language, and text-based communication. Depending on their communication abilities and preferences, some individuals utilize several methods while others solely depend on one. Each method has different requirements, strengths, and challenges.

2.1.2 Verbal Communication

Deaf individuals who communicate verbally can be categorized into late-deafened adults and verbally educated deaf people. Late-deafened adults experience a progressive adjustment of their communication approaches slowly, parallel to their progressing hearing loss [1]. Those who lose their hearing ability later in life have already practiced speech through hearing and associate with hearing persons [29]. Verbally educated deaf people are deafened in childhood and attended schools that emphasized verbal and reading skills [1]. According to a National Longitudi-

nal Transition Study (NLTS2) [27] conducted in the United States from 2000 to 2009, DHH students who attended regular schools are more likely to use spoken language (Figure2.1) [27].

	DHH students overall		Secondary school type: Regular schools only		Special schools only		Mix of special and regular schools	
	Percent	*SE*	Percent	*SE*	Percent	*SE*	Percent	*SE*
Youth uses:								
Oral speech (800)	87.2	*1.93*	94.5	*1.53*	59.0	*8.39*	70.0	*8.53*
Lipreading (800)	77.3	*2.62*	76.5	*3.02*	79.2	*4.98*	80.5	*7.70*
Cued speech (800)	33.8	*2.88*	29.4	*2.66*	52.4	*6.57*	40.9	*11.86*
Sign language (810)	61.9	*3.24*	51.6	*3.57*	98.1	*1.29*	91.6	*4.50*
Members of youth's household use sign language (among households of students who use sign language, 570)	73.8	*4.15*	67.6	*4.81*	87.8	*5.63*	82.0	*7.72*

Figure 2.1: Parent-reported demographic characteristics of secondary school deaf and hard of hearing (DHH) students

	DHH students overall		Secondary school type: Regular schools only		Special schools only		Mix of special and regular schools	
	Percent/mean	*SE*	Percent/mean	*SE*	Percent/mean	*SE*	Percent/mean	*SE*
Severity of hearing loss (840)								
Mild/hears normally	13.3	*2.17*	15.7	*2.73*	2.3	*1.07*	9.6	*5.30*
Moderate	25.2	*3.32*	29.6	*3.80*	6.9	*2.27*	15.4	*6.04*
Severe to profound	61.5	*4.16*	54.8	*4.55*	90.8	*2.57*	75.1	*8.82*
Youth has a cochlear implant (810)	6.0	*1.48*	6.0	*1.64*	3.0	*1.39*	10.6	*7.39*
Youth has an assistive listening device (810)	86.8	*1.92*	87.7	*2.12*	83.6	*5.99*	83.4	*6.31*
How well youth hears with a hearing device (among those with a device; 660)								
Hears normally	21.4	*3.60*	24.4	*4.09*	7.6	*2.39*	14.3	*6.56*
Has a little trouble hearing	39.8	*4.00*	45.4	*4.44*	15.8	*3.20*	27.9	*8.66*
Has a lot of trouble hearing	28.4	*2.74*	25.6	*2.94*	38.0	*5.10*	37.7	*9.19*
Does not hear at all	10.5	*2.41*	4.5	*1.80*	38.5	*7.46*	20.1	*7.98*
Mean age of youth when started having problem/disability (840)	2.5	*0.20*	2.9	*0.22*	1.6	*0.61*	1.3	*0.48*
Mean age of youth when started receiving services (780)	4.1	*0.20*	4.5	*0.22*	2.5	*0.26*	3.3	*0.68*

Figure 2.2: Parent-reported disability categories and health problems of secondary school deaf and hard of hearing (DHH)

The majority of students used hearing aids or other devices, and a few students were able to hear normally with a hearing device (Figure2.2) [27]. DHH students who have less trouble hearing tend to attend regular schools.

It is important to emphasize that not every DHH individual is capable of communicating through speech. Other communication methods that do not involve the production or hearing of speech are utilized for DHH individuals who are incapable of verbal communication.

Lipreading

Lipreading, often referred to as speechreading in research, is a communication method that requires training. According to NLTS [27], lipreading is very common for DHH students regardless of the type of school they attend [27]. Shaver et al.'s (2014) analysis categorizes schools into three categories: regular schools, special schools (for disabilities) or attendance of both. Lipreading refers to, "the processes of interpreting mouth and facial movements along with information gained from residual hearing and conversational context to aid in the comprehension of spoken language [13]." Lipreading is a difficult skill to develop and is quite challenging for people who have never heard spoken language before [1].

Without sound, at best only 30% of English is readable on lips. [1] This is due to the high level of ambiguity in lipreading as several phonemes in English have similar lip patterns. [2] Thus, the amount and accuracy of information from lipreading varies with individual differences of the DHH. [31] Hearing aids are essential for lipreading to maximize the accuracy of information.

Sign Language

Unlike lipreading and verbal communication, sign language is a communication method that is entirely independent of speech. Sign language is its own distinct language with no reliance on languages of hearing people [5]. Sign language is a vital mode of communication for DHH individuals, particularly those who lose their hearing before the age of 3 [1]. Sign language is a highly visual language, incorporating more than simply movements of the hand. The meaning of signs depends on various factors. Hand orientation, movement, direction of movement, shape of hand, and location in space or on the body are vital to understanding the language [5]. For instance, words signed with a specific hand shape have a completely different meaning when movement is applied. Facial expressions and 3D space are also vital elements to the language [5]. Sign language is a common communication method among the DHH, however, when communicating with hearing persons, sign language is not as suitable.

Text-Based Communication

DHH individuals born deaf have a learning disadvantage with regards to reading and writing. As a consequence, they often face difficulties understanding the complexities and tones involved in writing. However, some forms of text-based communication are popular among the Deaf community in spite of these difficulties [5]. Text-based communication enables a deaf person to communicate with a hearing person who is unable to sign without an interpreter's assistance. Email and Short Message Service (SMS) are amongst the most common types of text-based communication technologies utilized by the DHH [5].

Email and SMS are the most popular technologies for the DHH due to the common usage by both DHH and hearing persons [24]. Smart phones allow for communication using a single device with various applications available (including notepad). Text-based communication exists on mobile phones, on computers, and in person through pen and paper. DHH individuals often carry a notepad and pen to facilitate communication with hearing individuals [5]. The pen and paper method is a more feasible solution in face-to-face communication, whereas email and SMS is best for asynchronous communication.

Deaf and Hard of Hearing Challenges

As discussed above, the DHH are extremely diverse in their ability to communicate. Regardless of the diversity in hearing impairment levels and communication ability, all DHH individuals face similar challenges. Some of these challenges include: social inclusion in various environments (e.g. school, work), active participation, and overall communication with hearing persons. Powell et al. (2013) conducted a survey with postsecondary DHH students across New Zealand. One of the participants indicated the common and large struggle with group discussions: "I just make sure that I know who is speaking. It is more of a challenge when it's not well controlled and people are dancing all over the place [23]." (Figure2.3) [23] highlights the results from Powell's study and shows the extent to which respondents felt their hearing loss affected their ability to participate in specific learning environments.

While lectures and social functions were ranked the most difficult, accessing support services was ranked the least difficult. During a lecture, DHH students

	Very little	Small amount	Fair amount	Quite a lot	Great deal
Lectures	11% (7)	20% (13)	24% (15)	18% (12)	27% (17)
Receiving instructions or supervision	15% (10)	24% (15)	29% (18)	13% (9)	19% (12)
Tutorials	19% (12)	21% (14)	23% (15)	16% (10)	21% (13)
Accessing support services	40% (25)	28% (18)	10% (7)	5% (3)	17% (11)
Casual interactions with other students	16% (11)	26% (16)	22% (14)	16% (10)	20% (13)
Social functions	10% (7)	15% (9)	21% (13)	21% (13)	33% (22)

Figure 2.3: Effects of hearing loss on ability to participate in different environments in percentages (N = 64)

have to switch focus between the lecture slides and the interpreter or note taker. It is very difficult to determine when to shift focus, thus causing significant missing of important information [12].

In addition, there are several difficulties concerning social interactions at universities or educational institutes. Students recognized that participating in the wider aspects of campus life produced a positive effect on their feeling of belonging and their overall postsecondary experience [23]. However, students had difficulties in access to and participation in activities such as debates, sports teams, and other social events. Some DHH students exhibited low expectations about accommodations of their social needs outside of Deaf communities [23]. Numerous participants experienced feelings of isolation, loneliness, and frustration with their lack of casual and social interaction with hearing students. It is difficult to overcome these challenges as DHH students often do not have the support they need to fully participate in extracurricular activities [23].

Despite accessing support services' ranking at the lowest level of difficulty, a number of participants had problems with building positive and effective relationships with disability support staff [23]. This is mainly due to the perceived attitudes, low staff awareness about being deaf and difficulties with communication. Participants felt that disability and academic staff should receive "deaf awareness" training prior to having a DHH student [23]. A shortage of qualified and experienced interpreters with the ability to deliver sufficient interpreting services at the postsecondary level was found. In addition, the quality of notes vary greatly depending on the note taker's experience [23]. Students may also find it difficult to understand signs for words used in a specific field of study — interpreters often finger spell such words. In particular, unfamiliar and long words are quite difficult to comprehend [28].

DHH individuals, specifically students, face serious challenges in accessing sup-

port services, such as note takers and interpreters. Support is needed in order to enhance learning, participation in discussions and meetings, and inclusion in social circles and activities. Universities and educational institutes lack access to a sufficient number of experienced note takers and interpreters. In addition, note-taking and interpretation services are expensive and time consuming. Taking the lack of support and cost factors into account, it is evident that technologies that allow DHH students to enhance learning and join social activities independently are essential. The following subsection of Chapter 2 will discuss related works regarding assistive technologies for DHH individuals, particularly students, which aim to enhance learning and communication with hearing persons.

2.2. Assistive Technology for the Deaf and Hard of Hearing

Assistive technology for the DHH is an extensively studied and researched topic. The scope of assistive technology is quite broad and changes with the emerging of new technologies. This section will summarize and discuss some of the recent assistive technology for the DHH. These will serve as related works, alongside various fieldworks conducted, which inspired the concept of Kooki. Related works cover assistive technologies such as: sign language translation and recognition, note-taking, speech recognition and note-taking, visual aids, and emotion and atmosphere recognition.

Sign Language Translation and Recognition

Sign language is a common communication method amongst DHH individuals. However, it requires hearing persons to study the language in order to be able to communicate with DHH individuals using signs. In an attempt to encourage hearing persons to use sign language and decrease the language barrier between the hearing and the DHH, various technologies have been explored to provide sign language translation and recognition.

Sign Language Translation

One of the recent studies on sign language translation is a type of user-generated sign dictionary. Boulares and Jemni created a web service for sign language translation. Users simply input text, of any word of interest, into the search box on a mobile phone application. The web service engine then extracts the sign for the searched word from the database. The unique feature of this system is that users can also participate in creating their own signs, on the web tool, and store it in the database. This encourages users to expand the database of signs and makes sign language learning a more interactive and fun experience. Although pre-made signs are stored and readily available in the database, sign language varies depending on the spoken language and Deaf community. This application is not only useful for the DHH who are learning sign language, but also applies to hearing persons to encourage them to learn sign language in an interactive manner [3].

The more the hearing persons use this application to communicate with the Deaf community, the more they will become aware of sign language and its implications. In addition, the increase in hearing persons who know sign language will facilitate and bridge the language barrier between hearing persons and the Deaf community. This can create opportunities for hearing persons to interact with the DHH. However, the potential is very limited and conditional — depending on the motivation to learn sign language. DHH persons have to rely on the users' efforts to understand sign language. Additionally, it is faster to communicate with a pen and paper than looking up a sign or waiting for a translation. Thus, this application does help hearing persons interact with DHH individuals through learning sign language, however, it does not give them independency in the communication.

Sign Language Recognition

Another approach to bridging the communication barrier using sign language is sign language recognition, rather than translation from text-to-sign. Chai et al. (2013) created a sign language recognition and animation system called VisualComm. VisualComm was designed to enhance communication between hearing individuals and the DHH by interactively communicating via sign language. As a preliminary test, a total of 370 different signs in Chinese sign language, chosen

from frequently used signs, were inputted into the system [4]. The system uses Microsoft Kinect, which captures the motion of a sign. The captured sign is then converted to text and shown on the display. The researchers recruited one deaf person and four hearing individuals for their experiment. During the experiment, the accuracy of recognition was approximately 95%. The speed of recognition was considered satisfactory according to the participants. In addition, the system converts text input or uttered speech by hearing individuals into sign language. An animated avatar demonstrates the converted sign language on the display, as well as delivers accompanying facial expressions [4].

In comparison to the mobile sign language translation system created by Boulares and Jemni (2012), VisualComm assists more of a two-way communication flow at a faster speed. This in turn could decrease the DHH's need for a note taker or translator when communicating with hearing persons. The issue of time is still present as use of VisualComm may not be feasible for long discussions and larger groups. Nevertheless, VisualComm would greatly contribute to the enhancement of real-time communication and interaction between hearing persons and the DHH.

Note-taking

Note-taking is the practice of recording information presented by another source. By taking notes, the writer records the essence of the information for later reviewing [15]. Powell et al. (2013) conducted a survey among 64 post-secondary DHH students across New Zealand. According to the survey, the most frequently accessed and requested academic accommodation was note-taking services (65%), and it was highly rated (47%). Although the majority of respondents found note-taking very useful, there were several concerns about note-taking services. Some of the concerns included the quality timeliness of the notes. For instance, some notes were unreadable, or a student received the notes a month after the lecture. Students classified trained note takers as delivering a better quality service than manual notes from peers or inexperienced note takers [23]. Furthermore, students indicated a strong preference towards electronic note-taking, rather than manual, as it guarantees readability [23]. Note-taking is a promising method in terms of accommodation of DHH students. Note-taking aids in the processes of

taking notes and understanding the contents of lectures. However, the aspect of interaction with other students and teachers is unaccounted for.

Speech Recognition and Note-taking

Speech (to text) recognition is the transcription of spoken words to text. The potential of speech recognition in note-taking is one of the recent researched topics surrounding assistive technology for the DHH. The use of speech recognition in note-taking can be categorized into automated real-time captioning and automated video transcription.

Automated Real-time Captioning

Real-time note-taking using speech recognition is a valuable resource for DHH individuals, especially students, as it provides up-to-date information. The use of speech recognition also eliminates the need for a note taker, thus reducing the cost and resources. Daassi-Gnaba and Krahe (2009) and Duerstock et al. (2011) utilized speech recognition technology to facilitate assistive note-taking. Daassi-Gnaba and Krahe (2009) used Dragon Naturally Speaking (ver 7.1.) software to facilitate note-taking in the hopes of reducing the communication barrier between hearing people and the DHH. Dragon Naturally Speaking (ver 7.1.) is a software that converts speech into text at up to 160 words-per-minute [6]. On the other hand, Duerstok et al. (2011) used International Business Machines Corporation's (IBM) ViaScribe for real-time lecture captioning. However, ViaScribe requires speaker training with IBM's ViaVoice to create a personalized user profile. ViaScribe was used to automatically display the instructor's speech transcription, in real-time, on a projection screen. Dual projection screens in the classroom were needed to display the instructor's caption in real-time and the instructor's materials (PowerPoint slides) [8].

Although real-time speech recognition is a feasible and efficient solution, there is a significant issue with regards to accuracy. In Duerstock et al.'s (2011) experiment, while the accuracy was 73.4% when the speaker went through training, the accuracy dropped down to 55% when the speaker did not go through the required training. This creates an extra requirement of time to train speakers. Feedback from students and instructors exhibited an overall positive response in that this

approach enhanced teaching and learning. However respondents indicated the benefits would only be significant if captioning was highly accurate (85% and above) [8]. Thus, error correction is necessary to improve the accuracy of transcribed information. This additional task would require human resources through volunteering, paid work, or academic incentive. The speaker training is also a significant issue as instructors are often busy and may not always have time to do the required training prior to lectures.

From Daassi-Gnaba and Krahe's (2009) and Duerstock et al.'s (2011) perspective, real-time captioning may not be effective for learning. However, if the problem of accuracy is resolved, real-time transcription using speech recognition would give DHH students independency and enhance their real-time communication and interaction with hearing people in classroom and meeting settings.

Automated Video Transcription

Automated video transcription also involves transcription using speech recognition technology; however, it is not done in real-time. For instance, lecture transcription performed after the lecture has been recorded. Duerstock et al. (2011) conducted a comparative study of real-time lecture captioning (discussed above) and lecture transcription. In lecture captioning, the software used was IBM's Hosted Transcription Service (HTS) for speech recognition. The best feature of this speech recognition engine is that the system does not require speaker training for the recording quality, unlike real-time lecture captioning. In addition, word error correction is performed after transcription is completed. The processes involved the recording of the instructor's voice, with the corresponding PowerPoint slide, during class. The audio was then converted into text through HTS. The word accuracy with HTS was an impressive 87.5% [8]. Throughout the experiment, multimedia files (slide images, audio file and timings for synchronization) and lecture transcripts were generated. These synchronized class notes were then uploaded to Synote[5] for students to view once registered [8].

Synote is a web application accessible to learners with any learning or physical disability. Synote "works with web multimedia and stores annotations separately in XML format; synchronizes captions, images, tags links, notes and bookmarks; enables users to add and search for annotations quickly and easily; supports pri-

vate or shared annotations" and is accessible to people with any disability [33]. Bookmarks in Synote are called "Synmarks". Synmarks contain titles, tags, notes, and links. When the recording is played, words are highlighted in the transcript simultaneously. Selecting a Synmark, transcript word, or slide image moves the recording to the corresponding time. Users can search transcripts, Synmarks, in addition to slide titles, notes and, text content [33]. This kind of multimedia class note technology is a very valuable resource for DHH individuals attending universities and educational institutes as it provides detailed, accurate transcription of lectures.

Overall, the outcome of the lecture transcriptions studies conducted by Duerstock et al. (2011) was positive. Most of the students said lecture transcripts improved learning, efficiency, and test results. Wald (2010) teaches electronics and computer science at the University of Southampton using Synote with over 40 recordings of his lectures. A high percentage (80%) of his 200 students found the lecture transcripts easy to use and beneficial to their learning [33].

Automated video transcription technology, such as lecture transcription, is great assistive technology, which helps all students, including individuals with disabilities, in getting the most out of their learning experience. As for students with disabilities, such as the DHH, it provides information they have no access to due to their impairment. Furthermore, lecture transcription provides a long-term relatively low cost alternative compared to hiring a professional note taker for every individual lecture. In addition, the technology gives DHH students confidence by allowing them to learn independently. However, learning with lecture transcripts can hinder student attendance. In fact, 42% of Wald's students stated that is does a have an effect on attendance, which reduces the opportunities of interaction between students in the classroom [33]. This could have a profound impact on DHH students' interaction with classmates, instructors, and their overall inclusion in the social activities of school life.

Visual Aids

Sign language translation and recognition, note-taking, and speech recognition are methods that focus solely on information in the spoken word. Providing the DHH with captioning or transcription of the spoken word is a significant step

towards their accommodation and inclusion. However, there is much more to human communication beyond spoken words. Facial expressions, tone of voice, and body language are amongst some of the vast variety of non-spoken language that humans use to communication with each other. Attention and eye contact are key elements in locating important information and expressing interest. DHH individuals are overwhelmed with information at lectures — teaching materials on the screen, lecturers, and notes or translation all need equal timely attention in order to maximize the learning experience. This puts great pressure on DHH students and increases their stress when attending lectures.

In order to resolve some of these learning challenges, Kushalnagar et al. (2012) aimed to create lecture materials with reference cues that provide guided learning. They recruited hearing students to view a lecture video. While viewing, eye tracking data was collected using SensoMotoric instruments in order to recreate the lecture video with reference cues. The lecture was divided into segments of four and a half minutes each and the DHH students' eye movements with and without the cues (prerecorded) were observed. The lecture with reference cues displayed a slow moving spotlight with a 90% transparency portraying hearing students' gaze during that very lecture [12].

Results yielded a significant improvement (31%) in the DHH students attention on teaching materials. The spotlight eye tracking visual cues emphasized important information, which gave the DHH students enough time to take notes and understand the content. However, this approach is still not completely independent, as an interpreter is needed nonetheless. In addition, this approach requires the DHH students to watch the video after the lecture is over in order to collect the eye tracking data during the live lecture. This discourages the attendance of DHH students and decreases their inclusion in the classroom.

Emotion and Atmosphere Recognition

Emotion and overall atmosphere of a conversation is something that can not be transcribed into text. Emotions have a profound effect on communication. The meaning of spoken words changes with the way the speaker utters the words — often related to their emotional state. This inspired some researchers to take a different approach to assistive technology for the DHH, exploring emotion and

speech recognition and representation.

Emotion Recognition

Emotions are often expressed through voice and the way spoken words are uttered. These expressions cannot be transcribed into text via note-taking or similar communication methods for the DHH. Daassi-Gnaba and Krahe (2009) tackled this issue by creating an avatar, which displays emotions expressed in speech. Alongside speech recognition, a software called WinSnoori was utilized to create Greta with the aim of visualizing nonverbal information from speech. WinSnoori was used to collect phonetic information and analyze acoustic and prosodic elements of speech. Furthermore, Greta is a 3D model that talks and simultaneously gives facial expressions, gestures, gaze, and head movements. [6] Greta has six types of facial expressions; disgust, happiness, fear, anger, surprise as well as neutral [6]. In their research, Greta's facial expressions were used to portray emotion. Emotion is determined by analyzing the speech signal and contour [6].

This approach has the potential to enhance real-time communication between hearing and the DHH in large groups by providing another layer of information — emotions. This enables the DHH to understand and create more emotional connections with hearing persons in a conversation. However, the analysis of phonetic information and operation of Greta required professional knowledge, making it different for DHH users to use the system independently.

Emotional Cues and Atmosphere Recognition

The emotions of speakers in a conversation create an overall "atmosphere" to the interaction. Atmosphere can guide others in the conversation and change the way people interact with each other. However, DHH individuals lack access to this kind of information, which makes seamless inclusion and participation in conversations difficult. In a fun attempt to visualize emotional cues and the atmosphere of a conversation, Nambo et al. (2012) proposed a system that visualizes nonverbal expressions for the DHH. Inspired by techniques used in Japanese cartoons to express emotion and atmosphere, they proposed a system which mimics such expressions. The proposed system consists of three subsystems: an ambient font subsystem, balloon and graphical symbol subsystem, and onomatopoeic subsys-

tem [19]. In the ambient font subsystem, the size or the width of the written font changes according to the volume of the voice or the pitch of the speech. Speech in all systems is captured through a microphone. In the balloon and graphical symbol subsystem, the text extracted from speech is displayed in a balloon shape on the screen [19]. Depending on the volume and pitch of the speech, the balloon is decorated by graphic symbols to show the speaker's emotion. These two subsystems can substantially contribute to DHH individuals' understanding of emotional cues from speech. For instance, understanding stress points and a better knowledge of what is emphasized in a conversation. However, the mixture of different fonts could be a bit distracting when viewed alongside notes from note-taking. The onomatopoeic subsystem captures ambient sounds via another microphone in the classroom, which is then translated into onomatopoeic words [19]. This subsystem focuses on distinguishing other aspects in the atmosphere, such as chatting voice and noises in the classroom [19]. For example, sharing the real-time students' reactions to the lecturer's speech, such as laughter, applause, or even booing, has the potential to make the DHH students feel more integrated in the classroom environment. Such an experience can lead them to have a less stressful and more enjoyable learning experience during lectures. Although there is an issue with the accuracy of expressions as it is dependent on the different speakers, the system can be applied to speech recognition and note-taking as well.

Research on assistive technology is largely focused on providing as much as possible of the verbal information to the DHH. Note-taking, speech recognition, and sign language translation aim to bridge the information gap between the DHH and hearing persons. Visual aids, and emotion and atmosphere recognition adds another layer of information. All of these methods focus on a one-way flow of information, whether in real-time or not; there is little focus on providing incentive and encouraging the DHH to enter the conversation and be involved in a conversation. The research presented in this thesis aims to create a two-way flow of communication to encourage and facilitate the integration of DHH students in school and social activities.

2.3. Communication Theory

Atmosphere in face-to-face communication is a notion that is easily felt, but difficult to describe. Rutkowski and Mandic (2007) referred to this ambience as communication atmosphere [25]. Communication atmosphere is a term used to describe a collection of nonverbal cues from speech, facial expression, and body language that are evident when participating in a conversation [25]. Rutkowski and Mandic (2007) state that the notion of communication atmosphere has no exact definition and most commonly refers to a "conversation episode" [25]. As an interaction between individuals encompasses both verbal and nonverbal elements, communication atmosphere is an important factor in our understanding of and integration into a conversation.

Communication atmosphere is a phenomenon that is shaped and affected by three dimensions: environmental, communicative, and emotional [25]. Rutkowski and Mandic (2007) discuss each dimension and its impact on the "climate of human communication". Environmental factors are comprised of "ambient conditions in which communication takes place [25]." Ambient conditions not only affect how we perceive the communication, but can also change how we interact [25]. For instance, if the noise level in a room is too high, people tend to speak louder and their attention levels drop. Communicative factors are directly related to the individuals' involvement in a communication event [25]. This dimension is the most important component in communication atmosphere as it "refers to the communicator's audiovisual behavior in terms of their ability to interact in a meaningful way during a conversation [25]". Meaningful interaction involves the successful synchronization between the sender and receiver in a conversation, for example, turn taking [25]. Emotional factors are simply a reflection of the emotional state of participants in a conversation [25]. Emotions are an integral component in a conversation as they can change the course, tone, and overall "climate" of a conversation. Hence, environmental, communicative, and emotional factors have a profound effect on the communication atmosphere of a conversation.

In the case of communication between a DHH individual and a hearing individual[6], there is a prominent communication gap, largely due to lack of or low representation of communication atmosphere. Communicative and emotional factors

of communication atmosphere are particularly difficult to portray. Environmental factors are more easily felt, as observation of the surroundings and ambient environment is independent of human-communication. Nonetheless, environmental factors affect DHH communication with hearing individuals. For instance, some background noise can highly influence the DHH individuals' ability to understand speech and conversation. Communicative and emotional factors are produced and influenced by the people involved in the conversation. For DHH individuals, attention is a critical issue. As their focus is primarily on transcription via sign language interpreters or note-taking, meaningful interaction is very difficult. Additionally, perception of the emotional state of the participants is hindered due to the lack of information that is difficult to transcribe and thus feel. Hence, DHH individuals are often unaware of the atmosphere of a conversation, which further challenges their active participation. One of the largest contributing factors to these challenges is the absence of nonverbal communication in speech transcription.

2.3.1 Cue Perception and Processing

Nonverbal communication is an extensively studied and thoroughly examined topic. There are several definitions of nonverbal communication – worded differently – that share the same underlying messages. A simple definition of nonverbal communication is, "[it] consists of all the messages other than words that are used in communication [21]." Hence, a nonverbal cue is a wordless signal that is said or done by an individual when interacting and communicating with others.

Nonverbal cues are vastly diverse and appear in various forms. The four main categories nonverbal cues can be classified into are chronemics, kinesics, paralanguage and proxemics [14]. Chronemics [14] refers to the use of and interaction with time. Some cues related to chronemics are being late or early for an event or meeting and affecting the time of others (such as keeping someone waiting) [14]. Kinesics[7] refers to body movements such as facial expressions, eye contact, posture, and gestures [17]. Paralanguage refers to various aspects of voice that convey meaning beyond spoken word such as prosody[8], nonfluencies[9], volume, tempo[10], and pitch [25]. Proxemics refers to the use and perception of space, for instance conversational distance[11] and use and arrangement of physical space [25]. Thus,

nonverbal cues cover a wide range of actions that we exhibit everyday – both intentionally and subconsciously.

Nonverbal cues are a ubiquitous part of everyday life, particularly in face-to-face communication as they convey information parallel with the spoken word [20]. Approximately as much as 65% of overall communication in a face-to-face interaction is nonverbal, with only 35% of the verbal component [25]. In certain category-specific situations, for instance business related communication, nonverbal cues can impact 60% to 80% of overall communication [25]. Due to our vast exposure to nonverbal cues, we have a very clear understanding of their meaning and thus, react instinctively.

The non-spoken, information rich cues we exhibit alongside speech influence judgment of others, the overall communication, and ourselves. For instance, changes of body posture (kinesics) foreshadow a long utterance and may be kept for the duration of the speaking turn [11]. In this case, body posture cues act as markers for the start and end of a speaker's turn in a conversation. Similarly, the time of arrival to a meeting is a cue dependent on the speech and status of the speaker. In the case of an employee arriving late (chronemics), this is interpreted as being 'tardy' and explanations are regarded as an 'excuse' [14]. On the other hand, if a Chief Executive Officer (CEO) arrives late, it is reaffirmation of status and their 'busy' lifestyle [14]. Moreover, the distance (proxemics) between speakers is an indicator of their status and relationship. For instance, the style of speech and choice of words coupled with physical distance distinguish a business from a personal relationship [11].

One of the most relevant, and difficult to represent, nonverbal cues for the DHH are related to voice and speech (paralanguage). Verbal speech, and how it is uttered, contains an immense amount of information pertaining to the message itself and feelings behind it [26]. Serup et al. (2012) go as far as stating that, "Paralanguage can be recognized as something communicated 'beyond language"'. Pitch, volume, voice quality, and speech rate are among some of the cues that convey emotion, such as confidence, nervousness, anger, and enthusiasm [14]. For instance, a fast speech rate with higher frequency and intensity is a cue of anger [11]. Such verbal cues are difficult to transcribe using sign language interpretation, note-taking, or other common assistive methods. Thus, important

beyond language information is inaccessible to DHH individuals.

Contemporary developments in technology allow for the recreation of various psychological phenomenon, such as communication atmosphere and nonverbal communication. Human beings sense nonverbal cues in an unconscious manner, through visual and auditory perception [17]. In order to replicate this natural phenomenon, technology that is capable of capturing data similarly to eyes and ears is essential. Vinciarelli and Mohammadi (2012) suggest that most technological sensing of nonverbal communication have four main technological components: Capture, person detection, behavioral cues detection, and behavioral understanding. Capture is the initial and fundamental stage in sensing nonverbal communication. A wide variety of cameras, microphones and various sensors are capable of collecting and outputting data that is analyzed in the "sensing" process. The person detection component focuses on the segmentation of the captured data into parts that correspond to different individuals [17]. The behavioral cue detection component is the stage of processing nonverbal cues into meaningful data [17]. Examples of behavioral cue detection include facial expression recognition, gesture and posture recognition, and laughter detection. The final component is behavioral understanding, which focuses on human perceptions of nonverbal cues and their respective meaning. Emotion perception and social signals (relationships between individuals) are examples of behavioral understanding. Hence, representation of communication atmosphere is achievable when the above components are taken into consideration.

Notes

1 "Deaf Training and Awareness," Accessed on June 10, 2014 http://www.vicdeaf.com.au/content.asp?cid=8

2 "Deaf Training and Awareness," Accessed on June 10, 2014 http://www.vicdeaf.com.au/content.asp?cid=8

3 "Deaf Training and Awareness," Accessed on June 10, 2014 http://www.vicdeaf.com.au/content.asp?cid=8

4 "Deaf Training and Awareness," Accessed on June 10, 2014 http://www.vicdeaf.com.au/content.asp?cid=8

5 Synote. Accsesed on June 12th, 2014. http://www.synote.org

6 Hearing individual refers to someone a sense of hearing that considered normal medically.

7 Kinesics is also referred to as body language.

8 Prosody refers to rhythm in speech such as stress points and intonation.

9 Nonfluencies are utterances such as uh, um, ah.

10 Tempo refers to the speed or pace of speech.

11 Conversation distance is the distance between two people during a conversation.

Chapter 3

Fieldwork and Concept

The name of the proposed concept, Kooki, is a modification of the Japanese word "kuuki" within the context of the phrase "Kuuki wo Yomu." "Kuuki" means air and "yomu" means to read. When combined, the phrase means, "to read the atmosphere." This is relevant to the goals Kooki hopes to achieve — providing the DHH with a way to better "read the [communication] atmosphere." By offering more information from communication atmosphere, Kooki hopes to encourage the DHH to actively participate in the conversation and keep them informed.

Kooki aspires to support the communication between DHH and hearing individuals in various face-to-face communication environments and social interactions. For the purpose of this research, the main field of study is DHH students in educational settings, such as meetings, discussions and lectures. In order to better understand the DHH situation, various kinds of fieldwork were conducted. The findings will be discussed in this chapter as well as their influence on Kooki.

Due to the broad nature of this communication gap, this research is divided into two categories; section 3.1 and 3.2 will cover the first category, while 3.3 will cover the core concept and design of Kooki with regards to the second category. The two categories are as follows:

1. Identification of the components of communication atmosphere missing in text information from note taking that the DHH students need.

2. Creation of a tool (Kooki) that captures needed data from communication atmosphere and illustrates it in another form.

3.1. Understanding the Deaf and Hard of Hearing

Participation in Konektino[1] — a subproject under the Global Education Project[2] at the Graduate School of Media Design, Keio University[3] since September 2012 provided the opportunity to delve into the problems the DHH encounter in communication. The Konektino project focuses on utilizing Information and Communication Technology (ICT) tools to support DHH students in higher educational institutes. This gave the opportunity to work closely with the founder of the Konektino project — Hideyuki Kodama — who is a DHH individual. The various projects in Konektino, provided the chance to experience the problems of a DHH individual first hand. This two-year experience coupled with related fieldwork gave a better understanding of the difficulties DHH individuals face in face-to-face communication, social interactions, and being a part of a group.

3.2. Deaf and Hard of Hearing Observations

In order to better understand the communication amongst DHH individuals, as well as their communication with hearing persons, three types of fieldwork were conducted. The first fieldwork was conducted at a cram school for DHH high school students, where both the teacher (or tutor) and students are DHH and the main channel of communication is sign language. The second fieldwork consisted of observation and participation in a sign language class with hearing students and DHH teaching assistants. Finally, working for two years as an unprofessional note taker for a DHH individual, the above-mention Hideyuki Kodama, provided very valuable insight on the situation of DHH minorities in educational settings.

3.2.1 Cram School for Deaf and Hard of Hearing High School Students

For a hearing person it is often difficult to imagine a situation with regards to communication amongst DHH individuals. For this purpose, fieldwork was conducted at a cram school for DHH high school students. Table 3.1 outlines the

details pertaining to this fieldwork.

Table 3.1: Details of the First Fieldwork

Cram School for DHH Highschool Students	
Location	Shinjuku, Tokyo, Japan
Date	May 31st, 2013
Number of DHH	3 (2 students, 1 tutor)
Number of Hearing	none

Two approaches to fieldwork were conducted, passive and active observation. The passive observation was of a math class conducted by a DHH tutor. The active observation consisted of experiencing giving an English lesson, for the first time, to the two DHH high school students.

Passive Observation

The objective of the observation of the math class was to note how communication is carried out and what is important aside from the common language itself (sign language). The lesson took place for one hour and a half with two DHH students and one DHH tutor. The lesson format was open style, where the students asked questions, attempted to solve them independently and asked the tutor for help. The tutor gave a lesson for the duration of half the time about new concepts and concepts the students had trouble with in their homework. The amount of information exchanged was overwhelming amongst the students and the tutor without the utterance of a single spoken word. The most interesting finding was the method of getting each other's attention. Essentially, when hearing individuals want to direct a question at someone, they often call them by their name or look at them and the eye contact acts as a signal. The DHH individuals have an adaptation to compensate: the students were knocking on the table to get the tutor's attention. Although neither could actually hear the knock, when asked about this at the end of the class, the tutor explained that it is part of Deaf culture. Regardless of the ability to hear the sound, the vibration from the knock is felt and that it is a signal often used by the DHH to get each other's attention.

Other highlights included the structures of sign language and lipreading. Sign language was not just used as a language. The students hand movement, facial expression, hand shape, and even head tilt were all interconnected and working together to express what words could not. In the case of a very difficult word or concept, the tutor either wrote the words on the whiteboard or mouthed the letters slowly and the students were able to lipread and understand the information being presented.

Active Observation

The objective of conducting an English lesson was to gain experience of the problem first hand in order to note the difficulties in communication between the DHH and hearing persons and see how it can be resolved. In addition, another point of interest for this research was what components of communication proved to be the most important to get the point across. The lesson took place for 30 minutes and the students found it very difficult to communicate with this setting at first. The students often asked the tutor, who was also present, to translate. However, the tutor encouraged the students to try to understand independently. The observation made from the overall interaction is that it was difficult to communicate at first, as out of habit, such words were used that the students were unable to lipread when speech is too fast. However, as the lesson progressed, the students became more comfortable when different methods were tried out, such as using the whiteboard, written text, facial expressions, and body language to teach. The importance of multimodal communication was very prominent. The experience helped in confirming the importance and often underestimation of the power of non-spoken language, such as gestures, facial expression, and using the whole body to communicate.

Summary of Fieldwork 1

Overall, Fieldwork 1 provided valuable insight into the communication amongst the DHH as well as limited insight of the communication between hearing and DHH individuals. Some of the most important overall findings were:

1. Voice is still an important part of communication regardless of hearing loss.

2. Body language, facial expression, and gestures are common communication channels.

3. Tools used other than text: sign language, paper, whiteboard, markers, gestures, and facial expressions to express emotion.

3.2.2 Japanese Sign Language Class

As the previous fieldwork did not provide a large enough sample to observe the communication between hearing individuals and DHH individuals, further fieldwork was conducted at a Japanese Sign Language class in Asia University. The unique point of this class is that the professor is a hearing person, all the students are hearing persons, but the teaching assistants are all DHH individuals. Table 3.2 outlines the details pertaining to this fieldwork.

Table 3.2: Details of the Second Fieldwork

Asia University (Japanese Sign Language Class)	
Location	Musashisakai, Tokyo, Japan
Date	June 15th, 2013 & June 29th, 2013
Number of DHH	10 (teaching assistants)
Number of Hearing	51 (50 students, 1 professor)

Two approaches to fieldwork were conducted: observation and participation as well as conduction of interviews. The observation of and participation in Japanese Sign Language was to experience first hand the communication between DHH students and hearing students, as well as amongst the DHH themselves. Sign language was also studied to some extent out of interest sparked by working with Hideyuki Kodama and in order to observe the way one can communicate without the use of spoken words. The interviews were conducted to survey what kind of support DHH students get at their educational institute, their evaluation of the support, and the general difficulties they face in interacting with others in social scenarios and school-related gatherings (e.g. meeting, discussion, group work).

Observation and Participation

The objective of observing and participating in the Japanese Sign Language class was to look at how communication is carried out and what is important aside from sign language. The most intriguing observation was the use of lights. Hearing persons can simply announce the beginning and end of class and the start and end of a test. However, for DHH individuals, announcing using spoken words is not feasible. Thus the professor at Asia University utilized the flickering of light (turning the classroom lights off and back on) as a signal to get the attention of both hearing students and DHH teaching assistants. This finding offered a broader perspective on how non-spoken communication can be represented. Other findings included the use of exaggerated gestures, body movements (such was waving and knocking on the table to get the attention of the DHH), and the significance of facial expressions in expressing emotions.

Interview with the Teaching Assistants

Five of the DHH teaching assistants were interviewed for this research. Four out of five stated that the most common support available is note taking, but there is the problem of timing, as well as the inability to feel the atmosphere of the classroom and the speaker's emotions. One individual stated that the most common support in his university is sign language interpretation. However, it is difficult to request this service depending on the availability of the interpreter. He stated that it is difficult to understand the reason behind the class' laughter as he is unable to hear the laughter and there is a short time lag before knowing what is happening from the interpreter. Interview results can be summarized as follows:

1. Difficult to know about emotions (e.g. why everyone is laughing), need to ask other students constantly.

2. The most difficult thing to communicate is Deaf culture.

3. Facial expression is a part of grammar of communication.

Summary of Fieldwork 2

Overall, Fieldwork 2 provided valuable insight into the communication amongst the DHH as well as between hearing and DHH individuals. Some of the most important overall findings were:

1. There are interesting non-verbal ways of getting attention besides calling someone's name or making eye contact — especially when there is a large group – as seen with the flickering of lights.

2. Note-taking (one or two note takers) and sign language interpretation do not provide enough information for the DHH to participate in the conversation or be fully informed.

Both methods are one-way passive deliveries of information.

3.2.3 Experience as a Note-taker

In addition to the two fieldwork experiences conducted, observations were also made by experiencing what it is like to be an unprofessional note taker for two years at the Graduate School of Media Design at Keio University. This experience reconfirmed the findings of the fieldwork and brought to light the following additional problems:

Lectures

Problems observed when note taking in lectures included time lag, difficulty in keeping up with the speakers and decreased motivation. Time lag makes it difficult for DHH students to ask a question. In addition, DHH students are unable to know if there are people talking or not during a large class discussion. This in turn creates very little motivation to join or ask questions due to larger group.

Group Discussions

Problems observed when note-taking in-group discussions for class projects included great pressure on the note-taker. It is difficult for the note-taker to multitask and keep up with the note-taking, specifically in the case of multiple speakers.

Meetings

Problems observed when note taking in Global Education Meetings included difficulties working in a team, timing issue and difficulty in response. It was evidently difficult for the DHH student to work in a team, as additional support is needed in order to communicate with other members in the team. In addition, the DHH student was often unaware of the status of the conversation, causing interruptions while others were in mid-speech. This trimming issue created stress for the DHH student and discouraged active participation.

3.3. Kooki and Communication Atmosphere

After a thorough survey of existing related works, observations of communication habits of the DHH, and first hand experience as a note taker for two years, it was decided that the focus of this research would be the representation of non-verbal communication in a meaningful way. Non-verbal cues proved to be a vital part of communication and are the key to smoother communication. As note taking is a common practice for getting information for the DHH, it is important to consider the limitations of note taking. The limitations include the issue of attention. The DHH need to concentrate their undivided attention on the notes, causing them to miss a large amount of information. In addition, some of this information is in the sound itself, the way people utter spoken words. In order to provide the DHH with some of the missing information, the concept of Kooki was developed.

3.3.1 Concept and Purpose of Kooki

DHH students face difficulties being an active part of the discussion in meetings at higher educational institutes. In the specific case of note taking assistance, the limitations, as discussed above, discourage active participation, increasing the stress level of DHH students and excluding them from the conversation. Figure 3.1 describes the general communication model with the presence of a note taker. The communication is often channeled through the note taker rather than to the DHH student directly.

However, all the other information, which is not transcribed, is often “lost in

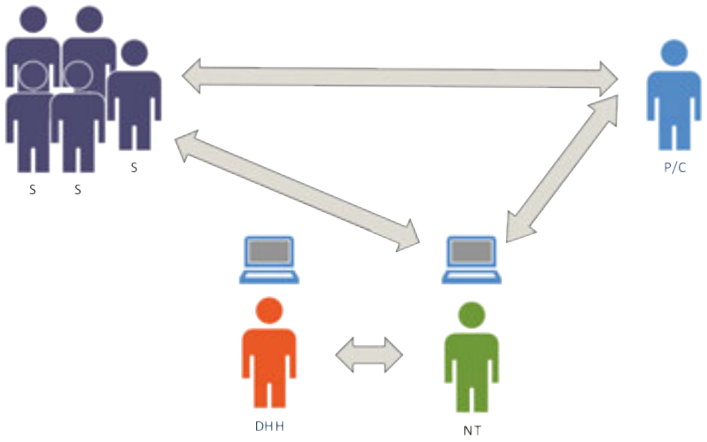

Figure 3.1: General Communication Model

transcription". As seen in Figure 3.2, there is a lot of additional information the communication atmosphere which is difficult to capture through note-taking and transcription methods.

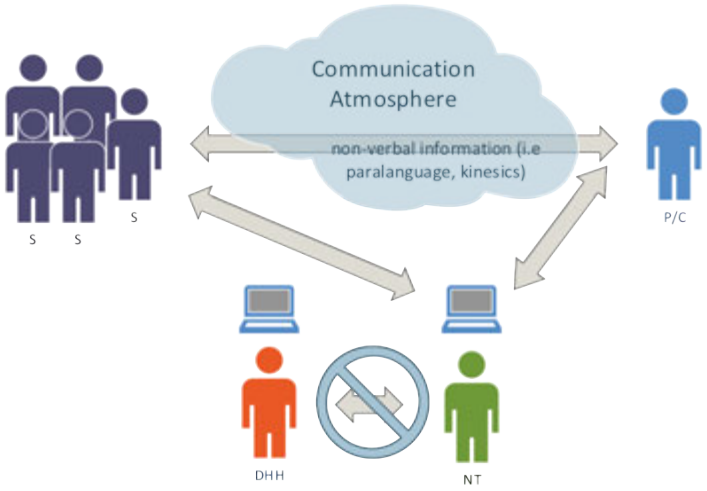

Figure 3.2: Current Communication Model and Problem

This lack of information is the biggest limitation of note-taking, which Kooki aims to supplement in order to create smoother communication and encourage

DHH students to join the conversation and participate more actively (Figure 3.3).

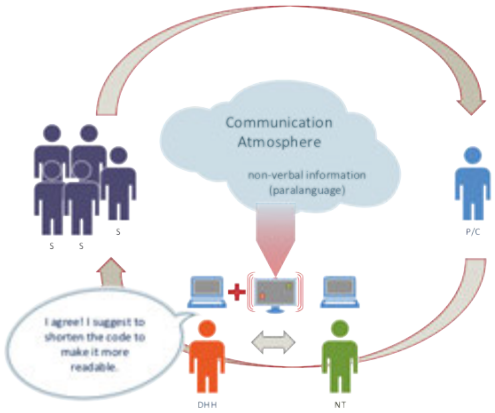

Figure 3.3: Revised Communication Model and Goal of Kooki

3.3.2 Characteristics of Kooki

Kooki is an experimental tool which portrays a representation of non-verbal cues from the communication atmosphere, in order to bridge the information gap from note-taking and provide DHH students with supplementary support in face-to-face interactions. The functions and characteristics of Kooki were influenced by limitations of existing solutions discussed in the related works as well as observations from the various fieldwork.

Literature Influence

The review of literature defined the problem the DHH face and some related works. Most of the related works, except for VisualComm, focused on getting the spoken words transcribed. It is a one-way flow of information and conversation, with the DHH individual left in a passive situation. This served as the inspiration to find non-verbal cues related to having a conversation: a two-way type of interaction.

Fieldwork Influence

The fieldwork helped identify some of the non-verbal communication necessary for the DHH as well as some representations that already exist in DHH culture,

such as vibration (knocking), visual use of color, and flickering of light. Table 3.3 outlines the problems faced by the two main stake holders, the note-taker and the DHH student, as observed in Fieldwork 3.

Table 3.3: Summary of Limitations of Note Taking

Note-taker	Time Lag, difficult to relay everything, capture only text
DHH	Difficult to participate, can focus only on notes, What? When? Who?

With fieldwork and literature findings taken into consideration, the desired overall characteristics of Kooki are summarized in (Table 3.4). This research proposal however focused on attention when spoken to (responsiveness) and conversation status (interruption).

Table 3.4: Functions and Specifications of Kooki

Input (microphone)	Output (screen)	Reason
Speech (SR)	Vibration (sensor)	Get attention when spoken to
Volume	Colored circle	Conversation status
Speech (pitch)	Display M/F	Gender of speaker
Speech	Display ENG/JPN	Language of speaker
Multiple Audio (multiple microphones)	Increase number of circles	Indicate number of speakers

Kooki works in a two-step process. Step one is capturing the data (as shown above) (Figure 3.4). The data is portrayed as voice data but the concept of Kooki is flexible and looks to explore other kinds of data in future developments.

Step two involves the analyzation of collected data and changing it into a different form. This form can be visual or tactile (multi-sensory). In future developments of Kooki other forms of representation of collected data will be explored.

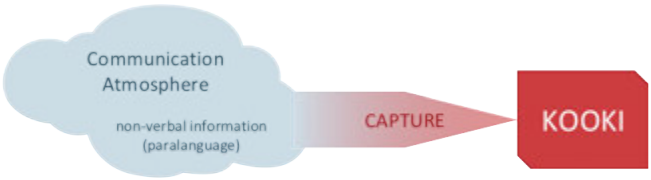

Figure 3.4: Kooki Step One

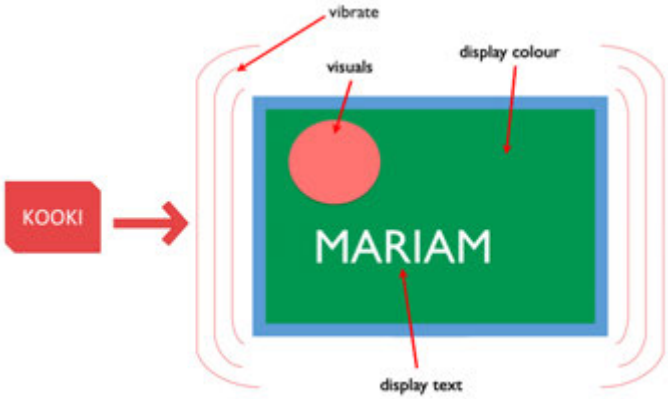

Figure 3.5: Kooki Step Two

3.3.3 Benefit for All Stakeholders

The benefits of Kooki are not strictly for the DHH; communication is a mutual two-way interaction. There are four main stakeholders in meeting interactions. Kooki aims to benefit each stakeholder in the following manner:

1. DHH student: Kooki will provide DHH students with necessary information to reduce their stress and exclusion, and encourage active participation in the conversation.

2. Note taker: Kooki will reduce the high demand of the task of providing information. The DHH student will know more and ask less of the note taker, decreasing the stress and increasing the efficiency of note taking.

3. Hearing students: Kooki will reduce the communication gap between DHH students and hearing students by providing smoother communication. This will hopefully encourage hearing students to interact with DHH students more.

4. Professors, lecturers, and faculty: similarly to hearing students, Kooki will provide easier, smoother communication between not only faculty and DHH students, but all stakeholders at once.

Notes

1 Konektino. Accessed June 18, 2014. http://konektino.strikingly.com/

2 Global Education. Accessed June 18, 2014. http://g-edu.kmd.keio.ac.jp/wordpress2012/.

3 Graduate School of Media Design - Keio University. Accessed June 18, 2014. http://www.kmd.keio.ac.jp/en.

Chapter 4

Implementation and Evaluation

In the implementation phase, the overall desired characteristics of Kooki, based on literature and fieldwork findings, were considered. However, this research utilizes the concept of Kooki as an experimental tool that provides a way of probing into the communication problems the DHH face and exploring possible solutions to these problems. Thus, Kooki is an ongoing project, with the initial proof of concept and respective findings discussed in this thesis.

Low-fidelity prototypes were created and tested over the course of two experiments. Each experiment included six prototypes tackling two specific problems regarding active participation of DHH students in the conversation. The prototypes served the purpose of identifying the needs pertaining to each problem and testing possible solutions to meet such needs and resolve each problem. Both Experiment 1 and 2 focused on the following problems:

1. **Interruption**: DHH students often interrupt the conversation while others are in mid-speech. This is due to their inability to know when someone is speaking, which is largely due to the time lag of the note-taking and focus on the note screen. Thus, DHH individuals often ask questions too late or interrupt the conversation at the wrong time.

2. **Responsiveness**: DHH individuals are unaware when they are being spoken to or being called upon. Considering their inability to physically hear their name being called, there is also an issue of missing the eye contact associated with being addressed. This is partly due to focusing on the note

screen or large numbers of speakers in group settings. Thus, communication is mainly channeled through the note-taker, placing additional stress on both the note-taker and DHH individual.

Evaluation of both experiments was conducted using qualitative methodology, as discussed by Hennik et. al in their book *Qualitative Research Methods* [10], using in-depth interviews and observations. In addition, a detailed pre and post questionnaire was administered in both experiments.

4.1. Experiment 1: Meeting

The first experiment was conducted on May 26th, 2014 (14:30 - 16:30 JST) at the middle meeting room on the 6th floor of the Collaboration Complex at Keio University (Hiyoshi Campus). The user study included feedback from one DHH student and six hearing students. The user test was held during the Global Education Project general meeting with 16 students in total. A summary of details pertaining to experiment one are outlined in Table 4.7.

Table 4.1: Summary: Experiment 1 Details

User Study 1 : Global Education Project Meeting	
Location	Middle Meeting Room (6F Collaboration Complex, Keio University, Hiyoshi Campus)
Date	May 36th, 2014 (14:30 - 16:30 JST)
Number of DHH Students	1
Number of Hearing Students	6 (1 note taker, 5 other)

4.1.1 Prototypes

The first low-fidelity prototypes of Kooki included three prototypes per problem area, as identified earlier (interruption and responsiveness). Each prototype

portrayed a different method of representation. The reason for testing three methods of representation per issue is an attempt to identify which representation is the most effective alongside note-taking. Thus, the goal of the prototypes was to identify the need, with regards to interruption and responsiveness, as well as find the best representation of relevant data for each specific need. The prototypes were created using a variety of approaches, such as paper-prototyping, digital-prototyping, and physical-prototyping (using arduino). The prototyping approach was selected based upon the feasibility and representation method.

Interruption Prototypes

In the interruption category, three prototypes were created with three corresponding representations of text, color, and vibration. The various indications aim to reduce interruption at the wrong time by the DHH individual and facilitate a natural flow of discussion.

Text representation was tested using a paper prototype (Figure 4.1). The purpose of the text (Yes/No) was to indicate the status of the discussion. The 'Yes' card indicates the current status as 'someone is speaking,' while the 'No' card indicates the current status as 'no one is speaking'.

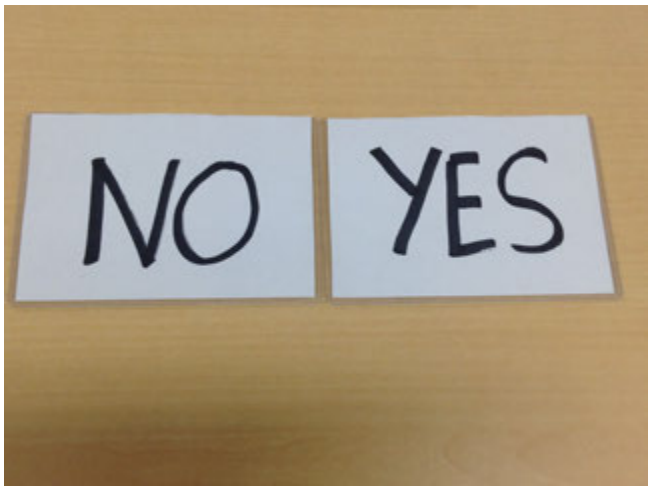

Figure 4.1: Interruption: Text Representation

Color representation was tested using a digital prototype (Figure 4.2). The program Processing 2.0.3 was used to create a circle that changes color (green

or red) with the change in volume (see appendix A). A laptop was used to run the prototype and display it, and the internal microphone was used to collect volume data for analysis. A red circle was displayed indicating the current status as 'someone is speaking'. Meanwhile, a green circle was displayed indicating the current status as 'no one is speaking'. The idea of using red and green circles is similar to a traffic light with red signaling 'stop, do not interrupt' and green signaling 'go, you may interrupt'.

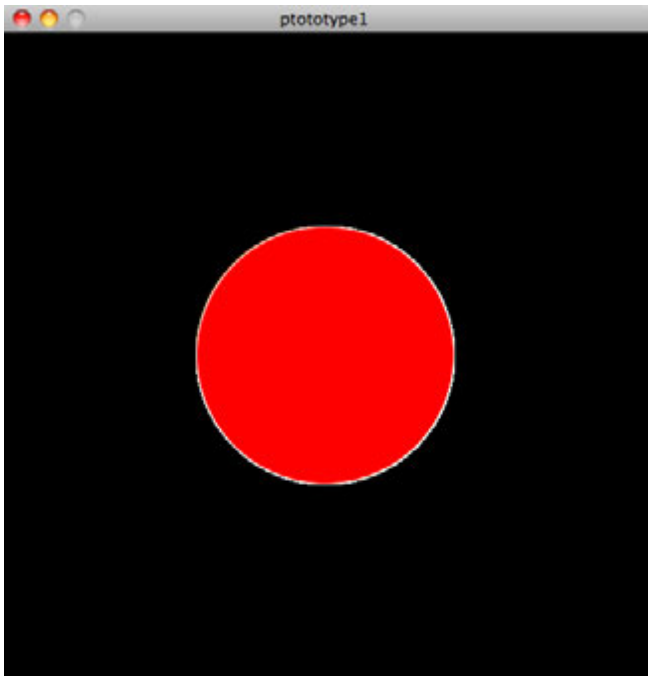

Figure 4.2: Interruption: Color Representation

Vibration representation was tested using a physical prototype (Figure 4.6). Arduino 1.0.1 was used to write and run the program (see appendix B.1). The prototype was created using one vibration motor, one button, one resistor, and one circuit board. The circuit was connected to one Arduino powered by a connection to a laptop. The vibration motor was activated by the push of a button. The vibration was a tactile representation of discussion status, where the onset of vibration indicates that 'someone is speaking' and no vibration indicates that 'no one is speaking'.

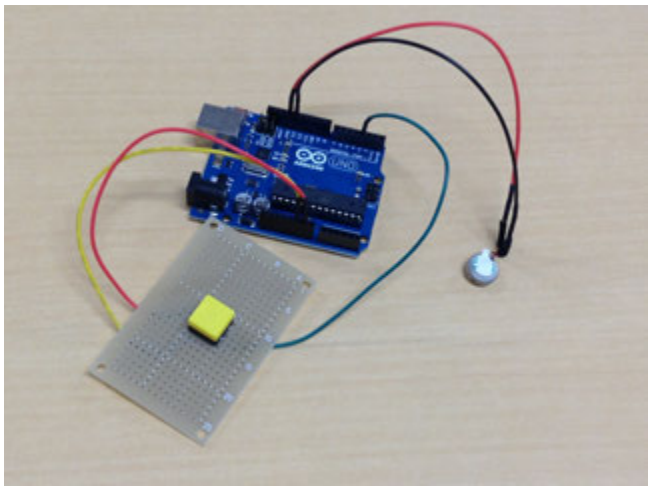

Figure 4.3: Interruption: Vibration Representation

Responsiveness Prototypes

In the responsiveness category, three prototypes were created with three corresponding representations of text, color, and vibration. The various indications aim to reduce the time-lag of the DHH student's response to being called upon or talked to, which in turn facilitates a more natural flow of discussion.

Text representation was tested using a paper prototype (Figure 4.4). The purpose of the text (the name of the DHH student) was to indicate that someone was addressing them or talking about them during the discussion.

Color representation was tested using a digital prototype (Figure 4.5). HyperText Markup Language (HTML) and Cascading Style Sheets (CSS) were used to create a prototype of a screen (see appendix C.3), which flashed red when the DHH student's name was uttered. The purpose was to catch the DHH student's attention on the laptop screen.

Vibration representation was tested using a physical prototype (Figure 4.6). Arduino 1.0.1 was used to write and run the program (see appendix B.2). The prototype was created using one vibration motor, one button, one resistor, and one circuit board. The circuit was connected to one Arduino powered by a connection to a laptop. The vibration motor was activated by the push of a button. The vibration was a tactile representation of the DHH student's name, where the onset of three short interval vibrations indicated that someone in the discussion

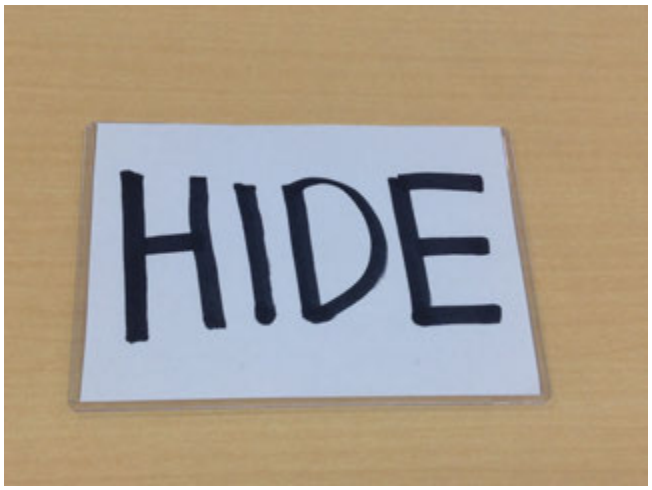

Figure 4.4: Responsiveness: Text Representation

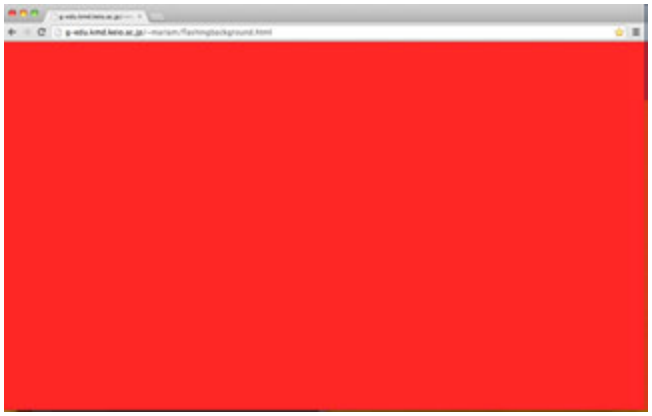

Figure 4.5: Responsiveness: Color Representation

was calling or talking about the DHH student. The reason for choosing three short interval vibrations was to mimic the knocking method the DHH use to get each others attention as discussed earlier in Chapter 3.

4.1.2 Setting

The first experiment involved one DHH student and 16 other students (including one note-taker). The meeting room had four long tables (Figure 4.7). The DHH student (DHH), note-taker (NT), and prototype operator (P) were located on one table next to each other. The prototype was located on a separate screen

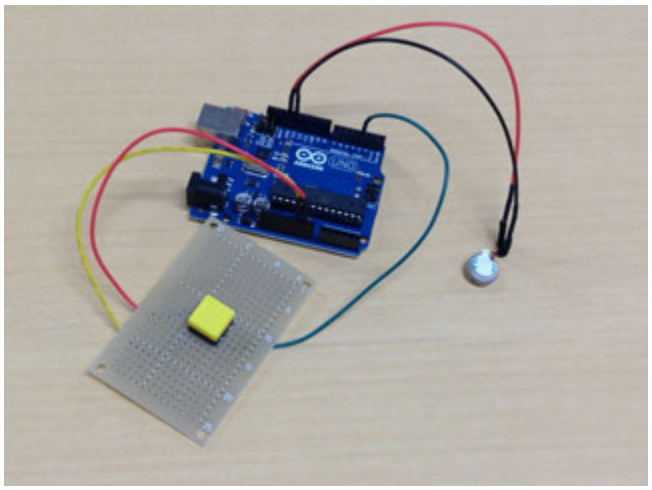

Figure 4.6: Responsiveness: Vibration Representation

(red laptop) next to the DHH student's laptop (orange) used to view notes from the note-taker. The note-taker used a laptop (green) and a Google Docs shared document to take and share notes.

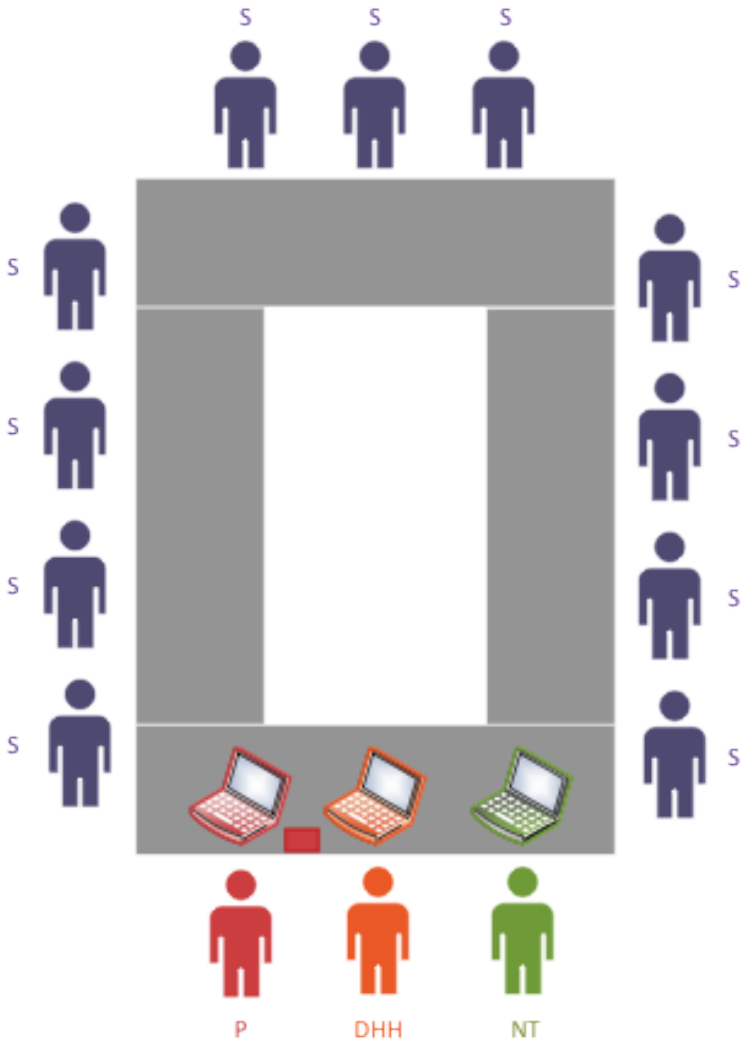

Figure 4.7: Experiment 1 Setting

Each prototype was used for 15 minutes per category. Interruption was explored first, with prototypes tested in the order of text, color, and vibration. Responsiveness testing followed in the same order as interruption. The text representation was displayed in front of the separate screen (green laptop), by the prototype operator. The color representation was displayed onscreen (green laptop) and vibration was placed on the table next to the separate screen (red box). The DHH student and prototype operator were the only individuals that had access to and the ability to see the prototypes at all times.

4.1.3 Results

Evaluation was conducted via observation, in-depth interviews, and pre and post questionnaires (see appendix for results). The experiment was recorded for later viewing and observation. The pre questionnaire was divided into two parts, one questionnaire for the DHH and one for the hearing students. The post questionnaire was the same for both DHH and hearing students. In total, nine students answered the pre questionnaire, seven students answered the post questionnaire, and two interviews were conducted.

In the pre examination, the DHH student felt that he was unable to actively participate in the discussion due to his inability to hear the discussion. He also expressed that although he is able to understand the discussion due to the note-taking and thus express himself, he needs additional support, apart from note-taking, in order to actively participate in the discussion. This support is often needed for questions such as,"what are they saying" and "what is the current status of the discussion?" He felt that asking such questions disrupts the discussion. Finally, he indicated that smooth communication depends on the level of support and understanding from his counterparts.

The hearing students were divided equally on their ability to have smooth communication with the DHH student. Hearing students expressed that communication was possible due to the presence of a note-taker. However, some students expressed that the DHH student seems to be too concentrated on the notes, making it difficult to communicate freely and smoothly. The note-taker expressed feeling most connected to the DHH student, as there is additional communication through the notes in order to clarify information and keep the DHH student updated. However, the note-taker felt some information was difficult to convey, such as emotions. Furthermore, physical interactions to catch attention, such as tapping the DHH student's shoulder, clapping, and waving hands, were viewed as disruptive actions during the discussion. Students expressed that time lapses in information, on the note-taker's part, caused delays and gaps in information.

The post examination questionnaire and interviews were divided into three categories: active participation of the DHH student, distraction and effectiveness of representation for interruption and responsiveness, and the change in the conversation flow. These categories are a measure of the success and effectiveness of

the Kooki concept.

Active Participation

Results yielded an overall positive evaluation of Kooki as 5 of 6 hearing students felt that the presence of cues improved the discussion and allowed the DHH student to be more engaged in the discussion. Students felt they allowed the DHH student to respond more easily and quickly.

The DHH student was noticeably more alert to the discussion, specifically when being called upon. He did not require a tap on the shoulder or extra support in getting his attention. However, he was still hesitant to enter the conversation as he expressed that it was still difficult to get the correct timing to speak, as the cue being on a separate screen from the notes was distracting. Attention was too divided between the notes and the other indicator for immediate awareness of conversation status.

Distraction and Effectiveness of Representation

Overall, none of the hearing students felt that the cues were distracting. Although they were unaware of the cues (as they were not visible to the hearing students), the introduction of the cues was indicated at the beginning of the experiment.

The DHH student felt that the separate screen was distracting from the notes and created additional stress. For interruption, the DHH student preferred the color representation best. However, he stated that since he wears a hearing aid, he can hear noise. Thus, it would be more effective to have information such as who is talking, how many people are talking, and what language are they speaking in. As for responsiveness, he preferred text representation over the other methods. The DHH student suggested that there is potential in the vibration indicator if it was wearable and the integration of representations with note-taking would improve their effectiveness.

Conversation flow

Both hearing and DHH students indicated a noticeable improvement in the flow of the discussion. This was greatly due to the faster response of being called upon

on the part of the DHH student, coupled with decreased need for extra support and indication on the part of the hearing participants.

4.2. Experiment 2: General Discussion

The second experiment was conducted on June 1st, 2014 (13:00 - 15:00 JST) in room C3S02 on the 3rd floor of the Collaboration Complex at Keio University (Hiyoshi Campus). This user study included feedback from four DHH participants and ten hearing participants. The context of this experiment was a general discussion between all participants, where hearing participants had not previously met the DHH participants. A summary of details pertaining to experiment two are outlined in Table 4.2.

Table 4.2: Summary: Experiment 2 Details

User Study 2 : General Meeting	
Location	C3S01 (3F Collaboration Complex, Keio University, Hiyoshi Campus)
Date	June 1st, 2014 (13:00 - 15:00 JST)
Number of DHH Participants	4
Number of Hearing Participants	10 (2 note takers, 8 other)

4.2.1 Prototypes

The secondary development of low-fidelity prototypes of Kooki included three prototypes per problem area, as identified earlier (interruption and responsiveness). Each prototype portrayed a different method of representation. Based on the feedback from the first user study, the prototypes were redeveloped. The first major change was the introduction of the representations on the same screen as note-taking. This was to resolve the significant issue of distraction and divided attention noticed in the previous test. In addition, the vibration tool was redeveloped as a wearable device in order to provide a subtler indication to the DHH individual. The prototypes were created using two approaches, digital-prototyping

and physical-prototyping (using arduino). The prototyping approach was selected based upon the feasibility and representation method.

Interruption Prototypes

In the interruption category, three prototypes were created with three corresponding representations of text, color, and vibration.

Text representation was tested using a digital prototype (Figure 4.8). HyperText Markup Language (HTML) and Cascading Style Sheets (CSS) were used to create a prototype of a screen (see appendix C.1), with 'Yes' and 'No' texts displayed largely on the screen. Similarly to the previous paper prototype, the purpose of the text (Yes/No) is to indicate the status of the discussion. 'Yes' indicated the current status as 'someone is speaking', while 'No' indicated the current status as 'no one is speaking'.

Figure 4.8: Interruption: Text Representation

Color representation was tested using the same digital prototype from Experiment 1 (Figure 4.2) (see appendix A). The only improvement to this prototype was placing the circle adjacent to the notes screen on the DHH participant's laptop.

Vibration representation was tested using the same physical prototype from Experiment 1 (Figure 4.9) (see appendix B.1). However, the vibration motor was attached to a rubber band, creating a wearable device. The DHH participants wore the rubber band on their arm during the testing of the vibration representation.

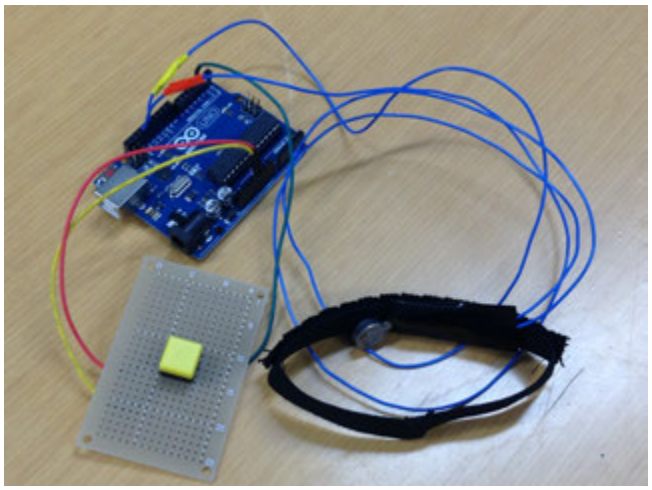

Figure 4.9: Interruption: Vibration Representation

Responsiveness Prototypes

In the responsiveness category, three prototypes were created with three corresponding representations of text, color, and vibration.

Text representation was tested using a digital prototype (Figure 4.10). HyperText Markup Language (HTML) and Cascading Style Sheets (CSS) were used to create a prototype of a screen (see appendix C.2), with the DHH individual's name appearing when their name is uttered.

Figure 4.10: Responsiveness: Text Representation

Color representation was tested using the same digital prototype from experi-

ment 1 (Figure 4.5) (see appendix C.3). The only improvement to this prototype was placing the flashing screen adjacent to the notes screen on the DHH participant's laptop.

Vibration representation was tested using the same physical prototype from Experiment 1 (Figure 4.9) (see appendix B.2). However, the vibration motor was attached to a rubber band, creating a wearable device. The DHH participants wore the rubber band on their arm during the testing of the vibration representation.

4.2.2 Setting

The second experiment involved four DHH participants and ten other hearing participants (including two note-takers). The room was divided into two tables, one for interruption and one for responsiveness (Figure 4.11). This user study had two phases - pre and post. In the pre phase (Figure 4.11), each table had one DHH participant (DHH), four hearing participants (H), and one note-taker (NT). Each group had a 15 minute discussion and a pre questionnaire was administered. The post phase (Figure 4.12) involved the introduction of Kooki, with each table having one DHH participant (DHH), four hearing participants (H), one note-taker (NT), and one prototype operator (P). The DHH participant, note-taker, and prototype operator (P) were located on one side of each table next to each other. The prototype was located on the same screen as the notes (red laptop) from the note-taker. The note-taker used a laptop (green) and a Google Docs shared document to take and share notes.

Each DHH participant tested all six prototypes. Each prototype was used for ten minutes per category. Interruption was explored first with prototypes tested in the order of text, color, and vibration. Responsiveness testing followed in the same order as interruption. The text and color representations were displayed onscreen (red laptop) and vibration was placed on the table next to the separate screen (red box). The DHH participant and prototype operator were the only individuals that had access to and the ability to see the prototypes at all times.

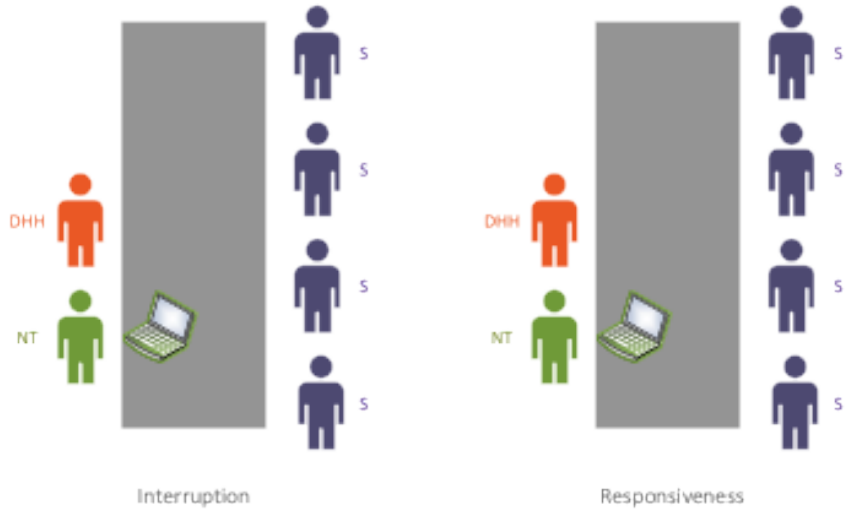

Figure 4.11: Experiment 2 Setting Pre Phase

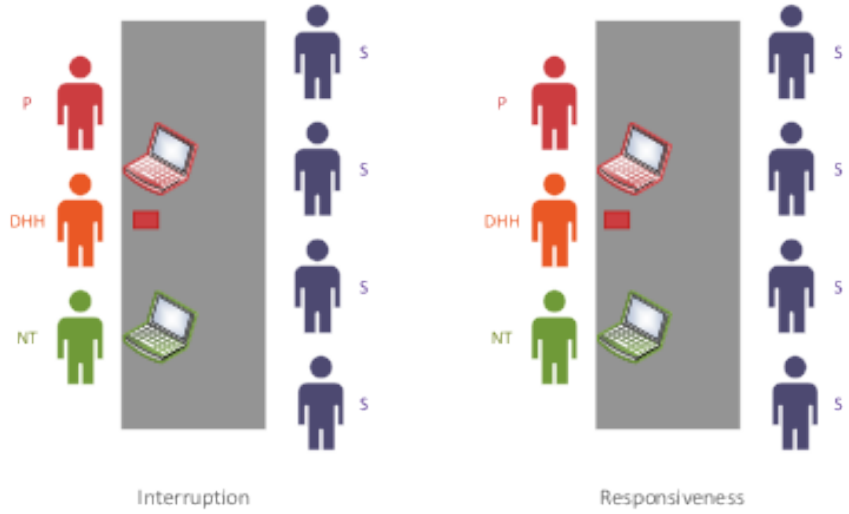

Figure 4.12: Experiment 2 Setting Post Phase

4.2.3 Results

Evaluation was conducted via observation, in-depth interviews, and pre and post questionnaires (see appendix for results). The experiment was recorded for later viewing and observation. The pre questionnaire was divided into two parts, one questionnaire for the DHH and one for the hearing participants. The post questionnaire was also divided into two parts respectively. In total, 14 participants

answered the pre and post questionnaire, and ten interviews were conducted.

In the pre examination, the DHH participants felt the quality of conversation and their ability to participate actively was hindered. The participants expressed difficulties in joining the conversation when there was more than one speaker and due to the time limitation, as it takes time to communicate smoothly. Furthermore, the note-taking was perceived as great support, but with great limitations. Some of the limitations discussed were time-lag, inability to understand non-verbal expressions, inability to feel the atmosphere of the conversation, and difficulty in maintaining eye contact and focusing on the conversation due to the focus on note-taking. All of the DHH participants expressed concerns about their disruptive actions in the discussion, such as asking questions to clarify understanding and shrugging or gesturing their misunderstanding.

Overall, hearing participants felt difficulties conversing with the DHH participants but showed great interest in the communication. Some of the participants expressed feeling more active than the DHH participants. Language barrier and time lag in note-taking were some of the reasons given for difficulties. Furthermore, participants explained that it was perceived as unnatural and disruptive to speak slower, however speaking slower was more accommodating for the DHH participant and the note-taker.

The post examination questionnaire and interviews were divided into three categories: active participation of the DHH student, distraction and effectiveness of representation for interruption and responsiveness, and the change in the conversation flow.

Active Participation

Results yielded an overall positive evaluation of Kooki as 8 of 10 non-DHH participants felt that the quality and flow of conversation improved with the presence of Kooki prototypes. Participants (9 of 10) felt that the representations did not directly influence the participation, but rather felt that the DHH participants seemed to be more at ease and that contributed to perceived confidence and more active participation.

All of the DHH participants reported feeling more comfortable and less anxious with the presence of the cues. They also felt more accommodated, able to know

when it's their turn to speak or being spoken to, which contributed to their active participation.

Distraction and Effectiveness of Representation

Overall, none of the hearing participants felt the cues were distracting. Although they were unaware of the cues (as they were not visible to hearing participants), the introduction of cues was indicated at the beginning of the experiment. Hearing participants indicated that it seemed easier for the DHH participants to know they were being asked something; the conversation was more direct and fun. Some participant stated that the DHH participants' focus on the screen was causing them to be distracted, but it didn't happen at other times (this could be attributed to having a different cue).

The DHH participants felt that having the cue adjacent to the note-taking was still distracting at some points; however, they expressed their need for this communication tool. They emphasized the importance of interpreters and note-taking, but that it is not enough. Another communication tool is needed for non-word information. As for the effectiveness of representation, color and vibration tied for most effective for interruption (two for each). Vibration was most popular for responsiveness as 3 of 4 DHH participants felt it was easy and quick to notice. Text representation was least favored for both interruption and representation as it changed quickly and required too much focus in addition to notes.

Conversation flow

Although many hearing participants stated that the difference was subtle, 8 of 10 participants felt the quality of the conversation improved with the presence of the cues. Some indicated feeling it was smoother and more relaxed in comparison to the discussion in the pre phase.

On the other hand, all the DHH participants felt more comfortable after the introduction of Kooki prototypes; they felt more involved in the conversation and that hearing participants became more accommodating. They attributed this to being able to know when they are being called upon and coupled with the knowledge of contents from note-taking, DHH participants felt that the speed of the conversation was more natural.

4.3. Overall Evaluation of Kooki

As an experimental tool, the concept of Kooki was perceived positively. To the DHH individuals, Kooki provided additional support — one they cannot acquire through note-taking. DHH participants became more aware of the conversation, which made them feel less anxious and more relaxed. In addition, the ability to know their name is being called without any time lag and enter the conversation at the correct timing encouraged active participation. Increased active participation ultimately created a two-way interaction in the discussion, which was felt and enjoyed by all participants. Regardless of the delivery (mixed results on representation methods), the issue of interruption and responsiveness proves to be prominent and important; there are potential ways to represent this data and resolve the issues.

Chapter 5

Conclusion and Future Work

Communication is a broad topic with incredible diversity. Although often misinterpreted as solely pertaining to oral communication, the matter of the fact is that there is communication occurring far beyond the limitation of our spoken words. Our behavior is an incredibly rich source of information when communicating with others. Nonverbal cues we send and exchange convey meaning and deliver information. Thus, communication can be defined as the action of transmission and exchange of messages using various channels, both verbal and nonverbal [9].

Although this exchange is intuitive, DHH individuals are unable to fully utilize all the information available. As assistive methods are often needed when interacting with others, there are limitations. Note-taking, for instance, has the limitations of a time-lag and the need for undivided attention. The DHH are often faced with stressful situations in large groups, discouraging them from participating actively. Furthermore, transcriptions of speech facilitate a one-way passive interaction where the DHH are receiving information, but are unable to respond and be truly integrated in the conversation.

5.1. Conclusion

This research proposed Kooki as one of the possible methods for the facilitation of a two-way interaction, to encourage active participation. Kooki aimed to identify the components of communication atmosphere missing that are necessary for the integration of the DHH in a conversation. Kooki provides multisensory

representations of components in communication atmosphere as a supplement to note-taking. Two specific components were tackled in this research — interruption and responsiveness. Interruption refers to conversation flow; the timing of entering conversation and turn taking. Responsiveness is the awareness of and timely response of hearing one's name or being addressed. Kooki proposed possible representations of these components and tested their importance and effectiveness in encouraging active participation by the DHH.

The concept of Kooki was received positively by both the DHH and hearing participants. Two experiments were conducted and evaluated via in-depth interviews, observations, and questionnaires. This extensive user study showed that Kooki has potential as a concept and its application in the real field. Both stakeholders saw the areas of interruption and responsiveness as issues and a solution was clearly needed. Although only three representations (text, color, and vibration) were tested, these options were perceived positively and participants indicated their desire to explore them more in-depth. The preferred representation varied depending on the individual, with color and vibration being most popular for interruption and vibration for responsiveness. The reason for these mixed results is that the DHH participants' degree of hearing impairment and use of hearing aids varied. DHH participants who used hearing aids and attended special schools preferred vibration cues. This could be attributed to the integration of knocking and tactile methods of getting attention in Deaf culture. DHH participants who used hearing aids and attended regular schools preferred other cues. This could be attributed to the fact that they are able to hear noise and produce speech, thus making their needs different and more specific.

Overall, the concept of Kooki was deemed effective through the evaluation discussed in this thesis. DHH participants felt less anxious and more relaxed while testing Kooki. These feelings encouraged their active participation and integration into the discussion. On the other hand, the presence of certain cues, such as color and vibration, facilitated smoother interaction and a more natural flow of conversation. Hearing participants observed similar consequences of Kooki. Although unaware of the specific cues, hearing participants reported sensing that the DHH participants felt at ease, participating more actively and with confidence. The reason was attributed to faster response to being addressed and following

the conversation with less of a time lag (in comparison to only note-taking and no Kooki involvement). Thus, the further development of Kooki, taking into consideration the feedback from the user studies, is a possible solution for the missing information in transcriptions and one-way interaction of the DHH in a conversation.

5.2. Future Work

Kooki's vision is to bridge the communication gap – be it due to language barrier or impairment – to bring people closer together through smoother communication and stronger mutual understanding. In order to achieve this vision, the first step is to bring awareness to the issue of this communication gap for DHH individuals, and contribute one of many potential solutions: in this case, a supplementary tool alongside note-taking, as it is one of the most common assistive methods for the DHH. However, Kooki's concept goes beyond representation of the two components discussed. It has broad possibilities as it has the potential to expand and include more elements. Ultimately, Kooki aims to be a comprehensive representation of communication atmosphere, giving one the ability to feel the atmosphere in a united manner.

With regards to the feedback collected, the future development of Kooki should consider integrating the concept of Kooki into note-taking as one platform rather than being a separate entity. For instance, having background color, text size or color of the notes change. This is critical for the seamless integration of Kooki, as Kooki aims to ease communication, rather than add an extra step. As discussed above, it is important to consider the difference in the level of hearing impairment in the needs of DHH individuals. Kooki's aim is to be a flexible, universal tool. Differences may vary not only due to the level of hearing impairment, but additionally due to culture and language ability.

Further research into communication atmosphere and the best representation is needed for the expansion of Kooki. As the name suggests, Kooki intends to provide a method of 'reading the [communication] atmosphere' for all, regardless of physical, language, or cultural differences.

"The two words information and communication are often used interchangeably, but they signify quite different things. Information is giving out; communication is getting through." — Sydney Harris

Acknowledgements

"ichi-go-ichi-e" "one time, one meeting"

This four-letter idiom is often translated to "one chance in a lifetime." Ever since my journey in Japan started, I've held this thought dear to my heart. Japan has brought me to places of wonder, and allowed me to try my best and be my true self. I could not have had this once in a lifetime opportunity if it was not for the people who are dearest to me — my mama and family. Thank you for giving me the opportunity to not only get a Master's degree, but go on a two-year adventure of self-discovery and growth. Thank you for your unconditional love, prayers, and support. I love you and will forever be grateful to have been born into the El Hussein family. Special thanks to my awesome sister Arwa — you are a beautiful person inside and out. May God protect you, always.

I have also been fortunate enough to join other families — KMD and Global Education. I would like to thank my supervisor Keiko-sensei, from the bottom of my heart. She has been an incredible supporter, both academically and personally, during my two-years at KMD. I will forever be indebted to your around the clock, year-round support!

Thank you to the Global Education family for your constant, incredible support. It was my pleasure to have become a part of the Global Education family. Special thanks to Goki, Marcos, Ohshima-san, Matsufuji-san, and Suzuki-san for the guidance along the way. I would like to thank Yuma, Hiromi, Tecchan, Mie-san, Alex, Shu, and Arima-san for their teamwork and warm smiles.

Thank you to Kato-sensei for the super awesome support. From generously installing an 8GB ram for me to giving me spot-on advice for fixing my midterm and final presentation to detailed feedback on my thesis, your support has been nothing but awesome and I will forever be grateful for this.

Thank you to Kishi-sensei for the interesting, fun discussions in class and advising me on the bigger possibilities of my concept.

Thank you to all KMD faculty and alumni; it was a true pleasure working and meeting each one of you. I hope our paths will cross again in the future and I will continue to learn from and get inspired by you.

A very special thank you goes out to my September 2012 batch. I truly believe I was very lucky to have joined this batch. Everyone has been an incredible family member. We all came from different places around the world and found a home in Japan and with each other. Thank you for the smiles, support, fun, and all around incredible experience. Special thanks to Roosa for being nothing less than her awesome self; Elaine for being my best food, Konbini buddy and my 24/7 emotional support; Hide, Flash, Gaby, Ivy, Carlos, Jimin, and Code for the days and nights of fun and thesis writing. Finally, thank you to Niya for being my amazing sister, roommate, adventure partner, and family here in Japan.

Thank you to Yuki and the whole Hayashi family. Thank you for accepting me into your family and treating me like your daughter. Thank you, Yuki, for your encouragement in the big move to Japan, all the help when I was lost, and unconditional support during my thesis writing.

I cannot give enough thanks to all the amazing people who supported me throughout this journey. To Yuka, Hideki, Eveey, Sabeen, Laura, Daniel, Joe, and the entire UTM Crew. Thank you for forgiving my long absence when things got too hard, checking on me from across the globe, and always keeping me in your thoughts and prayers.

Lastly, thank you to JASSO and Ishimori Foundation, I could not have made it this far without your kind understanding and generous financial support.

This has been a wonderful journey; thank you Japan for giving me new family members, new experiences, and a new me. Of course, I cannot forget to thank you, Ichigo Daifuku.

Thank you for everything. I am looking forward to meeting you again!

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Appendix

A. Processing 2.0.3 Code

```
import ddf.minim.*;

Minim minim;
AudioInput in;

void setup(){
  size(500, 500);

  minim = new Minim(this);

  in = minim.getLineIn(Minim.STEREO, 320);
}

void draw(){
  background(0);
  stroke(255);

for(int i = 0; i < in.bufferSize() - 1; i++){
  println(abs(in.left.get(i+1) - in.left.get(i))*100000);

if(abs(in.left.get(i+1) - in.left.get(i))*100000 > 200) {
  fill (255,0,0);
  ellipse(250,250,200,200);
```

```
  }

  else{
    fill (0,2555,0);
  ellipse(250,250,200,200);
  }
}
}


void stop(){

  in.close();
  minim.stop();

  super.stop();
}
```

B. Arduino Code

B.1 Interruption - Vibration

```
/*
  Button

 Turns on and off a light emitting diode(LED) connected to digital
 pin 13, when pressing a pushbutton attached to pin 2.


 The circuit:
 * LED attached from pin 13 to ground
 * pushbutton attached to pin 2 from +5V
 * 10K resistor attached to pin 2 from ground
```

```
 * Note: on most Arduinos there is already an LED on the board
 attached to pin 13.


 created 2005
 by DojoDave <http://www.0j0.org>
 modified 30 Aug 2011
 by Tom Igoe

 This example code is in the public domain.

 http://www.arduino.cc/en/Tutorial/Button
 */

// constants won't change. They're used here to
// set pin numbers:
const int buttonPin = 3;     // the number of the pushbutton pin
const int ledPin =  13;      // the number of the LED pin

// variables will change:
// variable for reading the pushbutton status
int buttonState = 0;

void setup() {
  // initialize the LED pin as an output:
  pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}

void loop(){
  // read the state of the pushbutton value:
```

```
  buttonState = digitalRead(buttonPin);

  // check if the pushbutton is pressed.
  // if it is, the buttonState is HIGH:
  if (buttonState == HIGH) {
    // turn LED on:
    digitalWrite(ledPin, HIGH);

  }
  else {
    // turn LED off:
    digitalWrite(ledPin, LOW);
  }
}
```

B.2 Responsiveness - Vibration

```
/*
  Button

 Turns on and off a light emitting diode(LED) connected to digital
 pin 13, when pressing a pushbutton attached to pin 2.


 The circuit:
 * LED attached from pin 13 to ground
 * pushbutton attached to pin 2 from +5V
 * 10K resistor attached to pin 2 from ground

 * Note: on most Arduinos there is already an LED on the board
 attached to pin 13.


 created 2005
```

```
 by DojoDave <http://www.0j0.org>
 modified 30 Aug 2011
 by Tom Igoe

 This example code is in the public domain.

 http://www.arduino.cc/en/Tutorial/Button
 */

// constants won't change. They're used here to
// set pin numbers:
const int buttonPin = 3;     // the number of the pushbutton pin
const int ledPin =  13;      // the number of the LED pin

// variables will change:
// variable for reading the pushbutton status
int buttonState = 0;

void setup() {
  // initialize the LED pin as an output:
  pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}

void loop(){
  // read the state of the pushbutton value:
  buttonState = digitalRead(buttonPin);

  // check if the pushbutton is pressed.
  // if it is, the buttonState is HIGH:
  if (buttonState == HIGH) {
```

```
    for (int i=0; i < 3; i++){
      digitalWrite(ledPin, HIGH);
      delay(500);

     // turn the LED off by making the voltage LOW
      digitalWrite(ledPin, LOW);
      delay(1000);}
  }
  else {
    // turn LED off:
    digitalWrite(ledPin, LOW);
  }
}
```

C. HTML and CSS Code

C.1 Interruption - Text

```
<!doctype html>
<html>
  <head>
        <style type="text/css">
        a:link {
                color:#000000;
                font-size:13em;
                text-decoration:none;
        }
        a:visited {
                color:#000000;
                font-size:13em;
                text-decoration:none;
        }
        a:hover {
```

```
                color:#000000;
                font-size:13em;
                text-decoration:none;
        }
        a:active {
                color:#000000;
                font-size:13em;
                text-decoration:none;
        }
        </style>
  </head>
<body>
<p><a href="no.html">YES</a></p>
</body>
</html>
```

C.2 Responsiveness - Text

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN"
"http://www.w3.org/TR/html4/strict.dtd">

<html lang="en">
    <head>
        <title>Test</title>

        <style type="text/css">
            html
            {
                background-color: #FFFFFF;
            }

            body
            {
                overflow: hidden;
```

```
            }

            div a
            {
                position: absolute;
                top: 0;
                left: 0;
                width: 100\%;
                height:  100\%;
            }
        </style>
    </head>

    <body>
        <div><a href="natsumi.html"></a></div>
    </body>
</html>
```

C.3 Responsiveness - Colored Background

```
<!DOCTYPE html>
<html>
<head>
<script src="http://ajax.googleapis.com/ajax/libs/jquery/1.11.1/jquery.min.js">
</script>
<script>
window.onclick = function(){

    $("body").toggleClass("on");

};
</script>
<style>
```

```
body {
    background-color: white;
}

body.on {
    -webkit-animation: colorchange 5s;
    animation: colorchange 5s;
}

@keyframes colorchange
{
0\%  {background: red;}
25\%  {background: white;}
50\%  {background: red;}
75\%  {background: white;}
100\% {background: red;}
}

@-webkit-keyframes colorchange /* Safari and Chrome */
{
0\%  {background: red;}
25\%  {background: white;}
50\%  {background: red;}
75\%  {background: white;}
100\% {background: red;}
}
</style>
</head>
<body>
</body>
</html>
```

D. Questionnaire Responses

D.1 Experiment 1 Pre (DHH)

1. Do you feel that you can participate actively in a discussion or meeting with hearing participants? ：聴者との会議や話し合いに積極的に加われていると思いますか？

Yes I can participate actively. : はい 0 0%
No I can't participate actively. : いいえ 1 100%

Please elaborate on the reasons for your answer. : その理由をお教えください

Because I cannot hear what do anyone talk in a discussion

3. How do you contribute to a discussion or meeting (with real-time transcription via note-taking)? : ノートテイクがある時はどのようにして会議や話し合いに参加できていますか？

I can understand anyone's talking via note-taking, so I can say my opinion and idea.

4. What difficulties prevent you from communicating with others and participating actively? : 聴者とのコミュニケーションや会議で困ったことは何ですか？

There is not support in all discussion, so I need to explain the participants and ask them to support me.

5. Do you feel other participants can communicate smoothly with each other? : （ノートテイクがない時）他の人たちはコミュニケーションがスムーズに出来ていると感じますか？

Yes : はい 1 100%
No : いいえ 0 0%

Please elaborate on the reasons for your answer. : そう感じる理由をお教えください

Of course other participants can hear anyone's saying.

6. Are there any actions that disrupt the flow of the conversation? : 会話の流れに入るために取っているアクションはありますか？（例：「何を話してるの？」と聞く等）

Yes : はい 1 100%
No : いいえ 0 0%

If you answered "yes" to the previous question, please elaborate. : "はい"と答えた方は、詳しくお教えください

I always ask them "what are you saying?", "what is the current discussion's theme?"

7. How do you evaluate your communication with hearing individuals? : 健常者とスムーズにコミュニケーションが取れていると思いますか？

Depends on the hearing individual. If he/she understand my DHH, we can communicate together smoothly.

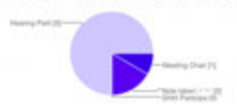
8. Feel free to add extra comments with regards to communication with hearing individuals. : 健常者とのコミュニケーションに関して自由に意見をお書きください

I think Support and Understanding DHHs are of importance in these communication.

D.2 Experiment 1 Pre (Hearing)

Summary

1. Please identify your role:あなたの役割を教えてください



Meeting Chair：議長	1	8%
Note-taker：ノートテイカー	2	17%
DHH Participant：聴覚障害、難聴者	0	0%
Hearing Participant：一般参加者	9	75%

2. Do you feel that you can participate actively in a discussion or meeting with DHH participants?：聴覚に障害のある方や難聴者との会議や話し合いに積極的に加われていると思いますか？

Yes I can participate actively.：はい、そう思います	6	46%
No I can't participate actively.：いいえ、積極的には加われていません	7	54%

Please elaborate on the reasons for your answer.：理由を教えてください

We can communicate effectively through a variety of means, both with and without particular tools. Usually, we have a note taker. 普段いたパソコンの画面を見ている時間が多いように思います。 ミーティングの内容が伝わっているかを配慮しつつ、なるべくたくさんコミュニケーションをとろうとしがけているため As notetaker I feel that I am most connected to the DHH participant. Along with having to keep up with notes at times we have conversations and there are clarifications made. 今までそういう経験がなかったから。 I like communication with people. Still not sure,because I participate in only a few meeting. ほぼすべての会議が、表出者が聴覚者であるという前提で行われているため。 I don't have opportunity so much to have a discussion or meeting in daily life. 会議で参加しているのをあまり見た事ないから。 I feel that the DHH participant is too concentrated on the note-takers log so communicating freely is sometimes not an option. I communicate with DHH as usual, I think.

3. How do you contribute to a discussion or meeting with DHH participants?：聴覚に障害のある方や難聴者との会議や話し合いに対してどのように貢献していますか？

Sometimes I do note taking. Through the note taking log I help facilitate communication. Also, I attempt to keep the participant as informed as possible. But that at times can be difficult when it comes to emotional responses. repeat saying, note-taking, gesture, say slowly. 貢献した事ないです。 特に何かを意識しているわけではありません。 まだ貢献していない。 By - listening carefully and indicating a request to repeat something if necessary. - speaking slowly while facing the DHH participant. - using hand gestures to supplement speech if it seems helpful to do so. - writing (on paper, tablet, or a computer) as needed. Global Education Project以外では貢献していない。プロジェクトではnote taking log(0作成のお手伝いをしている。 Either through using the note-takers log or directing my discussion to the notetaker. ミーティング内容を記録する。伝わらなかったときはもう一度大きな声で伝えるなど I will support Note-takers. 1. Note taking 2. Move my mouth exaggerately 3. Write text on paper Trying to talk slowly and make a gesture

4. What difficulties prevent you from communicating with DHH participants?：聴覚に障害のある方や難聴者とコミュニケーションをとるときの困ったことは何ですか？

- Use of complex terms which defy lip-reading, hand gestures, or simple written explanations - Occasional challenges in understanding DHH person's speech. I think the speed of my talking.I tend to speed up as I get excited. I can't inform about some music, because they hear it differently. Often when I am so concentrated on making sure I am taking down all the notes I can't participate well in all class discussions. Only when I want to talk with DHH, it's difficult. 聞き取りにくい言葉や、周りが騒がしいときは声をより大きくして伝えなければいけないとき 複雑なニュアンスが伝わりにくい 声色などしか伝えることができない幅かいニュアンスを伝えることができない I guess one of the problems is many people don't understand DHH itself. Their concentration level on the note-taking log and also the speed of the discussion. 友達としての意識が薄い必要なことだと思います。 To express finer nuances. スピード感。

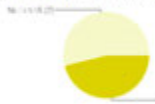
5. Do you feel DHH participants fulfilled their role in the discussion or meeting?：聴覚に障害のある方や難聴者は自分の役割を会議や話し合いの場で果たしていると思いますか？

Yes：はい	8	62%
No：いいえ	5	38%

Please elaborate on the reasons for your answer.：理由を教えてください

DHH participants are also KMD students. they are required to participate in meeting also. If DHH participants are not fulfilled their role in meeting,I think there will be a problem for other participants or way of meeting. Often the discussion I feel is moving too quickly for them. Generally, all members are aware of the DHH participant's needs and what is needed to accommodate them. DHH participant is also proactive and engaged in finding ways to follow the discussions, including requesting assistance or clarification as needed. Sorry but I have no idea. 周りにきちんと伝えようとし、話し合いに積極的に参加しているから 自分から積極的に発言を行う機会を持てないから。例えば、聴覚障碍者はディスカッションの流れをよんで、話をさえぎって発言することはできない。 Only when someone can do note taking. わからない。 Depends. I often feel like the participant is behind in the meeting discussions. Since the participant is always waiting for the discussion by the time they read it the conversation or more so the emotion is over. I always repeat someone's saying near DHH, do note-taking for him. 人それぞれであり、はいともいいえとも言えにくいのですが・・・。 手話の人とか、会議場であまり見た事ないので、話し合いが難しいと思う。なので、果たすことも難しいのでは。

6. Are there any actions that disrupt the flow of the conversation with DHH participants?：聴覚に障害のある方や難聴者との会話の流れを中断させるためのアクションはありますか？



Yes：はい	6	46%
No：いいえ	7	54%

If you answered "yes" to the previous question, please elaborate.：“はい”と答えた方は、理由を教えてください

say quickly, hold out my hand I feel the multilayer of the discussion and knowing when people are taking can sometimes prevent a natural flow of discussion. Knock his or her shoulder. Lapses in note-taking or inability of note-takers to provide comprehensive transcription can cause delays or gaps in communicating information. Sometimes when there are multiple people talking at the same time. Clap hands Touch their body

7. How do you evaluate your communication with DHH participants? : 聴覚に障害のある方や難聴者とうまくコミュニケーションをとれていると思いますか？

Almost. When it is a larger meeting I feel like it can be kind of limiting. Still not sure, but I hope so! It's not better than usually, but I can communicate with them more than minimum level. Yes, because I'm not tried to communicate with DHH. It is not special in the diary life. 思わない。 I feel like I can communicate with the participant but it is limited and often through a note taker or after the discussion because during the meeting its much harder. Unfortunately I don't think so...I need to have a communication with them. 思わない。ただし、Skypeをはじめとしたチャットではコミュニケーションをとれていると感じる。 今まで難聴者の方としか接していませんが、うまくコミュニケーションをとれていると思います。 Reasonably good. I try to always be aware of what is needed for effective communication. I do not feel that major obstacles to communication typically arise when I am talking to DHH participant(s), only relatively minor challenges. 難聴者の方は、大きな声とアクションで何とかなりそうな気がするが、重い障害のある方は、難しいのかなと思う。 文章はかなり苦が多いのですが、周りに人がいる時には、あまり大きな声を出すわけにもいかず、ことば数が少なくなってしまいます。

8. Feel free to add extra comments with regards to communication with with DHH participants. : 聴覚に障害のある方や難聴者とのコミュニケーションに関して自由に記入してください

I don't think I can communicate with DHH. 視覚に障害を持っている方とうコミュニケーションはずっとともやすいと思う。 I think that communication with DHH participant could be better facilitated for the note taker or atleast assist the notetaker in communicating the mood of the discussion. お互い「伝える・聞く」という姿勢がしっかりとれていれば、コミュニケーションをうまくとれると思います。 I enjoy it as usual:) リアルタイムでその場の雰囲気をくめるものが必要であると感じる We need more patient and consideration than talking to non-DHH 気軽にコミュニケーション出来るアプリなどがあるといいと思う。 I have never had chance to talk with DHH person, and I participate in only a few G-edu meeting, so I think my experience may not help your study...sorry If people can understand DHH participants, it would have a good communication more with them. If there was a way for the participant to feel more integrated and connected to whats happening in the meeting it would be great. 多くの人がスマホを持つ時代になったので、コミュニケーションを促進するアプリが開発されるといいなと思います。

D.3 Experiment 1 Post (All)

Summary

1. Please identify your role:あなたの役割を教えてください

Meeting Chair：議長	1	14%
Hearing Participant：一般参加者	4	57%
DHH Participant：聴覚障害、難聴者	1	14%
Note-taker：ノートテイカー	1	14%

2. Do you feel that you participated actively in today's discussion or meeting? : 今回の議論や話し合いに積極的に関われたと思いますか？

Yes：はい	3	43%
No：いいえ	4	57%

Please elaborate on the reasons for your answer. : その理由をお教えください

There is a note-taking, so I can know what they are talking in discussion. I think I did only speak "Round table". It is not "actively". 議論する話題ではなかったので。 I don't hesitate to speak, and I could talk freely. Participated in roundtable and "Hindoku" discussion, helped to take minutes. While I was doing note-taking, I couldn't join the meeting. I was busy to prepare equipments for this mtg, so couldn't do enough...:(

3. Do you feel you were able to express yourself in today's discussion or meeting?:議論や話し合いでどのようにして自分の意見や考えを伝えられましたか？

Yes,I think.But sometime such as "RINDOKU"time, because of my so much slow reading pace, I could not express my opinion. Yes. Yes, I can understand the current theme, so I can provide my idea about this. I stopped note-taking and spoke. ポイントを絞って発言に出そうとしたが、逆に具体性がなくなり抽象的になってしまった。 supplementation to others. Yes.

4. What difficulties prevented you from communicating with other participants? :ほかの参加者と話すことに関して何が一番難しかったですか？

特になし。 Change language from Japanese to English, English to Japanese. Reading context. Language barrier. Ihone, maybe Choice of topic, timming It's difficult to know when is good timing to express my idea because I avoid to prevent their talking.

5. Do you feel other participants can communicate smoothly with each other? : 他の人たちはコミュニケーションがスムーズに出来ていると感じますか？

Yes : はい	6	86%
No : いいえ	1	14%

Please elaborate on the reasons for your answer. : その理由をお教えください

They are well acquainted with each other and their communications needs. Because I think each member participated actively. We are close, so we could talk freely. When people speak to DDH, it takes time to translate from what they say through note-taking log. Of course they can hear. いつも通り特に問題はなかったと思います。 Cuz I think they talked and tell their own opinions, finally, they understood each other. I could read context easily.

6. In your opinion, which prototype was the most effective for 'interruption'? : どの試作品が話の流れに入るのに一番効果があったと思いますか？

Colour Cue : 色をつかったもの	2	29%
Text Cue : 文章をつかったもの	4	57%
Vibration Cue : 振動をつかったもの	1	14%

Please elaborate on the reasons for your answer. : その理由をお教えください

Vibration does not depend on DHH participant looking in a particular direction. Difference between colors were easy to know. 残念ながら、prototypeがどのようなものか分からなかったので、効果のあるなしがわかりません。ですから、以下の質問にも答えられないのですが、「この質問は必須です」となっているので、仮に、Text Cueにチェックを入れてあります。 I didn't know because I concentrated on note-taking. (I had to select one of options above) Hide-san were mainly looking pc. I can feel. Hide had been reading till meeting ended.

7. In your opinion, which prototype was the least effective for 'interruption'? : どの試作品が一番効果が無かったと思いますか？

Text Cue : 文章をつかったもの	4	57%
Colour Cue : 色をつかったもの	1	14%
Vibration Cue : 振動をつかったもの	2	29%

Please elaborate on the reasons for your answer. : その理由をお教えください

We need to focus when this vibrator vibrates. I didn't know because I concentrated on note-taking. (I had to select one of options above) I did not know "Colour Cue" was done. Text cues are not constantly visible and thus DHH participant's attention needs to be directed to them when they appear. It's difficult for others to notice Hide-san's situation like if he notice or not. Text can tell contents of talking in detail, but users have to read text, so take few time for understand, I think. 残念ながら、prototypeがどのようなものか分からなかったので、質問に答えられません。ごめんなさい。

8. In your opinion, which prototype was the most effective for 'name identification'? : どの試作品が自分の名前を呼ばれたこと知るのに一番効果がありましたか？

Text Cue : 文章をつかったもの	4	57%
Colour Cue : 色をつかったもの	0	0%
Vibration Cue : 振動をつかったもの	3	43%

Please elaborate on the reasons for your answer. : その理由をお教えください

He can see it and the note simultaneously. As for me, it will wake me up! I don't need to focus on the prototype, I can feel this vibration without seeing. I didn't know because I concentrated on note-taking. (I had to select one of options above) Even if we fail to realize someone show text or color cue, we can not avoid vibration cue...but, a bit surprised, lol Names were written clearly. 残念ながら、prototypeがどのようなものか分からなかったので、質問に答えられません。ごめんなさい。

9. In your opinion, which prototype was the least effective for 'name identification'? : どの試作品が自分の名前を呼ばれたことを知るのに一番効果がありませんでしたか？

Text Cue : 文章をつかったもの	4	57%
Colour Cue : 色をつかったもの	1	14%
Vibration Cue : 振動をつかったもの	2	29%

Please elaborate on the reasons for your answer. : その理由をお教えください

I saw no communication of complex information through vibration. Text makes us read themselves. I cannot notice? perceive? when the text is shown. ? I didn't know because I concentrated on note-taking. (I had to select one of options above) With the others, we can see his glance as the clue of his states. 残念ながら、prototypeがどのようなものか分からなかったので、質問に答えられません。ごめんなさい。

10. Did you find any cues distracting? : 試作品の機能で気が散るようなことがありましたか？

Yes : はい	2	29%
No : いいえ	5	71%

If you answered "yes" to the previous question, please elaborate. : "はい"と答えた方はその理由をお教えください

Malfunction and didn't work sometime... But it can be improved, so don't care :) ! I didn't know because I concentrated on note-taking. (I had to select one of options above)

11. How did the presence of the cues change the flow of the discussion or meeting? : この試作品があることでどのように会議や話し合いの流れが変わったと思いますか？

It was interesting ! And DHH, It make various discussion easy, I think.　DHH participant appeared more engaged and interested in general.　We don't need to wait his response.　easy to respond when they call my name　DHH was involved in the meeting more than before.　still not sure.　残念ながら、prototypeがどのようなものか分からなかったので、質問に答えられませんでした。ごめんなさい。

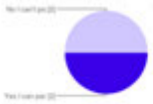
12. Feel free to add extra comments with regards to your experience today! : 本日の実験に参加した感想を自由に書いてください！

sorry to be late!　おつかれさまでシアム！！！I believe you can graduate finaly!　Note-taking is a tough job. But I like to do it :)　n/a　It's better to communicate with DHH naturaly.　prototypeがどのようなものか、今度見せてください。　Kookie!!!

D.4 Experiment 2 Pre (DHH)

Summary

1. Do you feel that you can participate actively in a discussion or meeting with hearing participants? : 聴者との会議や話し合いに積極的に加われていると思いますか？



Yes I can participate actively. : はい　2　50%
No I can't participate actively. : いいえ　2　50%

Please elaborate on the reasons for your answer. : その理由をお教えください

Talking session is very short and they are always quiet, so I could join the conversation but I'm not sure I can join the conversation if the discussion become heat-up.　- 通訳者がいない - 時間制限があるので話をまとめることができない（会議や飲み会などグループに当る）-> 1対1は問題ない - There is no interpreter. - There is a limitation of time, so we cannot stop the conversation (only group like meeting or morning assembly) -> no problem in one to one conversation.　文字伝達はほっきり伝わっているけどタイムだと多少遅れる（real time is too late.）Communication by text is accurate, but it takes time.　通訳などがないとまったく会議内容が理解できていない。If there are no interpreter, I can't understand the contents of meeting at all.

3. How do you contribute to a discussion or meeting (with real-time transcription via note-taking)? : ノートテイクがある時はどのようにして会議や話し合いに参加できていますか？

ある程度は参加できていると思う。しかし、ある程度アイコンタクトがあって、少し待ってくれているが、次誰が話しているのかすこしわかりにくい。To a certain degree I can attend. However, although there is some eye contact and others can wait a little, it's a little difficult to know who will speak next.　自分の生活上でノートテイクを使ったことがないが、あれば積極的に参加したいと思う。In fact, I have never used the note taking, but if I can use, I want to use it proactively.　Just watching the monitor to understand what they talked. There is little chance to understand non-verbal expression just because they talked a little.　Yes, 内容などはおくることも重要です。Yes, it's important to know the contents.

4. What difficulties prevent you from communicating with others and participating actively? : 聴者とのコミュニケーションや会議で困ったことは何ですか？

Time-lag no chance to join the discussion.　- 会議は通訳者を手配しないといけない（お金がかかる）- 聴者との会話時は慣れるまで時間がかかる（理解）- To attend the meeting, we need to prepare an interpreter (costs money) - It takes time to get used to have conversation with no handy-capped person (to understand)　100%伝達ができていない場面もあります。Sometime we couldn't convey the thought completely.　話していることがわからない I don't know what they are talking.

5. Do you feel other participants can communicate smoothly with each other? : （ノートテイクがない時）他の人たちはコミュニケーションがスムーズに出来ていると感じますか？

Yes : はい　3　75%
No : いいえ　1　25%

Please elaborate on the reasons for your answer. : そう感じる理由をお教えください

声でスムーズにコミュニケーションをとれていると感じる They can communicate smoothly by voice.　real timeも遅れてるし、すれ違いもあるから In real time communication, there must be delay, and maybe discommunication also.　There is time-lag in the communication and it doesn't make communication smoothly.　(None)

6. Are there any actions that disrupt the flow of the conversation? : 会話の流れに入るために取っているアクションはありますか？（例：「何を話してるの？」と聞く等）

Yes : はい　4　100%
No : いいえ　0　0%

If you answered "yes" to the previous question, please elaborate. : "はい"と答えた方は、詳しくお教えください

- アイコンタクト - 発言するタイミングを見る - 今何を話しているのか聞く - Eye contact - See the timing to interrupt - Ask them what is the topic　話し始手（しゃべる）が先になるからNote takesが出てくるタイミングが遅れると"何を話しているの"と聞くことになります。Because the opponent speaks firstly, if note takes are delayed, I have to ask "What are you taking?".　Show the gesture which "I don't understand"! "shrug"　様子をジッ・・・と見て空気を読む。大事な話かなと思ったアクションをやめてその場を離れる I see the atmosphere carefully. If I think this conversation is important, I give up the action and leave.

7. How do you evaluate your communication with hearing individuals? : 健聴者とスムーズにコミュニケーションが取れていると思いますか？

もし筆談ができるなら、ある程度コミュニケーションはとれるが、スムーズではない。If we can communicate in writing, we can communicate to a certain degree, but it's not smooth.　Time is too short and I'm not sure wether I could communicate with them.　そう思わない。手話以外のコミュニケーション方法は中は今難しいと思います。No, I don't think so. Surely the communication except sign language is difficult.　人による Depend on the person

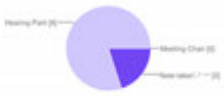
8. Feel free to add extra comments with regards to communication with hearing individuals. : 健聴者とのコミュニケーションに関して自由に意見をお書きください

今日のノートテイクはPC台数が限られているので打ちにくかったけど、内容がわかると楽しい。あと、カメラが付いていると表情が見やすい。Today the number of PC was limited, so it's difficult to type. However, if I can see the contents, I can enjoy it. Also, if there is camera, I can see the facial expressions.　International students are so generous and I think I could communicate with them. However, if there are all Japanese students the situation will be different.　(None)

D.5 Experiment 2 Pre (Hearing)

Summary

1. Please identify your role:あなたの役割をお教えください



Meeting Chair：議長	0	0%
Note-taker：ノートテイカー	2	20%
Hearing Participant：一般参加者	8	80%

2. Do you feel that you can participate actively in a discussion or meeting with DHH participants? ：聴覚に障害のある方や難聴者との会議や話し合いに積極的に参加できていると思いますか？

Yes I can participate actively.：はい	7	70%
No I can't participate actively.：いいえ	3	30%

Please elaborate on the reasons for your answer.：その理由をお教えください

But I think I'm too active adn DHH participants are kind of being passive. I want to understand them. Because I'm the note-take. No time to talk. Because I had questions to them about the difference between Japanese and American sigh languages. It was interesting and kind of fun to start a conversation using a moderating medium. With 1 note taker only 1 person can talk at a time, interrupts natural flow of conversation and makes conversations too formal and classroom like. It's work but it's slow and sometime, I forgot to see the laptop screen, so I don't know did she start typing or not. But it's work somehow. Because its in a real time, so it makes me very easy to understand them. Also its written English, so everyone can participate actively. It was difficult to say and participate because it was about reading and listening. Also I think the conversation was too quick for the note-taker. I can note-take fairly rapidly and I feel I understand the necessary techniques to do so effectively. It's fun to interact with people that maybe in other circumstances might be difficult.

3. How do you contribute to a discussion or meeting with DHH participants? ：聴覚に障害のある方や難聴者との会議や話し合いでどのように貢献できていると思いますか？

I was able to ask one question but felt like I needed consensus from non-dhh participants to decide that was the question we would all ask. The same way I would contribute to any other. By talking and it was all typed out. Also, by waiting for their response. Trying to type as fast as possible in order to deliver the conversation simultaneously. I can take notes. I can also talk to some extent by speaking clearly while pacing them. I talked as slow as I can to help the note taker typing for them. Try to speak slowly and use body language as a tool. I tried to speak slowly so that note-taker can catch up. Try to find topics that they are interested in. More passive then active more tolerant waiting for the end of a sentence slower then usual.

4. What difficulties prevent you from communicating with DHH participants? ：聴覚に障害のある方や難聴者とコミュニケーションをとる時に

speed of typing. I don't know when they start trying to communicate with us. I don't know whether they understand what I talked. We always have to try to say things clearly otherwise they can't catch smell nuance. When there are language barriers it means there are 2! Japanese<=> Shuwa etc. There is always a language barrier. In normal conversation, we talk to people directly and be responded soon after. However, since communicating with DHH participants needs a little bit more time. I don't understand sign language and in some cases may not share a spoken language either, or have trouble understanding their accents/dialect. The need of a computer and having to type. It slowed down the convs. Delay and texting (is not in real time and can't notice their face expressions. time delay -time lag -language barriers (2 "foreign languages" = japanese and sign language.)

5. Do you feel DHH participants were able to communicate with others in the discussion or meeting smoothly? ：聴覚に障害のある方や難聴者は会議や話し合いでスムーズにコミュニケーションが取れていると思いますか？

Yes：はい	4	40%
No：いいえ	6	60%

Please elaborate on the reasons for your answer.：そう感じる理由をお教えください

They also felt there needed to be consensus on who would answer each question. Two many participants typing interrupts flow of conversation. We understood each other very well. It's smooth but less smooth compared to normal oral communication. the note taking and use of gestures was reasonably effective. Yes but with much difficulty at first but then it slowly worked out. However, speaking participants kept forgetting the importance of who they are addressing. It's quite slow and somehow we started to talk and tend to talk with someone who can feel easier to communicate. Delay. Basically the same as the above questions. Communicating like this still presents difficulties that affect flow etc. I still can feel their words emotionally.

6. In your opinion, are there any actions that disrupt the flow of the conversation with DHH participants? ：聴覚に障害のある方や難聴者との会話の流れに入るためのアクションがあると思いますか？

Yes：はい	10	100%
No：いいえ	0	0%

If you answered "yes" to the previous question, please elaborate. ："はい"と答えた方は、その理由をお教えください

Two many participants typing interrupts flow of conversation. Influence of devices machine, computer etc. spontaneous comments jokes etc. Like eyes contact to start saying "I'm gonno start talk to you". waiting for the note-taking to catch up. Silence and waiting. The need for a computer. When there are multiple people speaking at the same time. Only 1 line of conversation can exist with current method of reading/typing in verbal conversations, the conversation sometimes breaks into smaller groups, multiple lines multiple topics then merges back together. Sometimes they don't realize when one of us giving a question. We have to take their attention something like "Hi" or "Excuse me"

7. How do you evaluate your communication with DHH participants? ：聴覚に障害のある方や難聴者とうまくコミュニケーションをとれていると思いますか？

I evaluate it as really low and some what non-existent with the reliance and speed of other people. I think so. friendly fun overall good slow awkward, difficult to follow. Not so bad but not so smooth. I am enjoying conversation with them. Moderately good. Maybe because it was first ever experience was hard. not good and smooth enough I'm the notetaker so I didn't really involve much in the conversation.

8. Feel free to add extra comments with regards to communication with with DHH participants. ：聴覚に障害のある方や難聴者とのコミュニケーションに関して自由に記入してください

It's not a problem. may even work better if we were all typing. none. maybe needs some ice breaking activities There needs to be a more fluid way for how other's (DHH) can be aware and also continue conversations. none Using google glass to show the text will be easier to use and you will know that someone start communicate. none.

D.6 Experiment 2 Post (DHH)

Summary

1. Do you feel that you participated actively in today's discussion or meeting? : 今回の議論や話し合いに積極的に関われたと思いますか？

Yes : はい 4 100%
No : いいえ 0 0%

Please elaborate on the reasons for your answer. : その理由をお教えください

自分の名前を呼ばれたときに何らかの効果があることで、会話に加わっていると実感がわくから。 When I was called, there is some effects and I felt I joined the conversation. 1回目と違って内容もはっきりわかりやすくて積極的に話せるかと思います。 I think this time we can know the contents clearly not like 1st time's one, so we can talk more actively. Yes, I could grasp the timing to join the conversation. 内容がわかる ノートテイクのスピードにみんな合わせてくれる I could know the contents. Everybody could fit the speed of note taking.

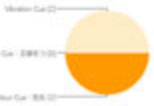
2. How did the presence of the cues change the flow of the discussion or meeting? : この試作品があることでどのように会議や話し合いの流れが変わったと思いますか？

少しだけだが、自分が参加するのを待ってくれる雰囲気が出ていて、安心感があったと思う。 Even though a little bit, there is an atmosphere that everybody was waiting for me to join and we can be relieved. It's easy to know when they talk and not. 話の流れも区別することもできる We can distinguish the flow of conversation. 上に同じ、みんながPCを見るのでスピードが ゆっくりになる Same as above. Everybody saw the pc, so the speed became slower.

3. Do you feel you were able to express yourself in today's discussion or meeting better with the presence of cues? How? : この試作品があることで議論や話し合いでどのようにして自分の意見や考えを伝えられましたか？

自分の意見を言うタイミングは試作品から影響はあまりない。 アイコンタクトやノートテイク内容でタイミングを見ていた。 The timing of stating my opinion was not affected by cues. Everybody saw the timing by eye contact or note taking. I can speak when I notice nobody speak. Yes, 1回目と違って区別ができる Yes, unlike the 1st one, we can distinguish (the flow?) 自分を呼んだタイミング、また、発言できるタイミングをつかめたので、不安は少し減ったと思う。 I could know the timing of calling me and understand the timing when I could talk, so I think I feel less anxiety.

4. In your opinion, which prototype was the most effective for 'interruption'? : どの試作品が話の流れに入るのに一番効果があったと思いますか？



Colour Cue : 色をつかったもの 2 50%
Text Cue : 文章をつかったもの 0 0%
Vibration Cue : 振動をつかったもの 2 50%

Please elaborate on the reasons for your answer. : その理由をお教えください

目に入る、信号と同じで考えなくても瞬時に状況がわかる。 It was in eyesight, and like a traffic signal, we can know the situation without consideration. Hard to watch monitor when we are in conversation. Vibration is better one. 色や文章より振動を使ってすぐに反応できるし By using vibration, we can react faster than using color and text. 話が話している/話していないとわかるので、質問できる/発言するタイミングがわかるのではないか。 We know whether someone is talking or not, so we may be able to know the timing of question and speaking.

5. In your opinion, which prototype was the least effective for 'interruption'? : どの試作品が一番効果が無かったと思いますか？

Text Cue：文章をつかったもの	3	75%
Colour Cue：色をつかったもの	0	0%
Vibration Cue：振動をつかったもの	1	25%

Please elaborate on the reasons for your answer. : その理由をお教えください

トークを使うため、文章と色を見る時間ならない Because we use talk(?), we don't have time to see the text and color.　日本人にYes/Noは慣れない、どちらかというとOK,NGから。 左と右の文面は同時に見るのは難しい。 Yes/No does not fit to Japanese people, it's better that OK/NG. It's difficult to see the both left and right simultaneously.　Yes/Noだけで、誰かが話しているのかつかめない。 We only know the Yes or No, and we don't know who are speaking.　It changes very quickly with word and need to focus on it.

6. In your opinion, which prototype was the most effective for 'name identification'? : どの試作品が自分の名前を呼ばれたこと知るのに一番効果がありましたか？

Text Cue：文章をつかったもの	1	25%
Colour Cue：色をつかったもの	0	0%
Vibration Cue：振動をつかったもの	3	75%

Please elaborate on the reasons for your answer. : その理由を教えください

Display my name is clear and easy to notice.　肩をたたいて呼んでいるのと同じ効果がある It has same effect with tapping.　振動を使うと反応もすぐにわかる We can know the response instantly by using vibration.　下、また画面から目をそらして他の人々を見ているときに振動だとわかりやすい。 When I see the outside of screen and look at the others, vibration is easy to notice.

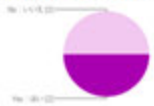
7. In your opinion, which prototype was the least effective for 'name identification'? : どの試作品が自分の名前を呼ばれたことを知るのに一番効果がありませんでしたか？

Text Cue：文章をつかったもの	3	75%
Colour Cue：色をつかったもの	1	25%
Vibration Cue：振動をつかったもの	0	0%

Please elaborate on the reasons for your answer. : その理由をお教えください

It changes quickly and hard to notice.　文章（文字）を見る時間がない We don't have time to see the text(letter)　おに同じ Same with 5　画面から目をそらしているとき、見逃してしまう。 When I see the outside of screen, I miss it.

8. Did you find any cues distracting? : 試作品の機能で気が散るようなことがありましたか？



Yes：はい	2	50%
No：いいえ	2	50%

If you answered "yes" to the previous question, please elaborate. : "はい"と答えた方はその理由をお教えください

Focus on display is hard.　慣れないので振動は振動が気になった Because I was not used to this, at the beginning it was distracted.

9. Feel free to add extra comments with regards to your experience today! : 本日の実験に参加した感想を自由に書いてください！

None　日本人向けに工夫するとまた違った効果があるかも？と思った。 Very interesting! You can ask me more in detail I have some opinion.　"日本人向けに工夫するとまた違った効果があるかも？と思った。あと、DEAFはアイコンタクト（表情）を大事にするので、PC内にカメラがあると良い。雰囲気がわかる I guess if you invent something for Japanese, there may be other effects. Deaf gives attention to eye contact, so it's good to have camera on PC. We can know the atmosphere."

D.7 Experiment 2 Post (Hearing)

Summary

1. Please identify your role:あなたの役割を教えてください

Meeting Chair：議長	0	0%
Hearing Participant：一般参加者	8	73%
Note-taker：ノートテイカー	3	27%

2. Did you face any difficulties communicating with DHH participants with the presence of cues? : この試作品があることで聴覚に障害のある方や難聴者とコミュニケーションをとる時に

I had to force myself to address the DHH participant by name. Since we were just focusing on 1 person it seems to be unnecessary. The clues weren't really evident to us but the conversation did go a lot more smoother. Nothing :) Typing Can't read the speed of talking , but the card. I felt a bit weird when there was lack of eye contacts, for example, we were trying to show one of the participants the chips, but he was too focused on the screen. It's take time. And I need to see display to know what he wants to talk. Participants were confused by signals in beginning, but Participant OhNo was able to answer my questions before it was typed, perhaps she was alerted to me talking and able to read my lips? :- Occasionally it seemed to be a challenge to get their attentions because they were focusing on the cues.

3. Do you feel that DHH participants participated actively in today's discussion or meeting? : 今回の議論や話し合いに聴覚に障害のある方や難聴者が積極的に関われたと思いますか？

Yes：はい	9	82%
No：いいえ	2	18%

Please elaborate on the reasons for your answer. : その理由をお教えください

More then excited I think people just wanted to hangout regularly and talk. (the same stupid things you talk about all the time) Perhaps if conversation time was longer we would have better conversation. But when some participants who where able to talk did so, convo went smoothly. (They still read screen to know what we said) Conversation seem to get smoother the less screen integration was used. They sometimes talked, but most of the time typing on computer. So it became a proof that they are participating actively in the discussion. She can hear us. Though not perfectly, but comparably better. They were of ease and we all seemed able to accommodate their needs. It was more like Q and A or interview. They were waiting for the our questions. Speakers were more focussed, less shy then in the first round. Addressing by name opens a more personal conversation. All non-DHH tried to talk DHH. There was little conversation among non-DHH. They seemed to be enjoying the conversations because the interactions went really well. They responded wholly and politely. They were in the centre of the conversation, directly addressed and the experiment was focused on them.

4. Do you feel DHH participants were able to communicate smoothly with others with the presence of cues? : この試作品があることで聴覚に障害のある方や難聴者は他の人たちとコミュニケーションがスムーズに出来ていると感じますか？

Yes：はい	8	73%
No：いいえ	3	27%

Please elaborate on the reasons for your answer. : その理由をお教えください

More focused, awkward self introduction phase was over, conversation became detailed. Actually not sure. But we were definitely able to converse more smoothly later in the session then the beginning. Yes, I feel they can communicate better with us cuz they asked us questions and they were active in the discussions. This lady was the first time we communicate to. So I can't major if it's more smooth or not. There were talking with little hesitation. Waiting time is reduced as well as uncertainty. I think for both parties. They could communicate smoothly, however I felt like sometimes they get confused about what we are talking on. Probably, it was because of note-taker typed a little bit late. personal address by home. Talk order was clear. Feel like they don't quite get it. Not sure. But I didn't realize any inconvenience. Because we have a goal to speak with him so it go smoothly but in the real situation when speak within the group. I still don't know when DHH people is going to start conversation. There is no cue from my side.

5. Did you find any cues distracting? : 試作品の機能で気が散るようなことがありましたか？

Yes：はい	0	0%
No：いいえ	11	100%

If you answered "yes" to the previous question, please elaborate. : "はい"と答えた方はその理由をお教えください

I did not see or experience the cues.

6. How did the presence of the cues change the flow of the discussion or meeting? : この試作品があることでどのように会議や話し合いの流れが変わったと思いますか？

I'm not sure how the cues were working but overall it was smooth. Things seemed a bit more relaxed. :- There is no cue from my side. If appeared to be easier for DHH participants to know that they were asked something. Much smoother, direct, and fun. Will not much different it seems to open things up more. I don't have any idea. I think we didn't had "Discussion". It will be better if we had topics provided at the beginning. the talk order seemed to be clear a bit more comfortable. In one case a participant was confused by meaning of on screen cue. However afterward I did not notice any confusion. I cannot say for certain it was because of cues, but conversation after cues were used was smoother then the first conversation without. the same as question No.6.

7. In comparison to the introductory session, did you notice any difference in the communication after the cues were introduced? 最初のセッションに比べて、この試作品があることでコミュニケーションに違いがあることに気付きましたか？

no difference. Yes, smoother Yes, but I don't know if it's because of the prototypes. I am not sure. Yes, it was more convenient to talk, which might be due to the self-introduction being over already. No Not sure. I only did 1 session as notetaker, so i can't compare. Commented about this in the last question. A little (see Q. 9) I didn't notice any differences actually because each discussion participants was different so i couldn't compare.

8. Feel free to add extra comments with regards to your experience today! : 本日の実験に参加した感想を自由に書いてください！

Good luck! <3 The risk with the experiment is that a comparison between a 3:2 conversation is difficult and 3:1 conversation is difficult. Since focus on 1 person is easier for both sides to understand. Maybe cues should be used in a 3:2 situation as well. very interesting, I think the design of the experiment itself can be improved. When DHH person was using typing in the log, the hearing participants had few cues to tell them that the DHH person had finished typing.. Manual note-taking is a big factor that makes the experience worse. Very Impressive. For participants able to read lips perhaps vibration cue is very good as there is no need to concentrate on screen. I noticed when we talked we tried to take turns and establish a pattern so as not to confuse DHH participant as to who is talking maybe vibration cue solves this? we need a cue from our side also. Communication is fun! none.