Influences of New Media Communication on the Deaf/Hard of Hearing as reflected in Interaction Design

Chia-Ming Chang

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School of Art & Design

Nottingham Trent University

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Copyright Statement

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Publications and Research Achievements

Publications (Appendix 22)

Journals:

- C. M. Chang, 2015, Innovation of a Smartphone App Design as used in Face-to-face Communication for Deaf/Hard of Hearing. Online Journal of Art and Design, Volume: 3, Issue: 4, October 2015, pp. 1-16. (ISSN: 2301 - 2501)

  Presented in the 4th International Conference on Communication, Media, Technology and Design (ICCMTD), Dubai, United Arab Emirates, 16th-18th May 2015

- C. M. Chang, 2014, New Media, New Technologies and New Communication Opportunities for Deaf/Hard of Hearing People. Online Journal of Communication and Media Technologies, Special Issue – October 2014, pp. 38-52. (ISSN: 1986-3497)

  Selected paper as special issue from the 3rd International Conference on Communication, Media, Technology and Design (ICCMTD), Istanbul, Turkey, 24th 26th April 2014. (To be published in the above journal)

Conference Papers:

- C. M. Chang, 2014, Interfaces of New Media Communication for Deaf/Hard of Hearing People, International Conference on Communication, CADBE College Research Conference, Nottingham Trent University, Nottingham, UK. 9th June.

- C. M. Chang, 2013, 'EyesTalk' A Potential Application (App) to bridge Communication Gap between Deaf/Hard of Hearing People and the Hearing Community through New Media Communication—Social Networking Services (SNS) and Smartphones, Research and the Researcher: 5th Annual Research Practice Course Conference, Nottingham Trent University, Nottingham, UK, 17th May.

Conference Poster:

- C. M. Chang, 2012, 'Silent Song' The Influence of New Media Communication on Deaf or Hard of Hearing People, Material World, Art & Design and Built Environment, 3rd College Research Conference and Festival, Nottingham Trent University, Nottingham, UK. 28th June.

Design Awards (Appendix 23)

The interaction design creative practice in this research: A smartphone app design 'Talk2Me' has been qualified in the below design awards.

- A' Design Award & Competition 2015, Silver Award Winner.
- IxDA Interaction Awards 2015, Shortlisted.
- iF Student Design Award 2015, Shortlisted.
- INDEX Award 2015, Nominated.

Other Research Achievements (Appendix 24)

- [Media Exposure] A Practice-based Research: Talk2Me. Featured in Yle TV, Finland, 25th January 2016 http://areena.yle.fi/1-3273671

- [Research Demonstration] Talk2Me: a novel communication app for deaf/hard of hearing people in face-to-face communication, Xmas Demo Day, Media Lab Helsinki, Aalto University, Finland, 15th December 2015

Abstract

In recent years different forms of media communication have increased in popularity and brought new technology into our daily lives, such as social media and smartphones. It has brought new opportunities for communication. However, there has traditionally been a communication gap between the deaf/hard of hearing (D/HoH) and hearing people. The question therefore arises: Are the new communication opportunities able to bridge this communication gap? This research aims to explore new communication opportunities for D/HoH people by the use of social networking services (SNS) and the new communication applications (apps). It will provide an innovative communication solution, via interaction design, for bridging the aforementioned communication gap between D/HoH and hearing people.

This study is divided into two parts: a. Preliminary study; b. Primary research and creative practice. The preliminary study shows that new media communication technologies (SNS and communication apps) can open new communication opportunities and bridge the communication gap between D/HoH and hearing people. This study argues it is possible because there are three specific features provided by SNS and communication apps. However, it also shows there is a further communication gap in face-to-face (FTF) communication even when using SNS and communication apps. This is because the physical interaction with nonverbal messages is absent in the use of SNS and communication apps. The primary research provides a communication solution (a smartphone app 'Talk2Me') that has been developed through interaction design creative practice and specifically a user-centred design (UCD) development process. The resulting app can be used to bridge the FTF communication gap between D/HoH and hearing people. This innovative communication solution provides a specific way to communicate between D/HoH and hearing people in FTF communication.

This study contributes new knowledge in the understanding of SNS and communication apps as used by the D/HoH, which are not studied in detail in existing literature. In addition, this research contributes an innovative communication solution for the D/HoH that has been specifically developed from an interaction design perspective.

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List of Abbreviations

App	(Smartphone) Application
BSL	British Sign Language
CMC	Computer-Mediated Communication
dB	Decibel
D/HoH	Deaf/Hard of Hearing
FTF	Face-to-Face
ECD	Experience-centred Design
GUI	Graphical User Interface
IM	Instant Messaging
NFC	Near Field Communication
NUI	Natural User Interface
OS	Operating System
PCD	Person-Centred Design
PD	Participatory Design
SMS	Short Message Service
SNS	Social Networking Services
UCD	User-Centred Design

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CHAPTER ONE

INTRODUCTION

Chapter 1: Introduction

This chapter introduces the original background and motivation for doing this research and defines the research aims and questions. In addition, this chapter provides an outline of this Ph.D. thesis.

There are three sections in this chapter:

a. Research Background
   This section describes the general research background and explains the original motivation for undertaking this research.

b. Research Aims and Questions
   This section explains the main research aims and defines the research questions of the study.

c. Research Findings and Contributions
   This section highlights the significant research findings and contributions of the study.

d. Thesis Structure
   This section provides a brief outline of the contents of the seven chapters in this thesis.

1.1 Research Background and Motivation

Communication is a very important aspect for human beings. ‘Every aspect of our daily lives is affected by our communication with others’ (Littlejohn and Foss 2007, p.2). Communication is one of the most commonplace and everyday human behaviours that conveys people’s thoughts. In recent years, our ways of communicating and interacting have been radically transformed through new forms of communication media and technologies, such as social media and smartphones. These new media communication technologies have changed our communication methods and behaviours: People avoid or have less and less oral conversation and face-to-face (FTF) interaction (Pierce 2009; Turkle 2012). In addition, the new media communication technologies (social media and smartphones) have opened new communication opportunities and people spend more and more time communicating using these methods (Baym, Zhang and Lin 2004; Keating, Edwards and Mirus 2008; Pierce 2009).

Communication is a primary problem for deaf/hard of hearing (D/HoH) people due to their hearing loss. Vernon and Andrews (1990, p1) indicate that ‘the very essence of the disability of hearing impairment is its effects on communication and the resulting impact of communication on behavior.’ People who are D/HoH use various methods to communicate and interact with hearing people. However, it will be shown in the following sections that there remains a communication gap between the D/HoH and hearing people. One main reason is that the primary communication methods (sign language, limited speech and lip reading) used by D/HoH people are different from the primary communication method (speech) used by hearing people.

New media communication technologies (SNS and communication apps) might open new communication opportunities that bridge the communication gap between the D/HoH and hearing people. This is because communication between the D/HoH and hearing people can bring them closer and improve understanding. For example, the author in his personal experience of communicating and interacting with one of his D/HoH friends has seen that there is no actual communication gap between him and his D/HoH friend when they are communicating via SNS and communication apps, such as the use of Facebook and WhatsApp. This is a significant improvement in an ability to communicate with the author's D/HoH friends that did not exist before. It is possible that the new forms of SNS and communication apps allow new opportunities and possibilities and richer communication experiences between the D/HoH and hearing people. This is the original motivation for undertaking this research project.

There are various communication solutions for the D/HoH. Signed communication and written communication are two typical solutions (Barnett 2002), whilst cochlear implants and hearing aids are two hearing technologies for the D/HoH. A review of existing D/HoH communication solutions (see 2.2.1 Existing Communication Solutions for the D/HoH, p.18) show there are three categories of communication solution/technology for the D/HoH: a. Teletypewriter (TTY), Telecommunications Relay Service (TRS) and Video Relay Service (VRS), b. SMS, IM, Email and Fax and c. Sign Language and Voice Recognitions. Current studies have shown that social media (SNS) and smartphones (communication apps) have brought new forms communication and opened new communication opportunities (see 2.2.2 Potential Communication Solutions: New Media Communication Technologies, p.22).

The existing literature that discusses SNS and communication apps as used by the D/HoH and with particular reference to the communication problem between the D/HoH and hearing people, is limited. In addition, most studies in the field of D/HoH communication solutions mainly focus on the development of relevant technology. In the recent years, design has become a significant part of solutions created to improve human health and wellbeing. This research attempts to investigate and provide a new communication solution for the D/HoH. This solution is specifically developed via interaction design practice.

1.2 Research Aims and Questions

Based on the above research background and the original motivation of this research, this section indicates the research aims and questions of this study.

1.2.1 Research Aims

Existing literature shows that new media communication technologies have affected the way people communicate and have opened up new communication opportunities (Baym, Zhang and Lin 2004; Keating, Edwards and Mirus 2008; Pierce 2009). However, within the existing literature, there is a lack of knowledge of new media communication technologies (SNS and communication apps) as used by D/HoH people, particularly in terms of communicating with hearing people.

Firstly, this research aims to build an understanding of new media communication technologies (SNS and communication apps) as used by the D/HoH and it is proposed that SNS and communication apps can open up new communication opportunities for communication between the D/HoH and hearing people. It will also be investigated how SNS and communication apps can bridge the communication gap between the D/HoH and hearing people.

Secondly, this research aims to investigate a new communication solution through a creative practice of interaction design (design of a smartphone app that can be used to bridge the FTF communication gap between the D/HoH and hearing people). Furthermore, the FTF communication gap is a significant communication problem found from this research. Part of this research shows that SNS and communication apps are able to bridge the non-FTF communication gap between the D/HoH and hearing people. However, there remains a further communication gap in the FTF communication between the D/HoH and hearing people even with the availability of SNS and smartphone communication apps.

There are two research aims in this study:

- **The first research aim is to investigate the influences of new media communication on the D/HoH and explore new communication opportunities offered by SNS and communication apps for bridging the communication gap between the D/HoH and hearing people.**

- **The second research aim is to investigate a new communication solution through an interaction design creative practice (design of a smartphone app) that can be used to bridge the FTF communication gap between the D/HoH and hearing people.**

1.2.2 Research Questions

There is a question that needs to be asked at the beginning of the study, so as understand the influence of new media communications on the D/HoH. This question aids in understanding how new media communication technologies (SNS and communication apps) are used by the D/HoH, an understanding that is limited in the existing literature.

The first research question of this study is:

- **Are the new media communication technologies of SNS and communication apps able to open new communication opportunities for the D/HoH to communicate and interact with the hearing community? If so, how?**

This research will conduct a preliminary study (see Chapter 4: Preliminary Study: New Communication Opportunities offered by SNS and Communication Apps for the D/HoH, p.63) to answer the first research question. From the preliminary study, the reasons of how and why SNS and communication apps are able to open new communication opportunities and bridge the communication gap between the D/HoH and hearing people will be argued. In addition, the preliminary study will argue there is still a communication gap in FTF communication between the D/HoH and hearing people even when using SNS and communication apps

The second research question that addresses the FTF communication gap is:

- **How to bridge the FTF communication gap between the D/HoH and hearing people via design of a smartphone app?**

This research will conduct an interaction design creative practice (see Chapter 5: Primary Research: Interaction Design Creative Practice, p.94) to answer the second question. A smartphone app will be designed that can be used to bridge the FTF communication gap between the D/HoH and hearing people.

1.3 Research Findings and Contributions

This section summarises the research findings and contributions of this study.

Four research findings:

- New communication opportunities offered by SNS and communication apps that can improve the communication between the D/HoH and hearing people.

- Three significant features involved in SNS and communication apps that can open new communication opportunities for the D/HoH.

- A FTF communication gap exists between the D/HoH and hearing people even when using SNS and communication apps.

- A novel communication solution is developed that can bridge the FTF communication gap between the D/HoH and hearing people.

Three research contributions:

- A new understanding of SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) as used by the D/HoH. This contribution shows that the D/HoH believe SNS and communication apps can improve the communication between the D/HoH and hearing people.

- A further understanding of three significant features (a. An accessible communication channel, b. An integrated communication and social platform and c. An optimised multi-function interface) involved in SNS and communication apps that can open new communication opportunities for the D/HoH.

- An innovative communication solution that can be used to bridge the FTF communication gap between the D/HoH and hearing people. This communication solution is a smartphone app design developed using interaction design.

1.4 Thesis Structure

This thesis is divided into seven chapters as outlined below. The appendices in this Ph.D. thesis include the questionnaire and interview data as well as the development materials of the interaction design creative practice, an ethics approval letter, relevant publications and research achievements. In addition, a CD-ROM is attached as part of this thesis containing the prototypes from the study.

Chapter 2: Literature Review, defines the D/HoH and their communication problems, and in addition explores existing and potential D/HoH communication solutions. Furthermore, this review reveals the differences between computer-mediated communication (CMC) and FTF communication and relevant design studies in the field of human health and wellbeing.

Chapter 3: Research Methodology, introduces the research design and the interaction design creative practice in this study. It also reviews relevant design methods and explain the design method (user-centred design) used in this study. In addition, this chapter states the ethical issues associated with this research.

Chapter 4: Preliminary Study: New Communication Opportunities offered by SNS and Communication Apps for the D/HoH, focuses on discussions new media communication technologies (SNS and communication apps) as used by the D/HoH and aims to answer the first research question. In addition, the findings from this chapter led to the secondary research question.

Chapter 5: Primary Research: Interaction Design Creative Practice, investigates and provides a new communication solution that addresses the FTF communication gap between the D/HoH and hearing people, through a creative practice of interaction design based on a user-centred design development process.

Chapter 6: A Smartphone App: Talk2Me, indicates significant innovations of the smartphone app design 'Talk2Me' and presents a completed prototype with detailed interfaces. Furthermore, this chapter compares the Talk2Me app with other similar apps. This chapter also summarises feedback from end-users about the final prototype of the Talk2Me app.

Chapter 7: Conclusion and Further Work, restates the principal outlines and significant outcomes of this practice-based research project. This chapter also states the potential limitations of this research and possibilities for future work.

CHAPTER TWO

LITERATURE REVIEW

Chapter 2: Literature Review

This chapter defines the D/HoH and their communication problems and reviews existing and potential D/HoH communication solutions. In addition, this chapter examines and discusses the difference between CMC and FTF communication.

There are four sections in this chapter:

a. The Communication Gap between Deaf/Hard of Hearing and Hearing People
   This section defines the D/HoH and the communication gap between the D/HoH and hearing people, and explores additional issues associated with the D/HoH in FTF communication.

b. Existing and Potential Communication Solutions
   This section reviews existing communication solutions for the D/HoH and potential communication solutions offered by SNS and communication apps.

c. Computer-mediated Communication and Face-to-Face Communication
   This part reviews CMC and FTF communication and indicates significant differences between CMC and FTF communication.

2.1 Communication Gap between Deaf/Hard of Hearing and Hearing People

Deaf and hard of hearing people are a particular group studied in this research. This section firstly gives a definition of the D/HoH and then describes the communication gap between the D/HoH and hearing people. In addition, it explores further issues with regard to the D/HoH in FTF communication.

2.1.1 Definition of the Deaf and Hard of Hearing

There are many types of deafness with nuanced differences in their communication behaviours due to dissimilarities in their communication abilities. The *Congenital Deaf*, for example, learn sign language as their primary communication method when they are born, whilst the *Acquired Deaf* become deaf after first being able to hear and speak without impairment. There are also different levels of hearing impairment, all types of deafness can be divided into two broad groups: deaf and hard of hearing people. Table 2.1 below shows the differences between deaf, hard of hearing and hearing people.

Definition	**Level of Hearing Impairment**
Deaf People	'Profound'- hearing loss where one can only hear sounds equivalent to or over 95 decibel (dB).
Hard of Hearing People	'Severe'- hearing loss where one can begin to hear sounds between 71 and 95 dB. 'Moderate'- hearing loss where one can begin to hear sounds between 41 and 70 dB. 'Mild'- hearing loss where one can only begin to hear sounds between 20 and 40 dB.
Hearing People	No hearing loss (one can hear sounds under 20 dB).
Conversational speech can be measured as having a loudness of approximately 60 dB (see Middleton 2010, p.1-2).	

Table 2.1. Definition of Deaf, Hard of Hearing and Hearing People

In other words, deaf people can be defined as people with hearing loss who receive no useful linguistic information from sound and use other communication methods such as sign; hard of hearing people can be defined as people with hearing loss who still receive limited linguistically useful information from speech and for example use lip movement/reading (they also use some physical information and sign language as a supplement) as their primary communication method (Barnett 2002).

The term Deaf/Hard of Hearing (D/HoH) is used to represent the target audience in this study. The target audience does not include the ‘mild’ hard of hearing people, who usually use oral language as their primary communication method, for the purpose of this study this sub group is being included as part of the hearing community.

2.1.2 A Communication Gap between the D/HoH and Hearing People

The nature of communication is an activity by humans to transfer information and thoughts. People ‘write themselves and their community into being’ through the way they communicate (Dansh 2007, p.2). Littlejohn and Foss (2007, p.2) note that ‘we treat communication as central to human life.’ Communication is one of the most commonplace and important activities in our daily lives; it conveys our thoughts and transfers information. However, Vernon and Andrews (1990, p1) indicate ‘The very essence of the disability of hearing impairment is its effects on communication and the resulting impact of communication on behavior.’ Communication is the main problem for the D/HoH because of their hearing loss.

Barnett (2002, p.695) notes, ‘The key to successful communication with people with hearing loss is the ability to adapt to the needs of the situation.’ D/HoH people use two systems to communicate: one is used to communicate with the D/HoH and another is used to communicate with hearing people (Schiff and Ventry, 1976). The communication methods used by the D/HoH not only depend on their communication ability but also on the people with whom they communicate. Looijesteijn (2009) indicates that the D/HoH face more stress and difficulties when they communicate with hearing people. D/HoH people and hearing people use different means as their primary communication methods. D/HoH people use sign language and limited speech with lip movement/reading, whilst hearing people use speech. Because of the different communication methods used by the D/HoH and hearing people there is a communication gap between the D/HoH and hearing people.

Although D/HoH are able to use their primary communication methods to communicate and interact with hearing people if those hearing people can understand and use these communication methods, most of hearing people do not understand sign language and have limited experience in communicating with the D/HoH (Bouvet 1990; Looijesteijn 2009).

2.1.3 A Further Issue of the D/HoH in FTF Communication

The primary research of this study (see Chapter 5: Primary Research: Interaction Design Creative Practice, p.94) aims to investigate a communication solution to address the FTF communication gap between the D/HoH and hearing people, visual attention is a significant issue in FTF communication. Visual attention is one of the five senses (sight, sound, taste, smell and touch) used to perceive the environment. Visual attention for the D/HoH is different from visual attention in hearing people and has a greater significance in communication. Watanabe et al (2011, p.1) explains that it is because of 'adaptation to hearing loss and/or consequential changes in communication strategy'. The D/HoH rely on visual sense much more than the audio sense during communication. Stivalet et al (1998) indicate that the D/HoH congenitally have more efficient visual processes than normal hearing people that can help the D/HoH during communication. The visual processes augment the verbal and nonverbal information.

Nonverbal information, such as eye contact, facial expressions, handshakes, head nods and smiles, are important communication elements that can help the D/HoH recognise and perceive information from those they communicate with, particularly when receiving emotional information during FTF communication. Nonverbal information is able to enhance the understanding of communication when the D/HoH communicate using sign language or limited speech with lip movement/reading (Bettger, et al 1998; Watanabe, et al 2011). In addition, nonverbal information (physical interaction with nonverbal messages) is one of the most significant elements in FTF communication, which will be discussed in the following section (see 2.3 Computer-mediated Communication and Face-to-face Communication, p.30).

2.2 Existing and Potential Communication Solutions

There are various existing communication solutions used in the D/HoH community. Sign language is the primary solution used by the D/HoH without needing speech and listening, whilst cochlear implants and hearing aids are two hearing technologies used to support the D/HoH to hear sounds. Cherniavsky et al. (2009) indicate sign language has the same communication rate as spoken language. However, only a minority of the hearing use and understand sign language. Furthermore, cochlear implants and hearing aids only benefit a small part of the D/HoH because most of the D/HoH do not wear cochlear implants and hearing aids (Looijesteijn 2009). For example, there are more than 10 million D/HoH people in the UK and only about 10 thousand of them wear cochlear implants and 2 million wear hearing aids (Action On Hearing Loss 2011).

Barnett (2002) indicates two typical communication solutions for the communication between the D/HoH and hearing people (when cochlear implants and hearing aids are not available): signed communication (via a sign language interpreter) and written communication (via a pen and a paper). However, a sign language interpreter and a pen and a paper are not always available when communication occurs between the D/HoH and hearing people. Also, people can feel awkward with the role the interpreter plays as mediators during more private communications (Barnett 2002). This section will review other existing communication solutions for bridging the communication gap between the D/HoH and hearing people when the above two solutions (signed communication and written communication) are not available. In addition, this section reviews and discusses new media communication technologies (social media and smartphones), which are the potential communication solutions investigated in this study.

2.2.1 Existing Communication Solutions for the D/HoH

In a review of the *Journal of Deaf Studies and Deaf Education*, there are various studies that investigate hearing technologies for the D/HoH in different communication circumstances (e.g. communication, education, emergency and medical care). In addition, a search of the UK Apple app online store by searching with the key words of ‘deaf’ and ‘hard of hearing’, shows three main types of smartphone apps specifically designed for the D/HoH: a. sign language learning apps, b. communication apps and c. other apps (e.g. alerts, subtitles). Existing communication solutions for the D/HoH can be divided into three broad categories: a. Teletypewriter (TTY), Telecommunications Relay Service (TRS) and Video Relay Service (VRS), b. SMS, IM, Email and Fax and c. Sign Language and Voice Recognition.

(1) Teletypewriter (TTY), Telecommunications Relay Service (TRS) and Video Relay Service (VRS)

Teletypewriter (TTY), telecommunications relay service (TRS) and video relay service (VRS) are three communication technologies specifically designed for the D/HoH, these are the three communication solutions/technologies commonly used between the D/HoH and hearing people (Maiorana-Basas and Pagliaro 2014; Power, Power and Horstmanshof 2007). TTY is a significant invention created by Robert Weitbrecht in the late 1960s for the D/HoH (Lang 2000). It was the first telephone specifically designed for the D/HoH, and it allows them to communicate over a telephone line via text and typing. It is a text-to-text communication solution/technology. However, in recent years Short Message Service (SMS), Instant Messaging (IM), and E-mail have replaced the TTY used by the D/HoH (Maiorana-Basas and Pagliaro 2014). TRS is a technology combining with TTY that allows a D/HoH person to make a call to a hearing person through text typing. The typed text will be relayed as voice messages via a TRS operator in real-time to the hearing person. It is a text-to-voice communication solution/technology. VRS is a technology similar to TRS but based on a video call that allows a D/HoH person to make a call to a hearing person through sign language. The sign language performed by the D/HoH will be relayed as voice or text messages via a VRS operator (a sign language interpreter) in real-time to the hearing person. It is a sign-to-voice/text translation communication solution/technology. For example, the P3 Mobile app is a VRS system used via a smartphone. In summary the three services are: a. text-based communication (TTY), text-to-voice communication (TRS), and sign-to-voice/text communication (VRS).

(2) SMS, IM, Email and Fax

SMS, IM, Email and Fax are communication solutions/technologies not specifically designed for the D/HoH but commonly used by the D/HoH to communicate and interact with hearing people. The technologies of SMS, IM, and E-mail have been used as common communication solutions to address the communication gap between the D/HoH and hearing people (Goggin and Newell 2003; Henderson-Summet et al. 2007; Maiorana-Basas and Pagliaro 2014; Pilling and Barrett 2008; Power and Power 2004; Power, Power and Horstmanshof 2007; Wagreich 1982). These communication technologies have also reduced the isolation of the D/HoH because there is no actual difference between the D/HoH and hearing people when they are using SMS, IM, and E-mail (Bakken 2005; Power and Power 2004). Power, Power and Horstmanshof (2007) indicate SMS, IM, and E-mail provide the D/HoH an equal communicative footing when they communicate with hearing people. Furthermore, Power, Power and Horstmanshof (2007) conducted a survey with 172 D/HoH participants to investigate the use of these text-based communication technologies. The study shows that these text-based communication technologies are regularly used by the D/HoH in different communication circumstances, for example, using SMS for personal interaction and Email for business.

Power, Power and Horstmanshof (2007) indicate the primary purpose of using these text-based communication technologies is to enhance D/HoH people's sociability. Text-based communication technologies for the D/HoH are not only used for the content of the messages, but for the sense of social interaction (Horstmanshof and Power 2005). The social issues of the D/HoH using text-based communication technologies will be discussed in the following section (see (2) Impacts of SNS and Communication Apps, p.24). In addition, fax is a telephone-based equipment for transmitting scanned material (text and images). It is also a communication solution/technology used by the D/HoH for both personal and business purposes (However, Power, Power and Horstmanshof 2007). However, today the use of fax has been replaced by SMS, IM, and E-mail (Maiorana-Basas and Pagliaro 2014).

(3) Sign Language and Voice Recognition

Sign language and voice recognition are two other possible communication solutions/technologies for the D/HoH. Sign language recognition is a technology that supports sign language to speech or text translation, whilst voice recognition is a technology that supports speech to text or sign language translation. These two technologies can be used to assist the communication between the D/HoH and hearing people e.g. when sign language interpreters are not available.

a. Sign Language Recognition

There are 1,190,000 research results shown in the past ten years (2005-2015) when searching for 'sign language recognition' in Google Scholar and 4,479 results in the ACM Digital Library. However, sign language recognition is still a developing technology and the recognition accuracy is still weak (Cooper, Holt and Bowden, 2011; López-Ludeña et al. 2013). Researches working on improving sign language recognition system for the D/HoH include examples such as SignSpeak (Dreuw et al. 2010), DICTA-SIGN (Efthimiou at al. 2010), LSESpeak (López-Ludeña et al. 2013), Microsoft Kinect (Sun, Zhang and Xu 2015) and MotionSavvy UNI (MotionSavvy 2015). The SignSpeak research project has developed a new vision-based technology for recognizing sign language and translating it into text. The DICTA-SIGN project developed a technology that allows D/HoH people make Web 2.0[1] interactions (e.g. via Facebook) by using sign language via a webcam. The LSESpeak project developed a spoken language generator by combining sign language recognition and SMS. The Microsoft Kinect project has proposed a novel algorithm to model and recognise sign language performed in front of a Microsoft Kinect sensor. The MotionSavvy UNI project is currently developing an application (for tablets and desktops) that supports sign-to-speech and speech-to-text translation. However, these current sign language recognition researches/technologies are still limited and are in the

[1] Web 2.0 is a new generation concept of web sites that are mainly based on user-generated content. Users interact with other through sharing information on Web 2.0 sites such as a social network.

process of being developed. Hence, they are still unable to accurately translate sign language[2].

b. Voice Recognition

In comparison with sign language recognition, voice recognition is a highly developed technology (Cooper, Holt and Bowden, 2011). Today voice recognition technology has been applied widely on digital devices. The most famous example is the Apple iPhone Siri, an intelligent personal assistant accessed via voice commands; this was introduced as a feature of the iPhone 4S on October 14, 2011. The Siri feature also supports speech to text translation for inputting messages via voice. Searching the keywords 'voice recognition' and 'speech to text' on Apple iTunes and Google Play app stores, there are a huge number of apps available to be installed on smartphones and tablets, such as Dragon Dictation, Voice Texting and Voice To Text. Dragon Dictation for example is a voice recognition app (iOS and Android) that allows users to easily input information via voice and instantly see in real time the information in text form. This app can be used to support messages, email, blog and SNS posts (e.g. Facebook and Twitter). The Dragon Dictation app has been proved that it can deliver up to 99% voice transcription accuracy as well as being up to five times faster than typing on the keyboard (Nuance 2015).

The above review has shown three main types of existing communication solutions used by the D/HoH (a. TTY, TRS and VRS, b. SMS, IM, Email and Fax and c. sign language and voice recognitions). Some of them are outmoded (e.g. TTY), some are still being developing (e.g. sign language recognition) and some are highly developed (e.g. voice recognition).

The review of the existing D/HoH communication solutions shows that text plays an important role in the communication between the D/HoH and hearing people (e.g. text-based, voice-to-text and sign-to-text). It also shows some existing communication solutions/technologies (e.g. SMS, IM, Email) have replaced others

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[2] MotionSavvy UNI project will be launched in public market in 2016 summer.

(e.g. TTY and Fax) used by the D/HoH. The latter phenomenon has produced additional communication technologies that may create additional communication opportunities for the D/HoH e.g. new media communication solutions such as social media (SNS) and smartphones (communication apps). The next section will review and discuss SNS and communication apps which have been selected to study as potential communication solutions for the D/HoH.

2.2.2 Potential Communication Solutions: New Media Communication Technologies

The reason to focus on these new media communication technologies is primarily affected by the author's personal experience in communicating with one of his D/HoH friends by using SNS (Facebook) and a communication app (WhatsApp), in particular via a smartphone. From personal experience there is no actual communication gap between the author and his D/HoH friend. The author assumes from experience that new media communication technologies (SNS and communication apps) might bring new communication opportunities and replace some of the existing D/HoH communication technologies/solutions used by the D/HoH.

(1) Definition of New Media Communication Technologies: Social Media and Smartphones

The Oxford Dictionary defines new media as 'means of mass communication using digital technologies such as the Internet'. Manovich (2011, p.19) states that 'the popular understanding of new media identifies it with the use of a computer for distribution.' New media is also known as digital media where people can communicate and distribute information through digital technologies: computers and the Internet (Flew 2005; Manovich 2011). It is approximately 30 years since the first IBM personal computer was produced in 1981[3] and the Internet as we know it was

[3] The first personal computer IBM 5050 was produced by IBM in 1981.

proposed in 1984[4]. In this research, the new media communication specifically focuses on the use of social media and smartphones, social media on smartphones has become extremely popular in recent years.

Social media are computer-mediated tools that allow people to create social networks. A social network is a theory in the social science discipline that is used to describe relationships and interactions between people, such as a set of social relations between two or more individuals in a society. Osterrieder (2013) indicates the core principle of social media is to share content with people; Ahlqvist, et al. (2008) explains that social media is built from three key elements: ‘content’, ‘communities’ and ‘Web 2.0’, and Kaplan and Haenlein (2010) suggests that social media exist in ‘virtual worlds: computer-based simulated environments’. Social media offers greater interactivity than traditional media (e.g. newspaper, broadcast and TV), it enables people to create, upload and share multimedia content in order to connect and interact with others. SNS is a web platform where people can build and establish their social networks by sharing information and communicating with each other. Today, SNS is one of the most representative and successful of the social media (Ahn, et al. 2007).

Smartphones have become popular mobile digital devices in recent years, people use them to access information immediately anytime and anywhere for different purposes (e.g. communicating, shopping, and working) (Dominick 2009). A smartphone is a type of mobile phone that offers more advanced functions than a feature phone, usually with a bigger multi-touch screen, better camera, faster Internet connection and app support. An app is a programme specifically designed to be run on smartphones (and tablets), it has the potential to offers a wide range of functions and services. It is similar to software on desktop or laptop computer. Because of the advanced functions, a smartphone has become a multi-function device, like a small computer rather than just a simple communication tool. Goggin and Hjorth (2009) indicate a smartphone plays in a positive role in our daily lives. A smartphone provides various ways (via different apps) for people to communicate and interact with each other.

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[4] Tim Berners-Lee proposed the World Wide Web (WWW) in 1984.

(2) Impacts of SNS and Communication Apps

Today, people use SNS to communicate and interact with other for different purposes (e.g. personal life and business). SNS has become an extremely popular communication tool in our daily lives. A report shows the top three most popular SNS in the world i.e. Facebook, Twitter and Linkedin, had a total of 1.465 billion users in 2014, and it is still growing (eBizMBA 2014). SNS has enabled new forms of communication and interaction between people. It has opened alternative ways of communicating whereby people spend a considerable length of time communicating and interacting with others via SNS rather than other means. There is a huge amount of SNS related research. Boyd and Ellison (2007) indicate four main themes of existing SNS research: a. Impression Management and Friendship Performance, b. Networks and Network Structure, c. Bridging Online and Offline Networks, and d. Privacy. The review of SNS in this study is based on a journal paper '*A review of social networking service (SNS) research in communication journals from 2006 to 2011*' (Zhang and Leung 2014). This journal paper discusses SNS by utilising the four themes of SNS proposed by Boyd and Ellison (2007).

People's communication behaviours have changed due to the use of new media communication technologies and online social interaction (Baym, Zhang and Lin 2004; Keating, Edwards and Mirus 2008; Pierce 2009). The review of SNS in this study specifically focuses on communication impacts. As a result of the new communication opportunities opened up by SNS, people invest a lot of time on its use. The review aims to investigate this phenomenon. By employing Boyd and Ellison's four themes of SNS (with the exception of the theme of 'privacy' because this study does not focus on SNS privacy issues) to discuss the communication impact of using SNS, there are three significant points that can explain the new communication behaviours/opportunities brought about by SNS: a. SNS Content and Information, b. Construction of Social Capital and c. Connection of Online and Offline Social Interaction.

a. SNS Content and Information

Content/information is a key element in social media (Agichtein, et al. 2008; Ahlqvist, et al. 2008; Osterrieder 2013). Boyd and Ellison (2007) indicate SNS allows people to undertake three main activities: a. ‘construct a public or semi-public profile within a bounded system’, b. ‘articulate a list of other users with whom they share a connections’ and c. ‘view and traverse their list of connections and those made by others within the system’. These three activities are based on the use of SNS content and information. The SNS content and information are such as users’ personal information (e.g. name, photo, affiliation, relationship status) and the information from others who are in the users’ networks. SNS content and information provide a more consistent and transparent social interaction process between users (Zhang and Leung 2014). In addition, Park, Kee and Valenzuela (2009) indicate SNS allows people to enhance social interaction by using SNS content and information.

b. Construction of Social Capital

Social capital is the resources accumulated through the relationships among people (Coleman 1988). Bourdieu and Wacquant (1992, p.14) define social capital as ‘the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition.’ Although there is some research that argues that SNS may decrease people’s social capital (NIE 2001), a lot of research indicates SNS enables people to bridge and increase their social capital (Donath and Boyd 2004; Ellison, Steinfield and Lampe 2007; Resnick 2001). SNS can be used as the foundation of social capital, such as online relationships, that is supported by technologies (e.g. distribution lists, photo directories, and search capabilities) (Resnick 2001).

c. Connection of Online and Offline Social Interaction

SNS enables users to bridge online and offline social connections (Ellison, Steinfield and Lampe 2007; Park, Kee and Valenzuela 2009; Zhang and Leung 2014). SNS allows user to use online networks as supplements to support their offline social interaction. For example, people have frequently used Facebook to organise and support offline meetings or events (Park, Kee and Valenzuela 2009). Today, the virtual network of SNS has become an important part of our offline social life. Ellison, Steinfield and Lampe (2007) indicate that online social interactions on SNS can enhance existing offline social relationships, particularly in a specific community (e.g. a campus or a company). The connection of online and offline social interaction has affected people's communication behaviours in the sense that they have increasingly spent time interacting with each other via SNS. In addition, Lee (2009) indicates that people who have strong social relationships make greater use of online communication tools, which supports the 'rich get richer' social life.

On the other hand, smartphone communication apps have opened new ways of communicating in recent years. Smartphone communication apps such as WhatsApp, LINE and WeChat. They are the top three most popular communication (messaging) apps in the world with a total of 1.438 billion users in 2014 and still growing (Forbes 2014). Many researches have shown that instant message (IM) via smartphone communication apps have often been used as a replacement for SMS (Baoguo and Xuyan 2014; Costill 2013; Kumar, et al. 2015; Terpstra 2013; Yeboah and Ewur 2014). A BBC report (2013) shows almost 19 billion messages were sent daily via communication apps in 2012, compared with 17.6 billion messages via SMS. Kumar, et al. (2015) indicates text-based and VoIP[5] communication apps have replaced traditional SMS and phone calls (conventional cellular voice services) due to three reasons: a. High-speed Internet, b. Smartphone Penetration and c. Cost Effectiveness.

a. High-speed Internet

[5] Voice over IP (VoIP) is a methodology and group of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet.

Text-based and VoIP communication apps use the Internet (3G/4G or Wifi) to transmit information, that has replaced the older mobile telephone transmission technology (GSM). Text-based messaging only requires low-speech Internet, whilst high-speed Internet supports VoIP functions. In the countries where high-speed Internet is available, VoIP based apps have wider acceptance.

b. Smartphone Penetration

Text-based and VoIP communication apps require smartphones to run in countries with a high availability of smartphone penetration. A smartphone has become an extremely popular digital device in our daily lives (Dominick 2009; Goggin and Hjorth 2009)

c. Cost Effectiveness

Text-based and VoIP communication apps transmit information over the Internet at often very low cost or in some cases free and the users need only pay the additional data usage charges for their mobile data or Wifi connection. The high cost of SMS in some markets has made consumers switch to inexpensive text-based communication apps.

In addition, there are some other reasons why IM communication apps are more popular than conventional SMS. Davey, et al. (2004) indicate IM communication apps have changed the way people communicate and they point out three reasons: a. Multi-Tasking, b. Screen Names, Profiles and Buddy Lists and c. Away Messages.

a. Multi-Tasking

IM allows users to conduct more than one task at the same time. For example, one of the main attractions of IM is that it is easy to have more than one conversation at a time about completely different subjects, whilst listening to music or doing something else.

b. Screen Names, Profiles and Buddy Lists

IM allows users to create their screen names, profiles and buddy lists. Screen names give individuals a sense of self and of belonging. Profiles are a way that allows users to become familiar with each other without their actual presence or direct communication. Buddy lists are a way to organize and track users with whom you communicate.

c. Away Messages

IM allows users to post a brief message as an away message so that people can find information about other users without actually initiating conversation. It helps users to express something personal about themselves without needing to be online all the time.

(3) Limitation of Existing Literature in SNS and Communication Apps as used by the D/HoH

The above review has shown that new media communication technologies (SNS and communication apps) have enabled new ways of communicating. SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) have opened new communication opportunities and people have been spending increasing time utilising these. However, the literature that discusses SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) as used by the D/HoH and with particular reference to the communication problem between the D/HoH and hearing people, is limited. For example, only two studies are found in the *Journal of Deaf Studies and Deaf Education* by searching for the key words 'Facebook', 'Twitter' and 'Linkedin', 'WhatsApp', 'LINE' and 'WeChat'[6]. One of these (technology use among adults who are deaf and hard of hearing: a national survey) is a study about communication technologies for the D/HoH. This study shows that 'social networking sites such as Facebook, Pinterest, and Twitter could help break down social barriers that often exist between individuals who are DHH[7] and individuals who are hearing' (Maiorana-Basas and Pagliaro 2014, p.407). The

[6] Although some results can be found by search 'LINE' it is not related to the LINE app.
[7] DHH (Deaf and Hard of Hearing), it is same as the abbreviation 'D/HoH' used in this study.

other (*Bullying and cyberbullying among deaf students and their hearing peers: An exploratory study*) is a study about cyberbullying among D/HoH students. Although this study is not directly related to the subject of this Ph.D. research, it shows that the use of Facebook is similar in both D/HoH and hearing groups (Bauman and Pero 2011).

Some communication features provided by SNS and communication apps are similar to the existing D/HoH communication solutions e.g. 'SMS, IM, Email and Fax' (see 4.2.1 Feature Review of SNS and Communication Apps, p.71). It is possible that SNS and communication apps might open new communication opportunities for the communication between the D/HoH and hearing people, and the reasons for this might also be similar to those the hearing community discussed above. In order to cope with this uncertain issue, this study conducts a preliminary study (see Chapter 4: Preliminary Study: New Communication Opportunities offered by SNS and Communication Apps for the D/HoH, p.63) to address the first research question: Are the new media communication technologies of SNS and communication apps able to open new communication opportunities for the D/HoH to communicate and interact with the hearing community? If so, how?

2.3 Computer-mediated Communication and Face-to-face Communication

Part of this research (see Chapter 4: Preliminary Study: New Communication Opportunities offered by SNS and Communication Apps for the D/HoH, p.63) has shown that new media communication technologies (SNS and communication apps) are able to open new communication opportunities and bridge the communication gap between the D/HoH and hearing people. However, the preliminary study shows that there is still a communication gap in FTF communication, even when using the new media communication technologies (SNS and communication apps). This is because communication features provided by SNS and communication apps are based on Computer-mediated communication (CMC) and not designed for FTF communication. The primary research (see Chapter 5: Primary Research: Interaction Design Creative Practice, p.94) in this study aims to address this specific issue. This section gives a review and discussion of CMC and FTF communication and indicates two significant differences between the two types of communication: a. Nonverbal Communication in FTF and b. Speed of communication in CMC.

2.3.1 Definition of CMC and FTF Communication

CMC is a type of communication where by people transmit information indirectly through digital devices by using text or multimedia messages. CMC is a communication process that occurs through the use of two or more computers. Berko, Wolvin and Wolvin (2010) highlight that CMC supports various forms of communication by using digital devices. Communication technologies mediate communication between people, such as using SMS, IM, Email, online forum and SNS on computers or digital mobile devices. FTF communication is a type of communication in which people transmit information in person directly by using oral speech and gestural language, this is the most common form of communication used between hearing people.

CMC technology is increasingly important for human communication and has changed our communication methods and behaviours. Turkle (2012) refers to this phenomenon, suggesting that people are spending increasing time communicating through digital devices that does not involve FTF communication. These media communication technologies have opened up communication opportunities for people, as discussed above (see (2) Impacts of SNS and Communication Apps, p.24).

2.3.2 Differences between CMC and FTF Communication

Both CMC and FTF are multimodal communication with both verbal and nonverbal communication. Verbal communication is a communication process that involves sending and receiving word cues between people. The word cues are such as spoken language in FTF communication and text messages in CMC communication. Nonverbal communication is a communication process of sending and receiving 'wordless' cues. The wordless cues are such as facial expressions and body gestures in FTF communication and emoticons in CMC communication. CMC communication generally allows people to communicate by using a single form at a time, such as text-only or multi-media contents. FTF communication generally combines more than one form as part of a conversation, such as speech involving eye contact and facial expressions (Dohen, Schwartz and Bailly 2010). Although verbal and nonverbal messages are used in both CMC and FTF communication, the main difference between CMC and FTF communication is the physical interaction with nonverbal messages (nonverbal communication) that occurs in FTF communication (Whittaker and O'Conaill 1997).

(1) Nonverbal Communication in FTF

Mehrabian (1972) explains that nonverbal communication is 'nonverbal behavior' that infers nonverbal messages. Nonverbal messages can be combined with verbal messages such that there is a consistent meaning. However, nonverbal messages also combine verbal messages with an inconsistent meaning, an example being sarcasm which can make communication complex and subtle. Hatem, Kwan and Miles (2012) indicate that verbal messages are more overt and easier to comprehend, whilst nonverbal messages involve the subconscious and are less easy to understand. 'Face-to-face communication tend not to be consciously aware of the non-verbal messages which are being sent to each other but nevertheless, they respond to these signals which can be very powerful' (Hatem, Kwan and Miles 2012, p.383). Nonverbal messages in FTF communication can sometimes be more powerful than verbal messages and help people understand other people much better (Morris 2002).

Nonverbal communication in FTF contains physical interaction with nonverbal messages such as eye contact, facial expressions, handshakes, head nods and smiles. Eye contact is an essential component in FTF communication, a 'special stimulus' in visual sense that affects communication (Bailly, Raidt and Elisei 2010). Jiang et al (2012) highlight two major differences between FTF communication and other types of communication:

a. 'Integration of multimodal sensory information'

   Sensory information such as eye contact, facial expression and body gestures that helps to convey additional information during FTF communication.

b. 'More continuous turn-taking behaviors between partners'

   Turn-taking is a communication behaviours in a conversation that helps people decide who will speak next.

Turn-taking behaviour plays a vital role for social interaction in FTF communication. Bailly, Raidt and Elisei (2010) indicate that eye contact plays a pivotal role in turn-taking behaviours. Social interaction is a fundamental aspect of everyday life whereby people communicate and interact with each other (Rogers, Helen and Preece 2011), whilst FTF communication is an essential element of social interaction (Pea, et al 2012; Starnini, Baronchelli and Pastor-Satorras 2013).

Okdie et al (2011) indicate that nonverbal communication combine richer and more abundant emotional information than verbal communication. Dohen, Schwartz and Bailly (2010, p.477) indicate the way people integrate information in FTF communication 'not only from the speakers but also from the entire physical environment in which the interaction takes place.' Nonverbal communication (physical interaction with nonverbal messages) is complex and subtle communication behaviour as well as a significant part of FTF communication that forces speakers and listeners into a deeper engagement during communication (Mehrabian 1972; Lipinski-Harten and Tafarodi 2013).

(2) Speed of Communication in CMC

Spoken language (mainly used in FTF communication) is an easier and faster way to send and receive information than typing text (as used in CMC communication). In general, spoken language allows transmitting 120-200 words messages per minute, whilst text typing only permits 5-60 words per minute (James and Reischel 2001; Clarkson et al. 2005). In addition, FTF communication is real-time communication by which speakers and listeners can immediately send and receive messages. CMC communication is not real-time communication (except for video calls such as when using Skype), even though some CMC tools provide near real time communication such as IM, people still need to spend time typing messages and waiting for messages before sending and receiving them.

Bordia (1997) conducted an experiment comparing time issues in CMC and FTF communication. The experiment was conducted via a group task-oriented discussion. The result of the experiment shows that people using CMC communication spend a longer time than people using FTF communication to complete an allotted communication task, that was because text typing in CMC communication takes longer. However, the CMC group produces less redundant ideas and performs better when time is limited, especially in task-oriented communication as it involves less social-emotional interaction. In addition, there is less social pressure in CMC communication due to CMC not being FTF interaction and CMC helping to reduce production blocking[8] and evaluation apprehension[9] (Bordia 1997; Gallupe, et al 1991).

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[8] Production Blocking: a common problem in a group discussion where one person blocks or inhibits other people during a discussion.
[9] Evaluation Apprehension: people who are scared to share their thoughts in a group because they feel they will be negatively evaluated.

CMC and FTF are two different types of communication. However, this research aims to integrate CMC and FTF communication, and to investigate a new communication solution that can be used to bridge the FTF communication gap between the D/HoH and hearing people. The above review has shown that physical interaction with nonverbal messages in FTF communication and speed of communication in CMC are significant differences between these two communication types. The communication solution designed in this study aims to reduce the differences and provide an innovative communication tool for the D/HoH to communicate with hearing people in person. Chapter 5: Primary Research: Interaction Design Creative Practice (p.94) will give a detailed discussion of the development process of this communication solution.

CHAPTER THREE

RESEARCH METHODOLOGY

Chapter 3: Research Methodology

This chapter introduces the research design and the interaction design creative practice conducted in this study. It furthermore reviews relevant design studies in the field of human health and wellbeing. In addition, a review of the relevant design methods will explain the design method (user-centred design) used in this study and finally this chapter states the ethical issues associated with this research.

There are four sections in this chapter:

a. Practice-based Research and Research Design
   This section introduces and defines that this study is a practice-based research project and provides the plan (research design) used to conduct this research.

b. Relevant Design Researches and Methods
   This section reviews relevant design studies in the field of human health and wellbeing and compares relevant design methods for conducting interaction design practice.

c. User-centred Design: Interview, Prototyping and User Evaluation
   This section explains the design method used to conduct the interaction design creative practice in this study namely a UCD approach that includes interview, prototyping and user evaluation.

d. Ethics
   This section states the ethical issues associated with this research study and that the study has been conducted in accordance with the university policy.

3.1 Practice-based Research and Research Design

This study is designed as a practice-based research project that aims to generate knowledge through a design practice. The design practice in this study is an interaction design development process (design of a smartphone app) that uses a UCD approach. The UCD process aims to investigate a communication solution for the D/HoH, particularly for bridging the FTF communication gap between the D/HoH and hearing people.

3.1.1 Practice-based Research

Frayling (1993, p.5) explains that research in the field of art and design can be classified using three categories—'Research into art and design', 'Research through art and design' and 'Research for art and design'. Research into art and design is research that contributes knowledge to art and design disciplines from a theoretical perspective. Research through art and design is research that generates knowledge through developing art and design work. Research for art and design is research that results in knowledge for developing art and design work. Frayling's concept is also used in design research (Frankel and Racine 2010). By relating to Frayling's terms, this study can be known as a 'Research through art and design' project that is specifically based on a design practice (not an art practice). In addition, there are two types of practice related research: practice-based research and practice-led research. Candy (2006, p.1) defines these two types of practice related research in a doctoral study:

> *'**Practice-based Research** is an original investigation undertaken in order to gain new knowledge partly by means of practice and the outcomes of that practice. In a doctoral thesis, claims of originality and contribution to knowledge may be demonstrated through creative outcomes in the form of design, music, digital media, performances and exhibitions.'*
>
> *'**Practice-led Research** is concerned with the nature of practice and leads to new knowledge that has operational significance for that practice. In a doctoral thesis, the results of practice-led research may be fully described in text form without the inclusion of a creative work.'*

In the art and design field a practice-based research Ph.D. not only can make contributions to knowledge (or knowledge-building process) through a creative practice but also produce an original art or design work (Barrass 2008). A design work (interaction design) is selected as the creative practice in this study as the author is an interaction designer/practitioner.

The research methodology in this study uses the concept of 'practice-based research' as described by Candy (2006) and 'research through art and design' as described by Frayling (1993), this is based on design (not an art) practice. Furthermore, UCD is an approach the author used to conduct the design practice in this study. The UCD approach aims to improve the interaction design practice by balancing a creative, purely designer led approach with user feedback at crucial times in the iterative design process. The UCD process significantly focuses on D/HoH people's communication problems, needs and solutions. In addition, this research project aims to improve human health and wellbeing through a design practice. A review of relevant design studies in the field of human health and wellbeing and design methods (e.g. UCD) will be discussed in the following sections.

3.1.2 Research Design

A research design is a plan and procedure used to conduct a study. Creswell (2009, p.4) divides research designs into three types: qualitative, quantitative and mixed methods.

> *'**Qualitative Research** is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem.'*
>
> *'**Quantitative Research** is a means for testing objective theories by examining the relationship among variables'*
>
> *'**Mixed Methods Research** is an approach to inquiry that combines or associates both qualitative and quantitative forms'*

Denzin and Lincoln (2011, p.3) indicate that 'qualitative research is a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible.' Creswell (2007, p.44) notes that ‘qualitative research begins with assumptions and the use of interpretive/theoretical frameworks that inform the study of research problems.’

This study is designed as qualitative research that mainly collects qualitative data through interviews during the interaction design development process. The purpose of using qualitative data is to collect in-depth information from the target population. The qualitative data will be used as fundamental knowledge to support the interaction design creative practice development process (understanding user requirements, testing design concepts and evaluating prototypes). However, a small amount of quantitative data is used in the early part of the preliminary study. The purpose of using qualitative data is to explore the original hypothesis of this research: new media communication technologies (SNS and communication apps) may also open new communication opportunities for the D/HoH.

The research design of this study is presented in Figure 3.1 below and includes four stages: Stage 1: Research Statements, Stage 2: Preliminary Study, Stage 3: Primary Research and Creative Practice and Stage 4: Research Results and Contributions.

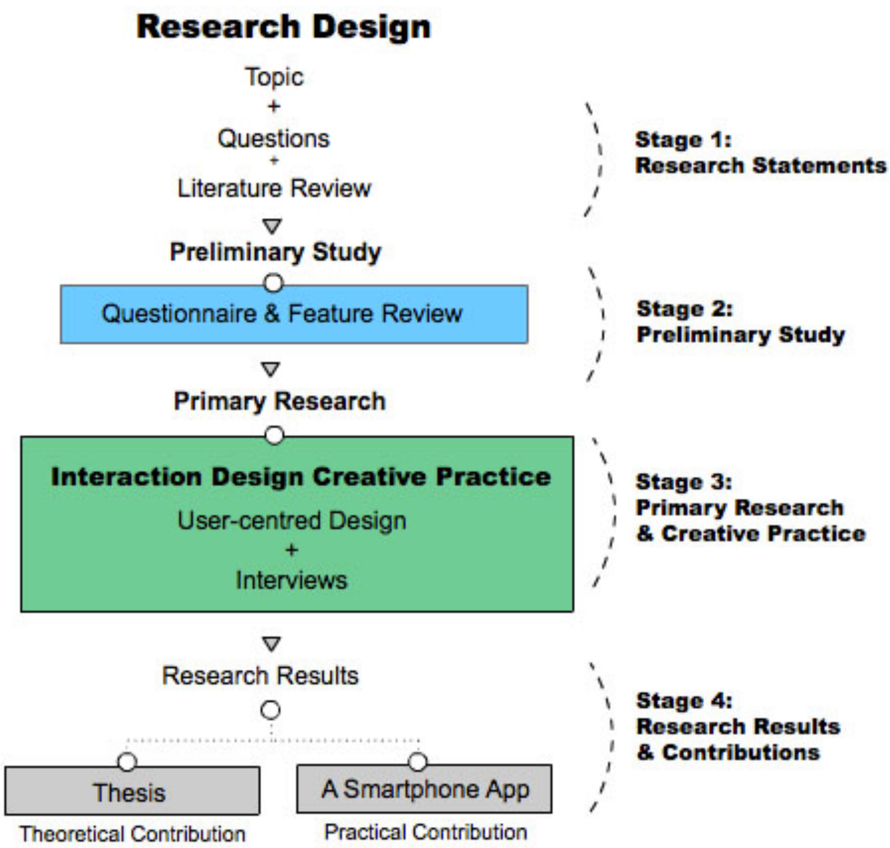


Figure 3.1. Research Design

- **Stage 1: Research Statements**

  In the first stage, a significant research topic will be chosen to study, specific research questions will be defined and relevant literature will be reviewed and discussed. This stage helps to outline the scope of the research.

- **Stage 2: Preliminary Study**

  In the second stage, a preliminary study will be conducted by way of the questionnaire and feature review (i.e. review of new media communication technologies: SNS and communication apps). This stage helps to answer the first research question.

- **Stage 3: Primary Research and Creative Practice**

  In the third stage, primary research will be conducted by means of a creative practice of interaction design. The interaction design development process uses a UCD approach that includes interviews. This stage helps to answer the second research question.

- **Stage 4: Research Results and Contributions**

  In the fourth stage, research results and contributions will be presented from both theoretical and practical perspectives. The final research outcomes include a thesis and a smartphone app design.

3.2 Relevant Design Researches and Methods

As interaction design is selected as the creative practice in this study, this section reviews relevant design studies in field of human health and wellbeing and compares relevant design methods for conducting an interaction design practice.

3.2.1 Design, Health and Wellbeing

Technology is an application of science that can be explained as a ‘tool’ to solve one’s problems (Jonassen, Howland, Moore and Marra 2002). ‘We place our hope in technology. We hope in technology to make our lives better, to solve our problems, to get us out of predicaments, to provide the future we want for ourselves and our children’ (Arthur 2009, p.11). 'Technology is seductive when what it offers meets our human vulnerabilities’ (Turkle 2011, p.1). Technology has improved D/HoH people’s ability to communicate while using the existing communication solutions (a. TTY, TRS and VRS, b. SMS, IM, Email and Fax and c. Sign Language and Voice Recognition). These existing D/HoH communication solutions are mainly focused the development of technology. However, as the author is a designer this research aims to investigate new communication solutions for the D/HoH specifically from an interaction design perspective. It means the communication solution developed in this study does not include creating and using new technologies, but new interaction designs.

‘In recent year there has been growing interest in the potential of design approaches to transform health care where we can draw on a tradition of creative and divergent thinking to address these fundamental and yet practical challenges to our societies’ health’ (Chamberlain, Wolstenholme and Dexter 2015, p.9). The role of design has become significant in the healthcare research field, which inspires creative solutions to improve human health and wellbeing. Designing for health and wellbeing is an interdisciplinary study that brings design theory and practice into the development process of health and wellbeing research. It aims to establish a greater understanding of healthcare research from a design perspective through design processes/approaches. The primary research in this Ph.D. study aims to investigate a communication solution through a creative practice of interaction design.

Currently, many research projects focus on the concept of designing for health and wellbeing and believe that good design can deliver benefits to human wellbeing. For example, *Designing wellbeing* (Thieme, et al 2012), *Designing for-and with-vulnerable people* (Vines, et al 2013) and *Making wellbeing: a process of user-centered design* (Marshall, et al 2014). These researches argue that design is a making and telling process where participants (end-users) can directly contribute to the design work and the design (making) process can facilitate and support both 'hedonic' and 'eudemonic' (producing happiness) facets of wellbeing through an exploration of psychological concepts of wellbeing. For example, the making activities can enhance the wellbeing of those who participate in the research. Marshall, et al (2014) indicate the making activities (design processes) bring three benefits for conducting a design, health and welling research project: a. Create 'a peaceful space for questions to settle and be lived with for a while before an answer can be found', b. Provide 'a space to meet the eudemonic aspects of wellbeing' and c. Influence 'feelings of competence in the participants'.

In addition, through a review of the Design4Health conference proceedings in 2011, 2013 and 2015, the 'designing for health and wellbeing' research projects are typically conducted via workshops that aim to bring researchers/designers and practitioners/participants together. For example, the *Resident user perspectives for the elderly care home guidelines* (Kälviäinen 2011) research project conducts workshops with the elderly for care home preferences, the *Dignified Spaces: participatory work de-institutionalises rooms in the heart of the clinical environment* (Fremantle, Hamilton and Sands 2013) conducts workshops for pattern explorations and the *Facilitating a 'non-judgmental'skills-based co-design environment* (Glazzard, et al 2015) conducts workshops for e-textile making.

A workshop is a method/approach used for collecting needed information by involving people in the design process. Other methods/approaches are interviews and focus groups. Involving people (end-users) in design processes is a necessary and important part of conducting a 'designing for health and wellbeing' research. The next chapter will discuss four relevant design approaches: a. user-centred design (UCD), b. participatory design (PD), c. person-centred design (PCD) and d. experience-centred design (ECD). A UCD approach is used to conduct the interaction design creative practice in this study and the reasons for selecting it will be given in the next chapter.

3.2.2 Interaction Design and Design Methods

Interaction design is predominantly concerned with practical work. Rogers, Sharp and Preece (2011, p.9) indicate interaction design is 'designing interactive products to support the way people communicate and interact in their everyday and working lives.' Winograd (1997, p.160) states that interaction design is used for 'designing spaces for human communication and interaction.' Saffer (2007, p.4) explains that 'interaction design is the art of facilitating interactions between humans through products and services', which is about 'behaviour' between humans and products. Interaction design is user-oriented design that includes various disciplines, such as user experience design, industrial design, human-computer interaction, information architecture, communication (or graphic) design, user interface design (or engineering), usability engineering and human factors (Saffer 2007, p.17), see Figure 3.2 below.

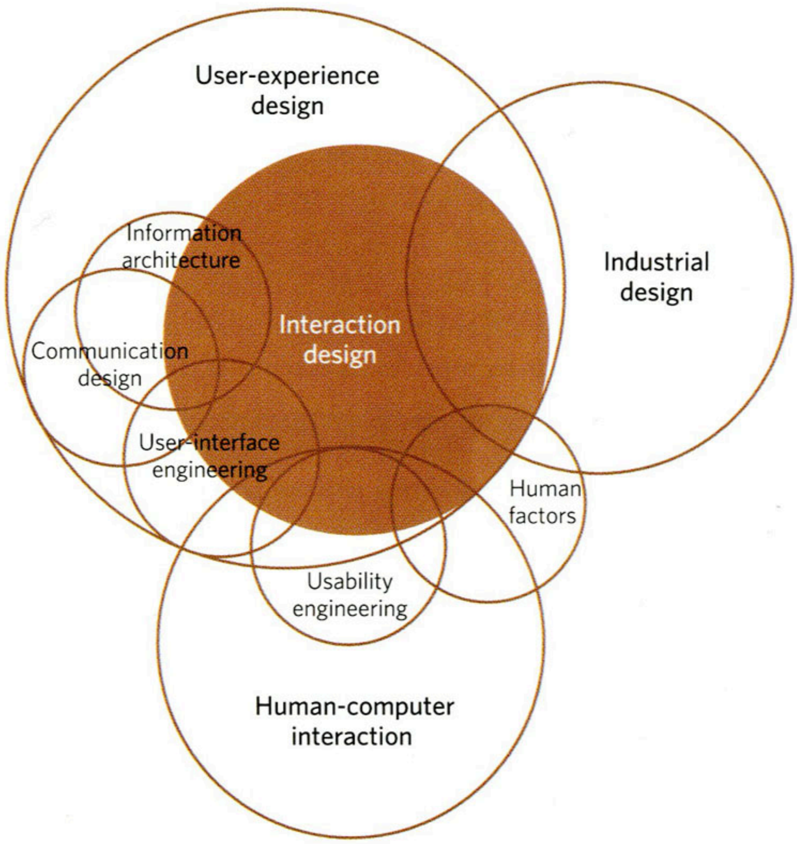


Figure 3.2. Disciplines of Interaction Design

An interaction design process is used in the design of products such as computers, mobile phones and automatic teller machines (ATM) to develop the interaction between products and users. Table 3.1 below simply shows how interaction design is implemented in product design.

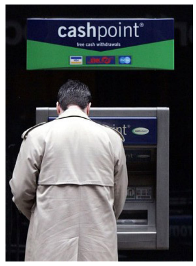
Product Design		
		
Interaction Design		
		

Table 3.1. Product Design vs. Interaction Design

Bill Verplank (2007) indicates interaction design is specifically focused on design for people. This design concept addresses three main questions: a. How do you do?, How do you feel? and c. How do you know? (Moggridge and Atkinson 2007). The first question explains how users interact with a product, the second question explains how users get feedback from a product and the third question explores how users know the steps of using a product. These are three basic elements of interaction design and the three elements are mainly focusing on the relationship/interaction between a product and a user, which is the most significant aspect of interaction design. These three elements also can be explained as usability of an interactive product: Jones and Marsden (2005) indicate usability is a specific and significant focus when developing an interaction design product.

Stolterman (2008) indicates that design practice in interaction design research must be grounded in a fundamental understanding of design methods, approaches and techniques. There are various design processes/methods that can be used to conduct interaction design creative practice by considering the relationship between products and people. The following section conveys a discussion of four design processes/methods related to interaction design: a. user-centred design (UCD), b. participatory design (PD), c. person-centred design (PCD) and d. experience-centred design (ECD).

(1) User-centred Design

UCD was firstly introduced by Norman and Draper in 1986 and is a common term used to describe a design process that grounds the development in information about the users of the product. Norman (2001, p.188) explains that UCD is ‘a philosophy based on the needs and interests of the user, with an emphasis on making products usable and understandable.’ UCD encompasses a philosophy and various methods that places end-users at the centre of design process and aims to satisfy them by producing usable products that meet their specific requirements (Detweiler 2007; Salah, Paige and Cairns 2014).

UCD is mainly based on the understanding of the end-users and their needs for developing a product. A development process of UCD can be discussed from the three principles proposed by Gould and Lewis (1985): a. Early Focus on Users and Tasks, b. Empirical Measurement and c. Iterative Design.

a. Early Focus on Users and Tasks

   Designers/researchers need to understand who the users will be and what the users will do by studying their cognitive, behavioural, anthropometric, and attitudinal characteristics, and studying the nature of the works the users expect to accomplish.

b. Empirical Measurement

   It is an early stage of development that presents design concepts to users by using simulations and prototypes. The reaction and performance of users should be observed, recorded and analysed.

c. Iterative Design

There must be a cycle of design-test-measure-redesign being repeated as often as necessary, for fixing the problems found in user testing. This means that the design process must be iterative.

Rogers, Sharp and Preece (2011) explain that in UCD users and their tasks are the driving force behind the development process. Furthermore, involving users in the process of design, development and evaluation is necessary (Gulliksen, et al 2003; Hermawati and Lawson 2014). The way of involving users includes questionnaires, interviews, focus groups and observations (Rogers, Sharp and Preece 2011).

The UCD process aims to gain a deeper understanding of users and user requirements and help designers/researchers to develop a product that is more efficient, effective and accurate for end-users by involving them in the design process. Although the UCD process has provided strengths in designing usable products, it has some weaknesses such as it may be very costly and it is time consuming for gathering data from end-users (Abras, Maloney-Krichmar and Preece 2004).

(2) Participatory Design

PD emerged in Scandinavia in the 1970s and 1980s and is often known or discussed as cooperative design (Spinuzzi 2005). Schuler and Namioka (1993) indicate that PD is a way of gaining a deeper understanding of users' thoughts when designing things by collaborating with the end-users throughout the design process. The cooperation is the key to the PD process. A PD process is not defined by the type of work or technology, it is an effort to rebalance the relations between researchers/designers and end-users (Kensing, and Blomberg 1998). Vines, et al (2013, p.429) indicate that 'sharing control' is a core value of PD because PD 'gives users more control in determining the technologies they might eventually use in work or leisure.' In PD, end-users are involved in the development process as 'co-designers' to ensure the product designed meets their needs (Abras, Maloney-Krichmar and Preece 2004).

PD has been used in various research areas. Druin and her research team have conducted many researches concerning children and technology by using the PD approach, e.g. children are co-designers for designing software for children (Druin 1999; Druin 2002; Guha, Druin and Fails 2008; Walsh, et al 2013). She also has a team of kids as part of her research team. PD is mainly based on a cooperation process that includes end-users whilst developing a product. Spinuzzi (2005) proposes three basic stages for conducting PD: a. Initial Exploration of Work, b. Discovery Process and c. Prototyping.

a. Initial Exploration of Work

   Designers need to meet end-users and familiarise themselves with the way they work together. The exploration includes workflow, work procedures, teamwork and routines as well as the technologies used.

b. Discovery Process

   Designers and users use various techniques to understand work organisation within the workplace. It allows designers and users to clarify users' goals and values and to agree on the expected outcome of the design process.

c. Prototyping

   Designers and users iteratively shape technological artefacts (prototypes) to fit the expected design outcome decided earlier.

Those stages of PD involve designers and users together throughout the design process. PD process is the ‘direct involvement’ of users in the shaping of future artefacts (Brandt 2006, p.57). PD has strengths in developing safe and appropriate products to end-users (Demirbilek and Demirkan 2004). However, to conduct a PD project may be very costly (Bentley 1992).

(3) Person-centred Design

PCD can be described as applying a person-centred approach to design. The term 'person-centred approach' was firstly proposed by the psychologist Dr. Carl Rogers (1902 – 1987) and is a 'unique approach to understanding personality and human relationships, found wide application in various domains such as psychotherapy and counselling (client-centred therapy), education (student-centred learning), organizations, and other group settings' (Rogers and Maslow 2008, p.272). Person-centred approach has developed from the term 'non-directive therapy' to 'client-centred therapy' to 'person-centred therapy' (Tudor, et al 2004). It is extensively used in the research area of healthcare where the relationship between the counsellor (physician) and the client (patient) is investigated.

The person-centred approach can also be used in design research. Kettley, Kettley and Bates (2015) indicate the person-centred approach can be used as a framework to conduct participatory design, particularly in the context of design for mental health and wellbeing. A person-centred approach can help 'the field of participatory design recognise that researchers and research teams constructively inform their practice through the attitudes they bring to what is necessarily a relational situation' (Kettley, Kettley and Bates 2015 p.1). Furthermore, Glazzard, et al (2015) conduct workshops from part of 'An Internet of Soft Things' (IoSofT) project that seeks to develop a person-centred approach to design. The IoSofT project is based on the concept of using a person-centred approach with an attitude in design process such that participants are situated within a non-judgemental (safe and supported) environment, one of the conditions of the person-centred approach being an unconditional positive regard (Rogers, 1957).

(4) Experience-centred Design

'Experience-centred design is about how to design for the richness of experience that these new technologies offer' (Wright and McCarthy 2010, p.3). ECD is a design process that specifically focuses on user experience. User experience is a person's perceptions and responses of using a particular product (Garrett 2010). Hassenzahl (2010, p. 8) indicates 'An experience is a story, emerging from the dialogue of a person with her or his world through action.' 'Storytelling is part of our everyday lives and the way in which we make sense of our experience' (Wright and McCarthy 2010, p.27). Wright and McCarthy (2010) argue that story or narrative is a good way to describe lived experience and understand user experience. Kearney (2002, p.3) indicates 'Telling stories is as basic to human beings as eating.' In user experience design, user experience as stories is told through products that provide potential to change the way people think and design (Hassenzahl 2013).

ECD is mainly based on stories of people's lives. Stories and narratives are design structures in the ECD process that are typically conducted by telling stories and listening between users and designers/researchers. The 'dialogue' is an approach used in storytelling for understanding users' experiences (Hassenzahl 2010; Wright and McCarthy 2010). In human-computer interaction or interaction design, user experience refers to the relationship between people and technology (McCarthy and Wright 2004). Experience helps to understand people's interaction and relationship with technology.

3.2.3 Summary of the Design Methods

The above section has reviewed and discussed the four design processes/methods (UCD, PD, PCD and ECD). All these design processes/methods focus on people (end-users) with a view to designing and developing a usable, understandable and appropriate products for users, which enhance their satisfaction. Notwithstanding, there are significant differences between these four methods in the development process. Table 3.2 below shows the specific development focus of each design process/method. UCD focuses on 'User and Task', PD focuses on 'User Cooperation', PCD focuses on 'User Attitude' and ECD focused on 'User Storytelling'.

Design Processes/Methods	Development Focuses
UCD	**User and Task** UCD process/method that mainly focuses on the understanding of who the users are and what users do. Users and their needs/requirements are two important elements for conducting a UCD project.
PD	**User Cooperation** PD process/method mainly focuses on the cooperation between designers/researchers and users/participants. In PD, users are co-designers throughout the development process.
PCD	**User Attitude** PCD process/method mainly focuses on the application of the person centred approach as an attitude to the discipline of design. It provides participants a non-judgemental (safe and supported) environment.
ECD	**User Storytelling** ECD process/method mainly focuses on users' lived experiences. Storytelling (dialogue) is typically used to understand user experiences.

Table 3.2. Development Focus of Four Design Processes/Methods

Sanders (2002) proposes the term 'Postdesign' to describe that there is a shift in design attitude from UCD to PD. In the UCD process, users are able to express their needs or experiences through what they say and do (via questionnaire, interview, focus group or observation). In the PD process, users are able to express their needs or experiences through what they make (by making practices as co-designers). In the concept of 'Postdesign', designers/researchers can not only access user experience through what users say and do but also what users make. When the three perspectives (what users say, do and make) are explored simultaneously, designers/researchers can more readily understand and establish empathy with users (Sanders 2002). Furthermore, Wright and McCarthy (2010, p.8) explain that UCD and PD 'offer the foundations for a humanist agenda in experience-centered design in which the design process focuseson the human beings who will ultimately benefit (or suffer) from the design deployment decisions that are made.' In addition, PCD is discussed along with PD as Kettley, Kettley and Bates (2015) also propose that the person-centred approach can be used as an attitude in the discipline of design. The above discussion has shown that these four design processes/methods (UCD, PD, PCD and ECD) each have their specific development focuses. It is also shown that different design processes/methods can be used together for understanding and establishing empathy with users more readily.

In addition, the review shows that weaknesses of UCD and PD are time consuming and costly. A PD process might be more time consuming and costly than a UCD process because a PD process conducts a deeper involvement with participants that typically involves a group of end-users as part of design team (Druin 1999; Druin 2002). The author provides a deeper insight in the use of UCD and PD what he learned from his experience by working with a D/HoH participant. The author found that, in a PD process, participants might have limited knowledge in relevant technologies and studies that would affect the design process.

Participants are end-users who understand specific needs and requirements for developing a product. However, participants might not be experts in the use of relevant technologies for developing a product and might not be familiar with relevant studies that have produced similar products. For example, the author's D/HoH friend was involved into the design process in the beginning of this study as a co-designer. The author found some of his friend's ideas and suggestions are out-of-date and not useful because his friend is not familiar with the latest technologies and relevant studies. Eventually, his friend (as a potential co-designer in a PD process) could only contribute useful information about user requirements, as he is an end-user, even through the author spent a lot of time explaining relevant technologies and studies to his friend.

From the author's experience, it shows that a deeper involvement with participants in a PD process might provide unnecessary and redundant information when the participants have limited knowledge in relevant technologies and studies. The author argues that this is a further weakness in a PD process. In addition, the author suggests that UCD approach would be an appropriate and better way to conduct a design process when the above weakness of the PD approach is apparent. The next section will discuss the reasons for selecting UCD as the design process/method to conduct the interaction design creative practice in this study.

3.3 Selection of User-centred Design: Interview, Prototyping and Evaluation

UCD has been selected as the design process/method to conduct the interaction design creative practice in this study. This is because this interaction design creative practice has clearly defined ‘user’ (D/HoH people) and a specific ‘task’ (FTF communication). In addition, the above discussion of design processes/methods shows that the primary development focus of UCD is the user and task. Moreover, UCD is a method typically used to conduct ‘designing for health and wellbeing’ research (Chamberlain, Wolstenholme and Dexter 2015; Marshall, et al 2014).

In the UCD process various methods can be used to understand users and their needs/requirements such as questionnaires, interviews, focus groups and observations (Rogers, Sharp and Preece 2011). Questionnaires are an approach used to collect data by asking specific questions. It is typically used when there is a need for a large amount of information (a large sample size). Interviews are an approach typically used to explore specific issues, deeper information is obtained via conversations. Focus groups are an approach used to collect multiple viewpoints through a group discussion about specific topics. Observations are an approach used to collect information through an observation of phenomena (e.g. ongoing behaviours).

The UCD development process in this study will be based on the three typical UCD development processes proposed by Gould and Lewis (1985): a. Early Focus on Users and Tasks, b. Empirical Measurement and c. Iterative Design, as described above (p. 46). The three development processes, interview, prototyping and user evaluation, are the three approaches used as the basis for the UCD process in this study. Interviews will be used to understand user requirements, prototyping will be used to present design concepts and user evaluation will be used to test and modify the designed product (a communication solution), so as to match the users’ (D/HoH people) specific requirements.

3.3.1 Interview

Interview and observation are two research methods used to collect qualitative data. Interview is a method used to gain information by means of sets of questions, whilst observation is method used to gain information by way of a period of observation. Becker and Geer (1957, p.28) indicate the main difference between interview and observation methods includes two interacting factors: a. 'the kinds of words and acts of the people under study that the researcher has access to' and b. 'the kind of sensitivity to problems and data produced in him'. The use of interview or observation methods mainly depends on research questions (Driscoll 2011). The interview method can be more structured than observation. In addition, Driscoll (2011) indicates that sometimes it is very difficult to gain all of the necessary information through the observation method and by using the interview and questionnaire methods these weaknesses can be improved.

Patton (1990, p.341) explains that 'The purpose of interviewing, then, is to allow us to enter into the other people's perspective.' Interview is selected as the method to gain information in the UCD process in this study. This is because the main purpose of interviews in this study is to investigate and develop a communication solution through collecting specific information rather than observing phenomena (e.g. observe D/HoH people's communication problems). The specific information is such as the understanding of D/HoH people's specific requirements in FTF communication and the user feedback concerning a specific communication solution (design of a smartphone app). Observation method is not used in this study because the phenomenon of the D/HoH communication problems has been indicated in the existing literature (see 2.1.2 A Communication Gap between the D/HoH and Hearing People, p.14).

There are three types of interviews: a. Unstructured, b. Structured and c. Semi-structured Interview (Rogers, Helen and Preece 2011).

a. Unstructured Interview

An unstructured interview is an open-ended interview that is conducted using open questions and without expecting an answer in particular format. The open questions are often not prepared in advance or can be tailored for the specific participant.

b. Structured Interview

A structured interview is a close-ended interview that is opposite to an unstructured interview. A structured interview is conducted using specific questions for each participant. The specific questions are prepared in advance and the answers collected using a particular format.

c. Semi-structured Interview

A semi-structured interview is an interview that combines the features of both the unstructured and structured interview. A semi-structured interview typically starts by asking specific questions and then allows the asking of further open questions, based on the respondent's answers.

In addition, there are various forms of interviews that can be developed to obtain qualitative data (Creswell 2007). A FTF interview is a common way of interviewing people, whilst telephone and online interviews are two other forms of interview. An online interview utilises email or synchronous communication tools (e.g. IM) that provide a more flexible interview environment. For example, an online interview helps researchers conveniently engage interviewees in different time zones and places (Nalita and Hugh 2009).

A semi-structured interview is used in this study because it is a flexible approach that not only allows the author to collect structured information (via specific questions) but also further information (further discussions based on the interviewees' responses). Furthermore, an online interview is selected as the primary form of the semi-structured interview used in this study because of the particular target interviewees. The target interviewees are the D/HoH (including a number of hearing people), with the author being a hearing person who does not know sign language. Text-based communication (written notes) is the only available communication method that can be used between the interviewees and the author when conducting an interview. In addition, most of the interviewees are from different parts of the United Kingdom, with some from Taiwan. Due to these considerations and after two pilot interviews were conducted successfully with D/HoH people by the use of email conversations, an email-based online semi-structured interview was selected as the primary form in this study, with a FTF interview designed as the secondary interview form.

3.3.2 Prototyping

'Prototypes have been used throughout design history as a means of bringing ideas to life before the ideas are built or manufactured' (Standers 2013, p.59). A prototype is a model created through an iterative development process, leading towards the production of a finished product. Prototyping helps the researcher obtain realistic feedback. Keyson and Bruns Alonso (2009 p.4548) explain that 'The designer-researcher can begin to explore complex product interaction issues in a realistic user context and reflect back on the design process and decisions made based on actual user-interaction with the test prototype.'

A prototype is a 'hypothesis', a 'marketplace' and a 'playground'. A hypothesis means that prototypes are educated guesses about the future: the future of how the prototype might perform, how the users might react to it and how its features and functionalities might be further explored, tested and refined by researchers/designers. A marketplace means that prototypes (as part of the design processes) are spaces, places and media where value is negotiated and exchanged between researchers, designers, engineers, programmers, marketers and so on. A playground means that prototypes are places where opportunities are available to safely explore alternatives. It is the freedom to go beyond known norms and standards to innovate and create (Schrage 2013).

Design and research is often presented and perceived as two different fields by different types of people with different aims. Prototypes in research can be known as 'a central vein for knowledge development' (Stappers 2013, p.85). At the *Prototype: Craft in the Future Tense 2010* symposium (University of Dundee, Scotland), prototypes are described as (Valentine, 2013, pp.85-86):

'Unfinished, and open for experimentation'
'A way to experience a future situation'
'A way to connect abstract theories to experience'
'A carrier for (interdisciplinary) discussions'
'A prop to carry activities and tell stories'
'A landmark for reference in the process of a project'

Prototypes are used as an important part of the creative practice in this research to develop and generate the interaction design work. The designed prototypes are evaluated through interviews with the end-users by following the 'DECIDE' guideline, which is a framework for evaluating an interactive product proposed by Rogers, Sharp and Preece (2011). The guideline includes the six elements listed below:

'Determine the goals'
'Explore the questions'
'Choose the evaluation methods'
'Identify the practical issues'
'Decide how to deal with the ethical issues'
'Evaluate, analyse, interpret and present the data'

There are various types of prototypes that can be classified as low-fidelity and high-fidelity prototypes. 'Fidelity describes how easily prototypes can be distinguished from the final product and can be manipulated to emphasise aspects of the design' (Walker, Takayama and Landay 2002, p.661). In general, low-fidelity prototypes are limited in function and interaction prototyping efforts; in contrast, high-fidelity prototypes are fully interactive such that users can enter data in entry fields similar to a real product (Rudd, Stern and Isensee 1996). Low-fidelity prototypes are such as sketches (visual appearance) and usually used to present original design concepts. It is a quick (time saving) way to test designs. High-fidelity prototypes are often made by the same methods (e.g. techniques or programs) and interactions as the final product. Both low-fidelity and high-fidelity prototypes have advantages and disadvantages. Walker, Takayama and Landay (2002, p.661) argue that 'low- and high-fidelity prototypes are equally good at uncovering usability issues', but high-fidelity prototypes are more expensive and time-consuming. Lim, et al (2006) indicates a high-fidelity prototype allows users to precisely capture interactions that users are unable to experience by using low-fidelity prototypes.

Prototyping in this research mainly uses low-fidelity prototypes, which includes paper-based sketches, digital graphs and prototypes in web-based and app-simulated environments (see samples in Appendix 16-19). The paper-based sketches are used to present and test design concepts (alternative potential features) and the digital graphs are used to present and evaluate designing features (design of a smartphone app). The visual-based prototypes are also presented in two simulated environments: a. a web-based environment via HTML and b. an app-simulated environment via X-code[10]. These two simulated environments allow users to experience simple interactions when using this smartphone app.

3.3.3 User Evaluation

Interaction design is specifically focused on designing interactions between a product and a user. Jones and Marsden (2005) indicate usability is a significant focus in interaction design. Maguire (2001, p.614) point out that there are two main reasons for usability evaluation: a. 'To improve the product as part of the development process (by identifying and fixing usability problems)' and b. 'To find out whether people can use the product successfully'. User evaluation is an important process when developing an interactive product that aims to test and improve the usability of

[10] X-code is software developed by the Apple Company for developing iOS apps and is specifically used by interaction programmers. X-code provides a 'Storyboards' feature that allows interaction designers to build interfaces in an app-simulated environment without the need for coding knowledge.

a product (Rogers, Sharp and Preece 2011). As the interaction design creative practice in this study is based on the three basic UCD development processes (a. early focus on users and tasks, b. empirical measurement and c. iterative design) (Gould and Lewis 1985), user evaluation can be used in the second and third processes to measure and modify designing products.

Maguire (2001) indicates eight different types of evaluation method in UCD process: a. Participatory evaluation, b. Assisted evaluation, c. Heuristic or expert evaluation, d. Controlled user testing, e. Satisfaction questionnaires, f. Assessing cognitive workload, g. Critical incidents and h. Post-experience interviews. The description of the eight evaluation methods as per Table 3.3 below:

Types of Evaluation Method	Description
Participatory evaluation	Users employ a prototype as they work through task scenarios. They explain what they are doing by talking or ‘thinking-aloud' e.g. evaluation workshops.
Assisted evaluation	An assisted evaluation is one where the user is invited to perform a series of tasks and is observed by a human factors specialist who records users' problems and comments, and events of interest.
Heuristic or expert evaluation	Heuristic or expert evaluation is a technique where one or more usability and task experts will review a system prototype and identify potential problems that users may face when using it.
Controlled user testing	The most revealing method of usability evaluation is to set up system trials where representative users are asked to perform a series of tasks with it.
Satisfaction questionnaires	User subjective questionnaires capture the subjective impressions formed by users, based on their experiences with a deployed system or new prototype.
Assessing cognitive workload	Measuring cognitive workload involves assessing how much mental effort a user expends whilst using a prototype or deployed system.
Critical incidents	Critical incidents are events that represent significant failures of a design. Verbal reports of the incident are analysed and categorized to determine the frequency of different incident categories.
Post-experience interviews	Individual interviews are a quick and inexpensive way to obtain subjective feedback from users based on their practical experience of a system or product.

Table 3.3. Types of Evaluation Method

These eight evaluation methods provide different benefits for different situations. Some are appropriate for the early design stages and some for late stages. A high-fidelity prototype (a workable prototype) is needed in some of the methods for users to evaluate as users need to be given specific tasks and observations be made of the users. However, this study only produces low-fidelity prototypes (with simulated interactions), hence some methods may not be appropriate or viable.

Interview is selected as the method to conduct user evaluations in this study, as the interview evaluation method is a quick and inexpensive way to obtain feedback from end-users. Additionally to the above evaluation method a short video description about the interaction design creative practice is produced at the end of this study and is used to evaluate the final prototypes. Maguire (2001) indicates that creating a short film is an additional and useful technique that can help the user to understand prototypes in user evaluation.

3.4 Ethics

This research presents a potential risk that has been identified in accordance with the University Ethics Clearance Checklist (Appendix 20) because the intended participants are D/HoH people who are deemed members of a vulnerable group. The risk for this group relates to their hearing disability and specific communication needs. The situation requires greater sensitivity on the part of researchers to avoid potential confusion and misrepresentation. The author has mitigated this risk through the use of appropriate ethical practices.

Online survey and online interview are two methods selected/designed to collect data in this research. These two methods do not present any significant risks (physical and psychological risks) to the participants in the process of data collection. Furthermore, the two data collection methods are less likely to face problems arising from communication barriers. All data collected from the intended participants will only be used for this research project in accordance with the University Research Ethics Policy, with the participants having the right to withdraw their data at any time without needing to give any reason. The survey document (Appendix 1) and interview document (Appendix 6. 9, and 12) include a brief explanation of this research and an informed consent section. It informs participants the data storage and use policies, and their right.

In addition, any additional ethical considerations which might arise will be resolved through seeking guidance from the NTU ethics guideline. The ethical issues of this study have been approved by the Joint Inter-College Ethics Committee (JICEC) in Nottingham Trent University. An ethics approval letter is attached in Appendix 21.

CHAPTER FOUR

PRELIMINARY STUDY: NEW COMMUNICATION OPPORTUNITIES OFFERED BY SNS AND COMMUNICATION APPS FOR THE D/HoH

Chapter 4: Preliminary Study: New Communication Opportunities offered by SNS and Communication Apps for the D/HoH

This chapter focuses on the discussion of new media communications technologies (SNS and communication apps) as used by the D/HoH and aims to answer the first research question: Are the new media communication technologies of SNS and communication apps able to open new communication opportunities for the D/HoH to communicate and interact with the hearing community? If so how? In addition, the findings from this chapter have led to the secondary research question: How to bridge the FTF communication gap between the D/HoH and hearing people via a smartphone app design?

There are three sections in this chapter:

a. New Media Communication Technologies used by the D/HoH
   This section conducts a pilot study to build an understanding of new media communication technologies (SNS and communication apps) as used by the D/HoH.

b. The Relationship between New Media Communication Technologies and D/HoH Communication
   This section reviews the features of SNS and communication apps, and discusses the accessibility of SNS and Communication Apps in D/HoH Communication.

c. A FTF Communication Gap
   This section indicates a significant gap in FTF communication, even when using SNS and communication apps and discusses the D/HoH communication possibilities in FTF communication.

4.1 New Media Communication Technologies used by the D/HoH

The literature review chapter has shown that new media communication technologies (SNS and communication apps) have brought new communication forms and opportunities to (hearing) people. The D/HoH should be involved in these developments. However, the existing literature that specifically focuses on SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) as used by the D/HoH, is limited. In order to deal with this shortage of empirical data, this study provides an initial hypothesis that presumes that new media communication technologies (SNS and communication apps) could also bring new communication forms and opportunities to the D/HoH.

The preliminary study in this research aims to explore this hypothesis and address the first research question: Are the new media communication technologies of SNS and communication apps able to open new communication opportunities for the D/HoH to communicate and interact with the hearing community? If so, how?

4.1.1 A Pilot Study: Questionnaire

A pilot study is a standard methodology that allows researchers to conduct a preliminary analysis before starting a full-blown study or experiment. The pilot study in this research is conducted via a questionnaire to timeously substantiate that the research hypothesis: new media communication technologies (SNS and communication apps) may also open new communication opportunities to the D/HoH. ‘Questionnaires are a well-established technique for collecting demographic data and users’ opinions’ (Rogers, Helen and Preece 2011, p.238). A questionnaire can collect both quantitative and qualitative data, dependent on the type of question. The purpose of this pilot study is not only to explore the research hypothesis but also build a further understanding of communication situations occurring and methods utilised between the D/HoH and hearing people.

(1) Data Collection

The questionnaire in the pilot study is executed by using an online survey tool (Google Docs[11]) with multiple-choice questions (Appendix 1). The sample group for the online survey is defined as deaf or hard of hearing people who are SNS (e.g. Facebook, Twitter and Linkedin) and communication app (e.g. WhatsApp, WeChat and LINE) users. The sample group in this survey were mainly recruited from the D/HoH online society, '*Hard of hearing/Deaf people need more help and support*', on Facebook. In addition, three D/HoH students were recruited from Nottingham Trent University in the United Kingdom and three D/HoH people from Taiwan. The online survey was conducted during the period from March 2012 and May 2012. Ideally, the survey sample size should be as large as possible. Eventually, 58 questionnaires were obtained, with 53 respondents meeting the ethical consideration criteria.

(2) Data Analysis

The questionnaire data (Appendix 2) is presented and analysed via a number of pie charts and graphs. It includes three categories below: a. General Information of the Survey, b. Data from Deaf People and c. Data from Hard of Hearing people.

a. General Information of the Survey

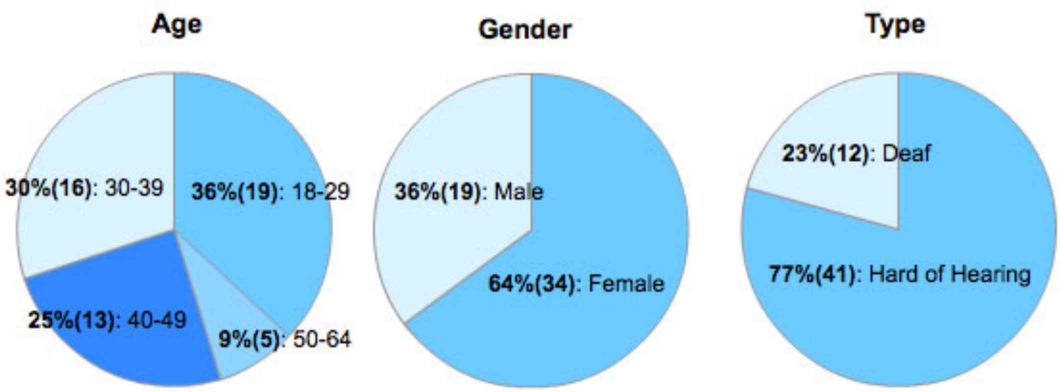


Figure 4.1. General Information of the Survey

[11] Google Docs is a free, Web-based office suite and data storage service offered by Google, which includes online survey services through which users can design questions flexibly.

The above three pie charts show age, gender and type of the sample population in the survey. The results show most of D/HoH SNS and communication apps users are in the young (age 18-29) and middle-aged (age 30-49) generation (91%) and less in the older (age 50-64) generation (9%). There are more female users (64%) than male (36%) and more hard of hearing (77%) users than deaf users (23%). The data analysis of the survey is not focused on the issues of age and gender, but the types of deafness.

b. Data from Deaf People

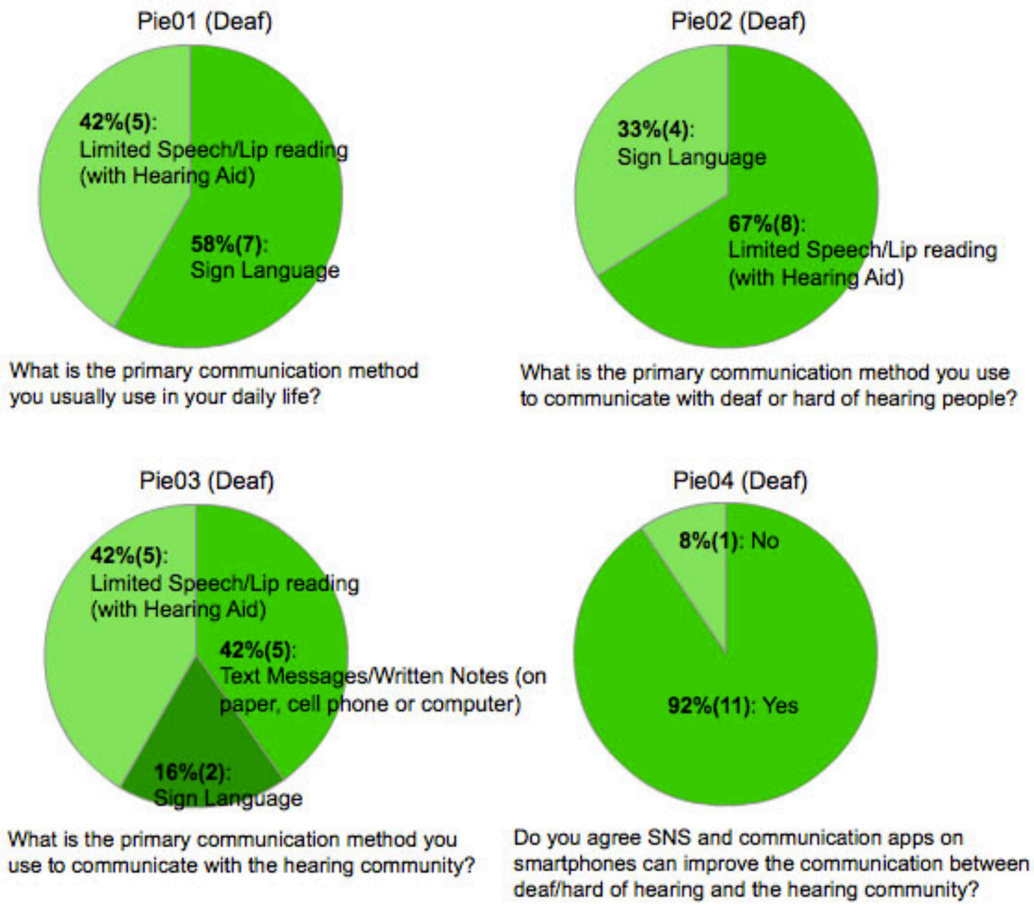


Figure 4.2. Data from Deaf People

The above pie charts show the results from deaf respondents by asking four questions: (Pie01) What is the primary communication method you usually use in your daily life?, (Pie02) What is the primary communication method you use to communicate with deaf or hard of hearing people?, (Pie03) What is the primary communication method you use to communicate with the hearing community? And (Pie04) Do you agree SNS and communication apps on smartphones can improve the communication between deaf/hard of hearing and the hearing community?

The results from the survey show that a majority of deaf people (58%) use sign language as their primary communication method, whilst a majority of deaf people (67%) use limited speech/lip reading (with the assistance of a hearing aid) for the communication between deaf and hard of hearing people. However, sign language becomes a useless communication method when Deaf people communicate with hearing people (16%). Instead, limited speech/lip reading (with hearing aid) (42%) and text messages/written notes (on paper, cell phone or computer) (42%) are the two primary communication methods used between Deaf and hearing people. In addition, 92% of Deaf respondents agree SNS and communication apps can improve the communication between the D/HoH and hearing people.

c. Data from Hard of Hearing People

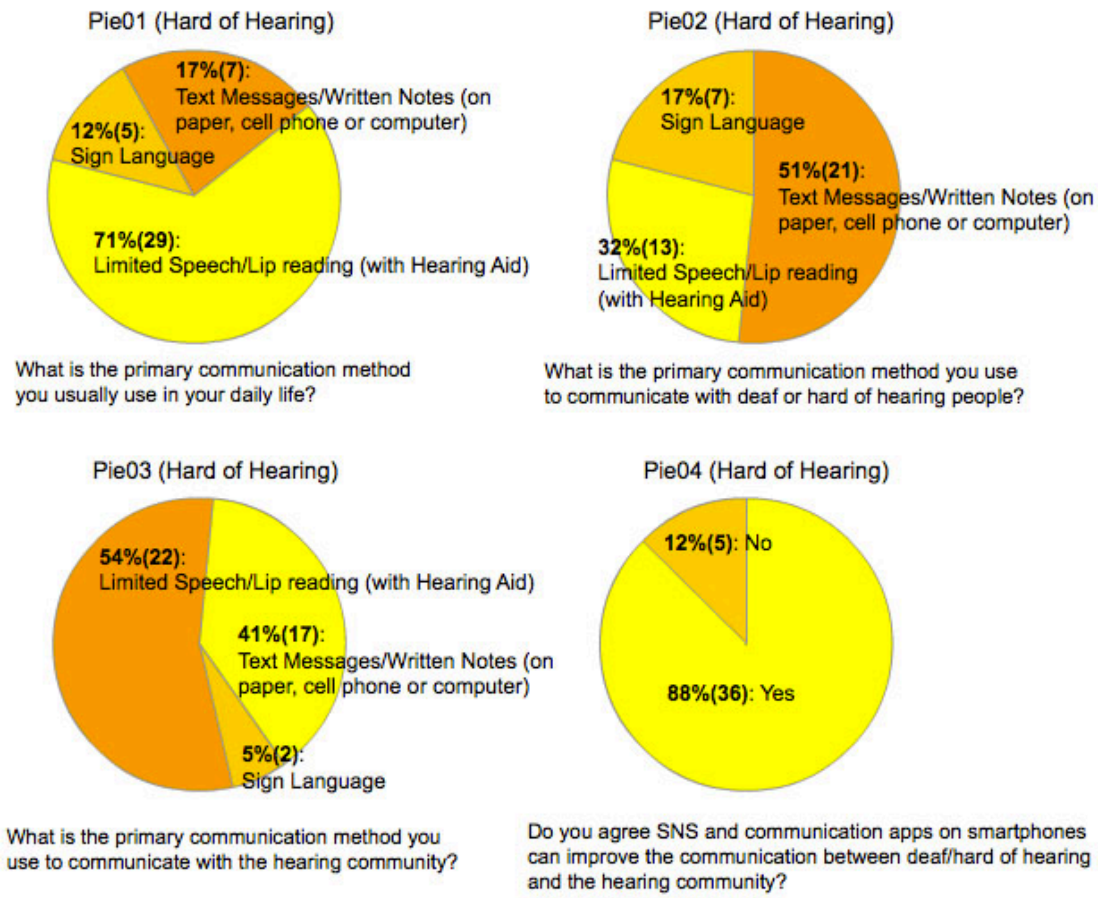


Figure 4.3. Data from Hard of Hearing People

The above pie charts show the results from hard of hearing respondents by asking the same four questions as from deaf respondents.

The results show that limited speech/lip reading (with the assistance of a hearing aid) is the primary communication method used by hard of hearing people (71%), whilst text messages/written notes (on a paper, cell phone or computer) is the primary communication method used between hard of hearing people and the D/HoH (51%). Furthermore, limited speech/lip reading (with the assistance of a hearing aid) (54%) and text messages/written notes (on a paper, cell phone or computer) (41%) are two primary communication methods used by hard of hearing people when they communicate with hearing people. In addition, 88% of hard of hearing respondents agree SNS and communication apps can improve communication between the D/HoH and hearing people.

4.1.2 Significant Findings from the Questionnaire

As seen in the survey data presented above, two significant findings emerge from the questionnaire: a. D/HoH people believe SNS and communication apps can improve the communication between the D/HoH and hearing people, b. Text-based communication is the primary communication method used between deaf, hard of hearing and hearing people.

a. D/HoH people believe SNS and communication apps can improve the communication between the D/HoH and hearing people

   The survey results have shown that D/HoH people believe that new media communication technologies (SNS and communication apps) can improve the communication between the D/HoH and hearing people, as 89 % of the D/HoH survey respondents (92% in deaf and 88% in hard of hearing) agree with this. This finding substantiates and provides support to the research hypothesis and shows that this research is taking a significant direction. The result has answered the first part of the first research question: Are the new media communication technologies of SNS and communication apps able to open new communication opportunities for the D/HoH to communicate and interact with the hearing community? (1st part) If so, how and why? (2nd part).

The second part of the research question is how and why the new media communication technologies (SNS and communication apps) can open new communication opportunities for the D/HoH. The reasons may be similar to the impact of SNS and communication apps as discussed in the Chapter 2. Chapter 2 has indicated three main reasons (a, SNS Content and Information, b. Construction of Social Capital and c. Connection of Online and Offline Social Interaction) why SNS open new communication opportunities and six reasons (a. High-speed Internet, b. Smartphone Penetration, c. Cost Effectiveness, d. Multi-Tasking, e. Screen Names, Profiles and Buddy Lists and f. Away Messages) for why communication apps open new communication opportunities.

b. Text-based communication is the primary communication method used between deaf, hard of hearing and hearing people

The survey results have shown that deaf and hard of hearing people use different communication methods as their primary means of communication. Deaf people use sign language and hard of hearing people use limited speech/lip reading (with hearing aid). However, the results show that deaf and hard of hearing people use the same communication methods when they communicate with hearing people. The results significantly show that there are two primary communication methods used between the D/HoH and hearing people as the number of using limited speech/lip reading (with hearing aid) and text messages/written notes (on paper, cell phone or computer) are very close. 42% of deaf and 52% of hard of hearing respondents use limited speech/lip reading (with hearing aid) and 42% of deaf and 41% of hard of hearing respondents use text messages/written notes (on a paper, cell phone or computer) when they communicate with hearing people.

From this finding, it shows text-based communication plays an important role in the communication between the D/HoH and hearing people. The text-based communication method also relates to the existing and potential communication solutions for the D/HoH as discussed in the Chapter 2. Chapter 2 shows that the existing communication solutions for the D/HoH use text as a primary communication form (e.g. communication via text-only and communication via voice-to-text/sign-to-text translation). Text is also mainly used in the potential communication solutions: SNS and communication apps (see 4.2.1 Feature Review of SNS and Communication Apps, p.71).

These two significant findings from the pilot study have shown that SNS and communication apps have the potential to open new communication opportunities for the D/HoH and improve the communication between the D/HoH and hearing people. One reason why SNS and communication apps can open new communication opportunities for the D/HoH is because the survey shows that text-based communication is the primary communication method used between deaf, hard of hearing and hearing people and text is a primary communication form used in SNS and communication apps (see 4.2.1 Feature Review of SNS and Communication Apps, p.71). However, there are other means of communication that may have similar impact to SNS and communication apps, as used by hearing people and discussed in Chapter 2. The next section will give a feature review of SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) and pursue a further discussion on the accessibility of SNS and communication apps in D/HoH communication.

4.2 The Relationship between New Media Communication Technologies and the D/HoH Communication

The pilot study has shown that new media communication technologies (SNS and communication apps) have the potential to improve the communication between the D/HoH and hearing people. The literature review chapter has shown some reasons why SNS and communication apps can open new communication opportunities. However, there is a shortage of study literature on these communication technologies as used by the D/HoH. This section provides a feature review of SNS (in Facebook, Twitter and Linkedin) and communication apps (in WhatsApp, LINE and WeChat) and gives a comparison between SNS/communication apps and traditional SMS. The purpose of the feature review is to understand actual communication forms used in SNS and communication apps, the comparison is necessary to understand the differences between new media communication technologies (SNS and communication apps) and traditional communication technology (SMS). Furthermore, this section indicates three specific features involved in SNS and communication apps that can open new communication opportunities for the D/HoH. Lastly, this section indicates that there is still an existing gap in the FTF communication between the D/HoH and hearing people even when using SNS and communication apps. It also provides a discussion of D/HoH communication possibilities and methods in FTF communication.

4.2.1 Feature Review of SNS and Communication Apps

This section gives a review of the main features provided by SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat). The reviewed versions of Facebook, Twitter, Linkedin, WhatsApp, LINE and WeChat are those that were running at the end of 2013, and these were the latest versions available during the review period.

(1) Main Features of Facebook, Twitter and Linkedin

a. Facebook

Features	Descriptions
Status Updates	This feature provides a broadcast posting function where users can post text or multimedia content (photos, videos, URLs and locations). Users can decide whether these contents are posted in public, friend-only or private.
Tag	This feature allows users to tag their friends into the contents they post (e.g. tag a friend on a photo or into context). When users' friends are tagged they will receive a notification. This feature can be combined with the Status Updates feature.
Like	This feature is such as a physical thumb up gesture, which is a quick way to give 'positive feedback' by a simple click. It supports all content posted by users.
Message/Chat	This feature is similar to Email and IM where users can send messages (text and multimedia content) to a single friend or a group of friends.
Events	This feature allows users to organise upcoming offline and online activities by giving details (e.g. topic, time, location and invitations).
Pages/Groups	This feature allows user to create their own pages/groups or join other users' pages/groups, for sharing and discovering specific information (e.g. users' interests).

Table 4.1. Feature Review of Facebook

b. Twitter

Features	Descriptions
Tweets	This feature is similar to Facebook 'Status Updates' feature. 'Tweets' is a specific feature that allows users to send and read short messages within 140-characters in length.
Tag	This feature is similar to Facebook 'Tag' feature.
Like	This feature is similar to Facebook 'Like' feature.
Following & Follower	This feature allows users to follow other users and be followed by other users on Twitter. When you follow other users their tweets will be shown on your Twitter home page immediately every time they post.
Message	This feature is similar to Facebook 'Message/Chat' feature.
Discover	Users can discover relevant information (tweets) that matter to them by following other users. The information is recommended by Twitter through incorporating users' personal signals. It is similar to Facebook 'pages/groups' feature.

Table 4.2. Feature Review of Twitter

c. LinkedIn

Features	Descriptions
Profile	This feature allows users to state their personal information (e.g. educational background and employment experiences, professional skills). It is an online CV/resume service.
Share a Update /Upload a photo /Publish a post	This feature is similar to Facebook 'Status Updates' and Twitter 'Tweets' features.
Like	This feature is similar to Facebook and Twitter 'Like' features.
Message	This feature is similar to Facebook 'Message/Chat' and Twitter 'Message' features.
Jobs	This feature allows users to discover job opportunities related to their specialties.
Interests	Users can discover information from companies, educational institutions, organisations and groups that have official LinkedIn pages. It is similar to Facebook 'pages/groups' and Twitter 'Discover' features.

Table. 4.3 Feature Review of LinkedIn

The main features of Facebook, Twitter and LinkedIn reviewed above show that these three different types of SNS provide similar features. These features can be classified into three significant points: a. Private and Broadcast Messages, b. Interaction and Connection Assistants and c. Society and Community.

a. Private and Broadcast Messages

Private messages and broadcast messages are two primary ways provided by Facebook, Twitter and LinkedIn for users to communicate with people. Private messages include email and IM, with broadcast messages including discussion boards and forums. The review shows that most of SNS features are based on the use of broadcast messages for conducting social interaction and communication.

b. Interaction and Connection Assistants

Facebook, Twitter and LinkedIn provide specific actions such as 'tag', 'like' and 'following/follower' that help users to interact and connect with people more easily and quickly through a simple tap/click. These specific actions help users track information related to them. The interaction and connection assistants are mainly used with broadcast messages.

c. Society and Community

Facebook provides the feature 'Groups/Pages', Twitter provides the feature 'Following/Follower' and LinkedIn provides the feature 'Interests'. These features provide a place like a society and a community that allows users to join a network and discover specific information and people they are interested. It allows similar groups of people to aggregate via online social networks.

(2) Main Features of WhatsApp, WeChat and LINE

a. WhatsApp

Features	Descriptions
Messages	This feature allows users to send text and multimedia messages (e.g. text, photos, videos). Special WhatsApp functions include sharing users' current location and contact.
Favourites	This feature allows users to save their favourite messages (e.g. text, photos, videos) from the messages they sent or received.
Status	This feature allows users to share text-only short messages (140 characters). Through the use of 'away messages' (p.28) users can express their personal thoughts and feelings without actually initiating conversation.

Table 4.4. Feature Review of WhatsApp

b. WeChat

Features	Descriptions
Messages & Voice Chat	This feature allows users to send messages (e.g. text, photos, and videos). Voice Chat is a specific feature that allows users to send voice messages via a simple action: 'hold to talk'.
Favorite Message	This feature allows users to save their favourite messages. It is similar to WhatsApp 'Favourites' feature.
Free Voice/ Video Call	This feature allows users to make a free voice and video call.
Moments	This feature allows users to post text or multimedia content on their WeChat Moments page. It is similar to Facebook 'Status Updates' feature.
Shake/People Nearby	This feature allows users to find new friends who are also WeChat users by shaking phones. Users can also see other WeChat users who are close to their current location.
Sticker/Sticker Shop	This feature allows users to use sticker pictures as a part of messages and buy sticker pictures in the WeChat sticker shop.

Table 4.5. Feature Review of WeChat

c. LINE

Features	Descriptions
Messages	This feature allows users to send messages (e.g. text, photos, and videos).
Free Voice and Video Call	This feature allows users to make a free voice and video call.
Timeline	This feature allows users to post text or multimedia content on their Line Timeline page. It is similar to Facebook 'Status Updates' feature.
Sticker/Sticker Shop	This feature allows users to use sticker pictures as a part of messages and buy sticker pictures in the LINE sticker shop.
LINE Games	This feature allows user to play games provided by LINE.

Table 4.6. Feature Review of LINE

As per the main features of WhatsApp, WeChat and LINE reviewed above, it shows that these three different types of communication apps provide similar features. These features can be classified into three significant points: a. Free Messages, Voice and Video Calls, b. Social Network Supports and c. Sticker Emoticons.

a. Free Messages, Voice and Video Calls

WhatsApp, WeChat and LINE provide free message transmission without having to pay for normal SMS cost. They use an Internet connection (3G/4G/Wifi) to transmit messages. WeChat and LINE also provide free voice and video calls. This different approach to transmitting messages has been able to reduce the cost of sending messages and making calls. This point is also raised by Kumar, et al. (2015) as one of the three reasons that communication apps have replaced traditional SMS and phone calls.

b. Social Network Supports

WeChat and LINE provide some features (e.g. 'Moments' and 'Timeline'), that are similar to the 'Status Updates' feature on Facebook, the 'Tweet' feature on Twitter and the 'Share a Update' feature on LinkedIn. These features allow users who share in SNS benefits to support their social interaction via the use of communication apps.

c. Sticker Emoticons

WeChat and LINE provide various sticker emoticons to enrich the communication process. Sticker emoticons are graphic messages specifically designed for use in communication apps. Sticker emoticons offer more advanced emoticons than basic emoticons. Sticker emoticons typically provide bigger images with more detail, such as illustrations and animation/movie characters, see Table 4.7 below.

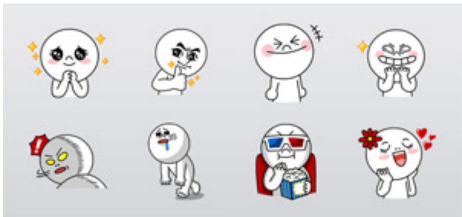
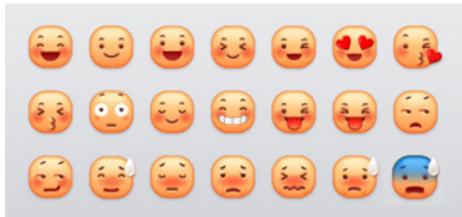
Sticker Emoticons	**Basic Emoticons**
	

Table 4.7. Stickers and Basic Emoticons

The above feature review of SNS (Facebook, Twitter and LinkedIn) and communication apps (WhatsApp, WeChat and LINE) has identified six significant points in the use of SNS and communication apps that may affect the ways that people communicate. In addition, the review shows that most features used in SNS and communication apps are based on text.

4.2.2 A Further discussion of SNS and Communication Apps

The feature review of SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) has pointed out six significant points in the use of SNS and communication apps. This section gives a further discussion of SNS and communication apps through a comparison of SNS/communication apps and SMS. This comparison aims to investigate the differences between new media communication technology (SNS and communication apps) and traditional communication technology (SMS). It is specifically focused on the communication forms used in SNS/communication apps and SMS and the interfaces designed in SNS/communication apps and SMS.

Facebook is chosen as an example of a SNS and WeChat as an example of a communication app to compare with SMS. The reason for choosing WeChat instead of WhatsApp (the most popular communication app) is because WeChat not only covers all the features of WhatsApp but also provides additional features (e.g. social network support). Therefore it is a better case to represent communication apps. Although Facebook and WeChat provide web and mobile versions for running on different types of devices, this comparison only focuses on the mobile version.

(1) Communication forms used in SNS/Communication Apps and SMS

Communication forms used in the Facebook, WeChat and SMS can be discussed in ten different forms: (1) Text Message, (2) Multimedia Message, (3) One-to-one Message, (4) One–to-Many Message (Group Message), (5) Private Message, (6) Broadcast Message (Public Message), (7) Real Time Message, (8) Non-real Time Message, (9) Voice Call and (10) Video Call. See Table 4.8 below.

Communication Forms	Explanation
(1) Text Message	Text message include text and simple symbols.
(2) Multimedia Message	Multimedia message include emoticons, photos, audio and video.
(3) One-to-One Message	One-to-one messages allow people to send messages to a single person.
(4) One-to-Many Message (Group Message)	One-to-many messages allow people to send messages to two or more people at the same time.
(5) Private Message	Private messages are personal information delivered via a platform that only can be seen by the senders and receivers.
(6) Broadcast Message (Public Message)	Broadcast messages are public information posted on a platform that all people can see on the platform, such as discussion boards and forums.
(7) Real Time Message	Real time messages in this study are defined as an instant message transmitting process by which people can send and receive messages instantly e.g. IM.
(8) Non-Real Time Message	Non-real time messages in this study are defined as a message transmitting process by which people can send offline messages and not expect to get a reply instantly. E.g. Email.
(9) Voice Call	Make a phone call via voice.
(10) Video Call	Make a phone call via video.

Table 4.8. Communication Forms

Facebook and WeChat support all the ten communication forms, whilst SMS only supports seven of the ten communication forms. SMS does not support broadcast messages (public messages), voice calls and video calls. See Table 4.9 below.

Communication Systems	Communication Forms	Availability
Facebook	(1) Text Message	√
	(2) Multimedia Message	√
	(3) One-to-One Message	√
	(4) One-to-Many Message (Group Message)	√
	(5) Private Message	√
	(6) Broadcast Message (Public Message)	√
	(7) Real Time Message	√
	(8) Non-Real Time Message	√
	(9) Voice Call	√
	(10) Video Call	√
WeChat	(1) Text Message	√
	(2) Multimedia Message	√
	(3) One-to-One Message	√
	(4) One-to-Many Message (Group Message)	√
	(5) Private Message	√
	(6) Broadcast Message (Public Message)	√
	(7) Real Time Message	√
	(8) Non-Real Time Message	√
	(9) Voice Call	√
	(10) Video Call	√
SMS	(1) Text Message	√
	(2) Multimedia Message	√
	(3) One-to-One Message	√
	(4) One-to-Many Message (Group Message)	√
	(5) Private Message	√
	(6) Broadcast Message (Public Message)	
	(7) Real Time Message	*
	(8) Non-Real Time Message	√
	(9) Voice Call	
	(10) Video Call	
* SMS is mainly not used as real time message because people typically do not expect to get an immediate reply. However, it is possible to be used as a real time message.		

Table 4.9. Communication Forms in Facebook, WeChat and SMS

The comparison of Facebook, WeChat and SMS shows that communication forms used in new media communication technology (Facebook and WeChat) and traditional communication technology (SMS) are very similar. The differences are the three communication forms (broadcast messages, voice and video calls) used in Facebook and WeChat, but not in SMS. The communication form of broadcast messages is accessible for the D/HoH, whilst voice and video calls are not accessible communication forms for the D/HoH (when sign language is unavailable). It significantly shows, in the D/HoH communication, broadcast message (public message) is the only difference between the use of new media communication technologies (Facebook and WeChat) and traditional communication technology (SMS).

(2) Interfaces of SNS/Communication Apps and SMS

Interface design is 'the engineering process of designing interactive computer systems' (Sutcliffe 1995, p.2). Rogers, Helen and Preece (2001, p.160) note that interface design opens 'possibilities for users to interact with a system and for information to be presented and represented at the interface'. Rogers, Helen and Preece (2011) indicate that a graphical user interface (GUI) is a versatile interface primarily used to support all manner of computer-based and smartphone-based activities. This section compares the GUI in Facebook, WeChat and SMS to understand how interface affects communication in SNS/communication apps and SMS.

The homepage and inputting page of Facebook, WeChat and SMS are selected as two interface cases for discussion. The homepage is the first interface displayed when starting an app and typically presents the primary features of an app. The inputting page is the interface used for inputting messages and usually includes a text typing feature with a virtual keyboard. In the case of the homepage, it helps to understand the main interface design of Facebook, WeChat and SMS. In the case of the inputting page, it helps investigate differences between Facebook, WeChat and SMS because inputting messages is an important and essential behaviour required when using these three apps.

a. Homepage Interface

The homepage interface of Facebook, WeChat and SMS can be divided into three interface areas: a. Navigation Area, b. Content Area and c. Feature Area. The navigation area is an interface element situated at the top of the homepage interface. The purpose of the navigation area is to help users realise the current feature they are using. The content area is an interface element situated in the middle of the homepage interface and occupies the most space on the homepage interface. The purpose of the content area is to present the main content of the current feature that the users are using. The feature area is an interface element situated at the top or bottom of the homepage interface. The purpose of the feature area is to provide links to other features. See Table 4.10 below.

Facebook	WeChat	SMS

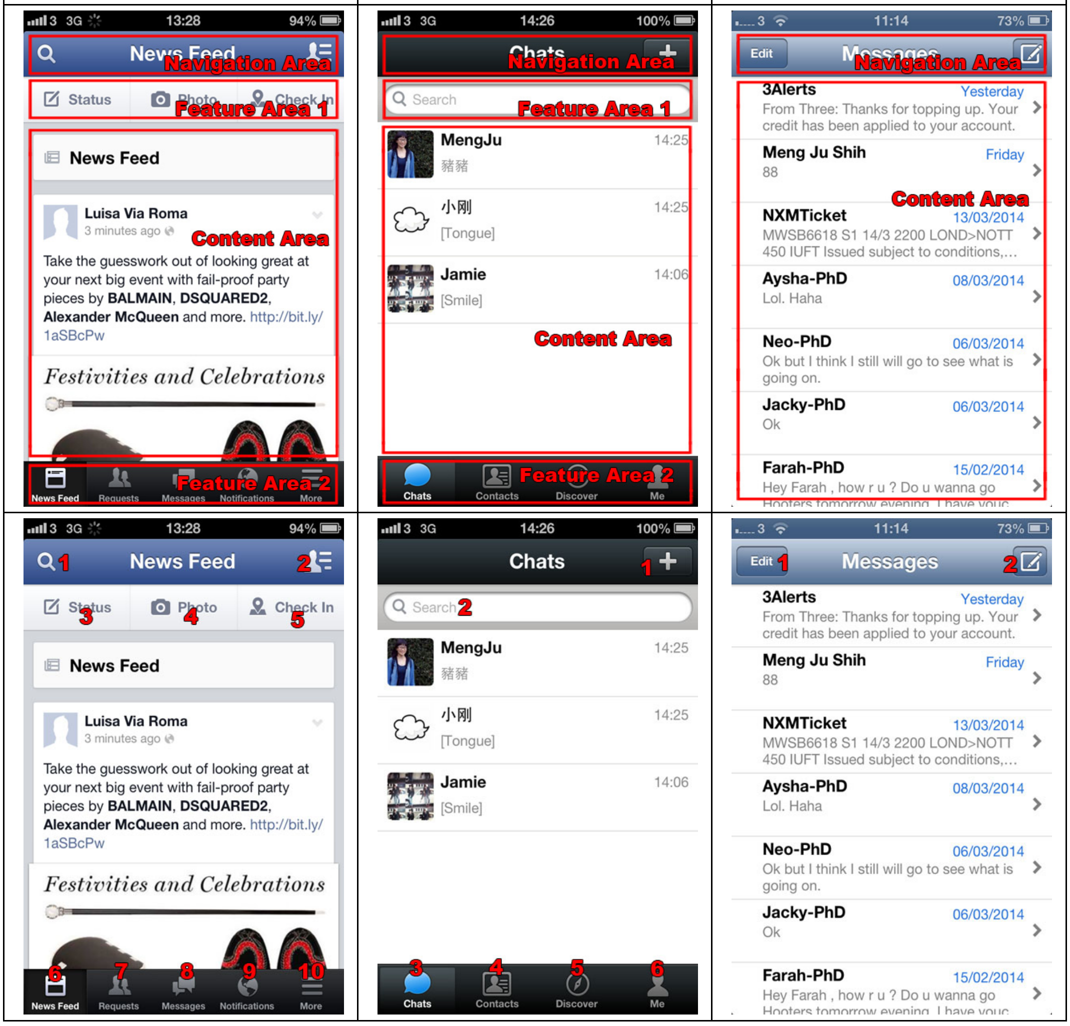


Table 4.10. Homepage Interface on Facebook, WeChat and SMS

The homepage interface on Facebook and WeChat combines a navigation, a content and two feature areas, whilst the homepage interface of SMS only combines a navigation and a content area. Furthermore, Facebook's homepage interface combines ten features, WeChat combines six features and SMS combines two features (see the lower image in Table 4.10). In addition, the

Facebook content area supports a multimedia content display (e.g. text, emoticons, photos, videos and URLs) that displays broadcast information.

b. Inputting Page Interface

The inputting page interface of Facebook, WeChat and SMS can be divided into three interface areas: a. Navigation Area, b. Message Display Area, c. Multimedia Inputting Area and d. A Virtual Keyboard. The message display area is similar to the 'content area' in homepage interface. It is used to present sending and receiving messages. The multimedia inputting area provides different ways to input messages (e.g. text, emoticon, photo and audio). See Table 4.11 below.

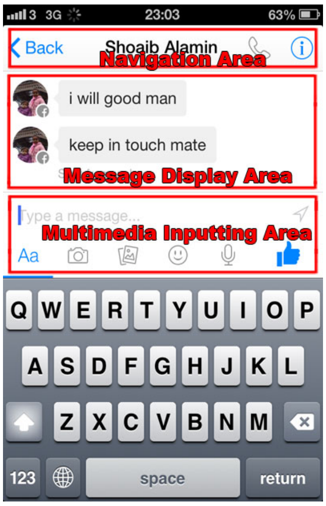
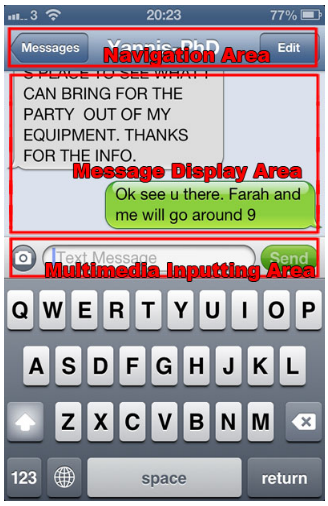
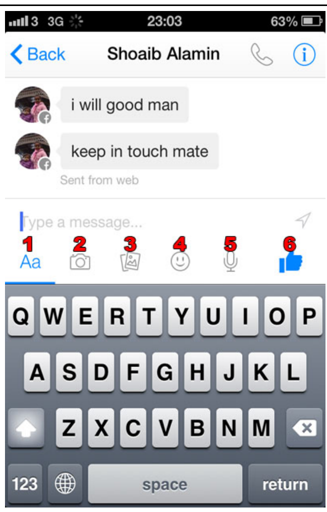
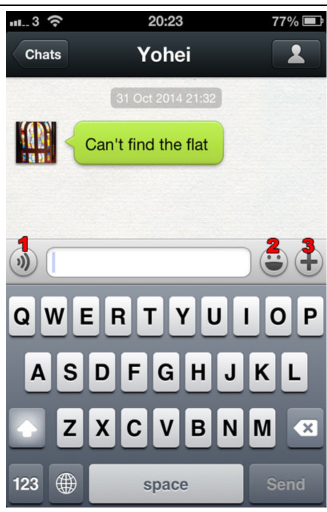
Facebook	WeChat	SMS
		
		

Table 4.11. Inputting Interfaces on Facebook, WeChat and SMS

The inputting page interfaces on Facebook, WeChat and SMS are very similar. A virtual keyboard interface occupies half of the space on the inputting page. The other half of the space combines a navigation, a message display and a multimedia inputting area. The Facebook inputting page interface provides six different ways for users to input messages (on the multimedia inputting area), WeChat three ways and SMS only one way.

Through the review of homepage and inputting page interfaces on Facebook, WeChat and SMS, it is shown that the interfaces designed in Facebook and WeChat are highly developed interfaces that allow users to use various features on a single page at the same time, whilst SMS only supports simple features. These multifunctional interfaces support 'Multi-Tasking' (Davey, et al. 2004), which is one of the impacts of the use of SNS and communication apps (see (2) Impacts of SNS and Communication Apps, p.24). These highly developed and multifunctional interfaces are the significant differences between new media communication technologies (Facebook and WeChat) and traditional communication technology (SMS).

4.2.3 Three Significant Features involved in SNS and Communication Apps

The feature review of SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) has indicated six significant focal points in the use of SNS and communication apps as well as showing that text is the primary form used in SNS and communication apps. Moreover, the comparison of new media communication technologies (Facebook and WeChat) and traditional communication technology (SMS) has shown that broadcast message (public message) and multifunctional interfaces are significant components in the use of Facebook and WeChat.

According to the review and comparison, this study argues that there are three significant features involved in SNS and communication apps that can open new communication opportunities to hearing people as well as D/HoH people. The three significant features are: a. An accessible communication channel, b. An integrated communication and social platform and c. An optimised multi-function interface.

a. An Accessible Communication Channel

Although SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) are not specifically designed for the D/HoH, they provide an accessible communication channel for the D/HoH to interact and communicate with hearing people. The feature review of SNS and communication apps shows that text (or non-speech) is the primary element and communication form used in SNS and communication apps. It allows D/HoH people the use of most of features (except voice call and audio-related features) in SNS and communication apps without problems regardless of their hearing loss. Furthermore, text-based communication is an important part in the existing D/HoH communication solutions (a. TTY, TRS and VRS, b. SMS, IM, Email and Fax and c. sign language and voice recognitions), these solutions mainly use text as a communication form or medium. In addition, the pilot study shows text-based communication (text messages/written notes) is one of the primary communication methods currently used between deaf, hard of hearing and hearing people.

Consequently 'text' is the prime element and communication form used in the communication between the D/HoH and hearing people as well as in the use of SNS and communication apps. This study argues that SNS and communication apps can provide new communication opportunities for the communication between the D/HoH and hearing people (via a text-based accessible communication channel).

b. An Integrated Communication and Social Platform

The comparison of SNS/communication apps and SMS has shown that SNS and communication apps support various communication forms that cover all the communication forms used in SMS. Users do not only use the basic communication forms via SNS and communication apps but they can also use additional features specifically provided by SNS and communication apps such as broadcast message (public message).

Furthermore, Table 4.12 below shows significant aspects in the use of SNS and communication apps via the literature review and feature review of SNS and communication apps.

Sources	SNS	Communication Apps
Literature Review	a. SNS Content and Information b. Construction of Social Capital c. Connection of Online and Offline Social Interaction	a. High-speed Internet b. Smartphone Penetration c. Cost Effectiveness d. Multi-Tasking e. Screen Names, Profiles and Buddy Lists f. Away Messages
Feature Review	a. Private and Broadcast Messages b. Interaction and Connection Assistants c. Society and Community	a. Free Messages, Voice and Video Calls, b. Social Network Supports c. Sticker Emoticon

Table 4.12. Significant Aspects of SNS and Communication Apps

Most of these prime aspects are relevant to social activities. It shows that social support is the most significant part in the use SNS and communication apps. Because of the social support, SNS and communication apps are not just simple communication tools, they are also social platforms where people can increase their social interaction and communication. The significant aspects of SNS and communication apps were discussed in the sections of 'Impacts of SNS and Communication Apps' (p.24) and 'Feature Review of SNS and Communication Apps' (p.71).

c. An Optimised Multi-function Interface

The comparison of SNS/communication apps and SMS shows that the interfaces designed in Facebook and WeChat are highly developed, that is they optimise the access of the users to the various communication features e.g. quickly sending text, emoticons, multimedia contents, posting and reading broadcast information. The optimised multi-function interface supports 'Multi-Tasking' (Davey, et al.

2004) and rapid use of the communication features. In addition, a multifunctional interface supports the above second significant feature of ‘an integrated communication and social platform’.

Furthermore, a multimedia content display is a significant part in the optimised multi-function interface. A multimedia content display provides a more readable and effortless operating environment via a large display area to support multimedia contents (e.g. text, emoticons, photos, videos and URLs). It is a specific design for broadcast messages as broadcast messages account for a significant difference between new media communication technologies (Facebook and WeChat) and traditional communication technology (SMS). The study argues that SNS and communication apps can provide new communication opportunities to the communication between the D/HoH and hearing people via a multiple function interface.

These are the three significant features of SNS and communication apps that the author argues can, open new communication opportunities for the communication between the D/HoH and hearing people in this study. The above arguments have answered the second part of the first research question: Are the new media communication technologies of SNS and communication apps able to open new communication opportunities for the D/HoH to communicate and interact with the hearing community? (1st part) If so, how and why? (2nd part).

4.3 A FTF Communication Gap

The pilot study has shown that the view of the participants is that new media communication technologies (SNS and communication apps) are able to improve the communication between the D/HoH and hearing people. Additionally, the above section has indicated three significant features involved in SNS and communication apps that can introduce new communication opportunities to the communication between the D/HoH and hearing people. This section indicates that there is still a further communication gap in FTF communication between the D/HoH and hearing people even when the new media communication technologies of SNS and communication apps are being used. In addition, this section has a further discussion of the communication possibilities and methods in FTF communication between the D/HoH and hearing people.

4.3.1 A Further Gap in FTF Communication even when using SNS and Communication Apps

Although part of this study has shown that SNS and communication apps are able to open new communication opportunities and bridge the communication gap between the D/HoH and hearing people, most communication features designed in SNS and communication apps are based on CMC, which is mainly used for non-FTF communication (see 4.2.1 Feature Review of SNS and Communication Apps, p.71). As previously asserted there is still a communication gap in the FTF communication between the D/HoH and hearing people even when using SNS and communication apps.

Chapter 2 has discussed CMC and FTF communication and indicated that physical interaction with nonverbal messages is a significant communication element that occurs in FTF communication. Physical interaction with nonverbal messages in FTF communication contributes to mutual attention, such as regulating turn-taking through eye contact, facial expressions and body gestures. It is a significant difference between CMC and FTF communication. Sassenberg, Boos and Rabung (2005) indicate physical information is unable to be presented in CMC but does take place during FTF communication. Although CMC also provides nonverbal messages, such as emoticons, the significant difference to FTF communication is that the speakers and listeners are unable to see each other (except via video calls). FTF communication provides an eye gazing environment, allowing speakers and listeners to immediately receive physical information with linguistic information, which is an opportunity to realise an implicit interpretation. Moreover, physical interaction with nonverbal messages is significantly important for D/HoH communication as the D/HoH rely on visual sense much more than hearing people during communication.

SNS and communication apps are based on non-local CMC and not designed for FTF communication, they therefore lack physical interaction. It confirms there is still a further communication gap in the FTF communication between the D/HoH and hearing people. The primary research of this study (Chapter 5) aims to investigate and provide a new communication solution to solve this communication gap.

4.3.2 D/HoH Communication Possibilities and Methods in FTF Communication

The pilot study (questionnaire) has shown that sign language is the primary communication method used by deaf people, with limited speech/lip reading (with hearing aid) being the primary communication method used by hard of hearing people. The survey also indicates that both deaf and hard of hearing people use the same methods (limited speech/lip reading and text messages/written notes) when they communicate with hearing people. This section provides an in-depth discussion of the communication possibilities and methods in FTF communication between the D/HoH and hearing people.

The communication in/between deaf, hard of hearing and hearing people can be divided into seven possibilities: (1) Deaf-to-Hard of Hearing People, (2) Deaf-to-Hearing People, (3) Hard of Hearing-to-Hearing People, (4) Deaf-to-Deaf People, (5) Hard of Hearing-to-Hard of Hearing People, (6) Hearing-to-Hearing People and (7) All Three Groups.

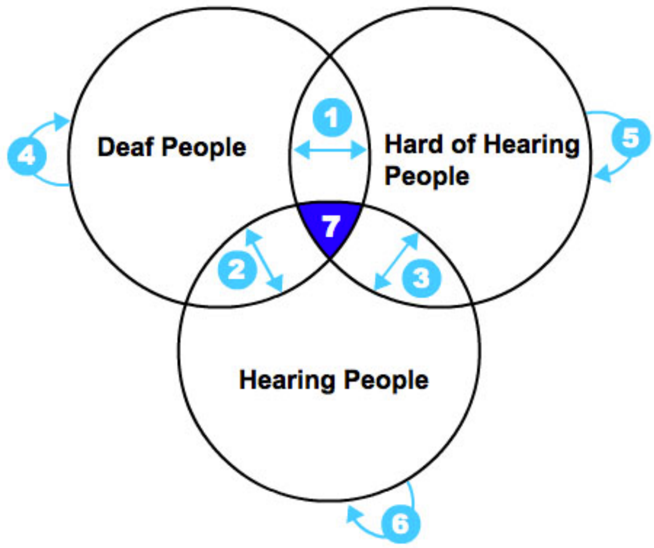


Figure 4.4. Communication Possibilities between Deaf, Hard of Hearing and Hearing People

The above Figure 4.4 shows seven communication possibilities that occur in deaf, hard of hearing and hearing people. These seven communication possibilities are discussed together with six communication methods/forms: a. Speech, b. Sign Language, c. Limited Speech (with lip movement/reading), d. Written Notes/Text (including graphs), e. Gesture-based Nonverbal Message (e.g. eye contact and facial expressions) and f. Voice-based Nonverbal Messages (e.g. rhythm, intonation). There are three reasons for discussing the six communication methods/forms:

a. Speech, sign language and limited speech (with lip movement/reading) are the primary communication methods used by hearing, deaf and hard of hearing people.

b. Limited speech (with lip movement/reading) and written notes/text (including graphs) are two primary communication methods used between the D/HoH and hearing people (when sign language interpreters are not available).

c. Gesture-based and voice-based nonverbal messages are two significant communication elements in FTF communication.

Table 4.13 below shows the six communication methods/forms used in the above seven communication possibilities. However, only communication possibility 2 (deaf to hearing people) and 3 (hard of hearing to hearing people) are given a detailed discussion here because the initial research purpose of this study is to investigate a communication solution for bridging the communication gap between the D/HoH and hearing people.

Communication Methods/Forms	**Communication Possibilities**						
	1	**2**	**3**	4	5	6	7
a. Speech						√	
b. Sign Language				√			
c. Limited Speech (with lip movement/reading)	√	√	√		√		
d. Written Note/Text (includes graphs)	√	√	√	√	√	√	√
e. Gesture-based Nonverbal Message (e.g. eye contact and facial expressions)	√	√	√	√	√	√	√
f. Voice-based Nonverbal Message (e.g. rhythm, intonation)	√	√	√		√	√	

Table 4.13. D/HoH Communication Possibilities and Methods in FTF Communication

Firstly, the above table shows that speech and sign language are not accessible communication methods/forms used between the D/HoH and hearing people (communication possibilities 2 and 3) when sign language interpreters are not available. The survey in the pilot study presents similar results that speech is a not an accessible method (0% D/HoH respondents use it), with very few D/HoH people using sign language to communicate with hearing people (16% deaf respondents use it, 5% hard of hearing respondents use it). Comparatively, the use of sign language only occurs when both the D/HoH and hearing people know sign language.

Secondly, the table shows that limited speech (with lip movement/reading) and written note/text (includes graphs) are two accessible communication methods/forms used between the D/HoH and hearing people (communication possibilities 2 and 3). The survey in the pilot study presents the same results that limited speech/lip reading (with hearing aid) and text messages/written are two primary communication methods used in the communication between the D/HoH and hearing people. However, some studies show that limited speech is only capable of transmitting very limited information. For example, Ruth and Tara-Jane (2010, p.5) indicate that lip reading is difficult because lip shapes do not always reflect the speech sound being made. Barnett (2002, p.670) indicates, 'With English, many sounds are formed behind the lips, in the throat and mouth, making them indistinguishable on the lips. Without sound, at best only 30% of English is readable on the lips.'

Thirdly, the table shows that gesture-based and voice-based nonverbal messages are two accessible communication methods/forms used between the D/HoH and hearing people (communication possibilities 2 and 3). It is a significant deduction from the table because these two communication methods/forms are significant parts of FTF communication. This finding shows that physical interaction with nonverbal messages is an accessible communication form in the FTF communication between the D/HoH and hearing people. However, gesture-based and voice-based nonverbal messages are very hard to use as a single communication method/form due the inability to transmit verbal information. These two communication methods/forms should be combined with other communication methods/forms for a completed communication.

The above table compares communication possibilities in the FTF communication between the D/HoH and hearing people when using different communication methods/forms. It shows that limited speech, written note/text, gesture-based and voice-based nonverbal messages are accessible communication methods/forms used in FTF communication between the D/HoH and hearing people (when sign language interpreters are not available). However, written note/text is the only communication method/form that can be completely used, as there are still limitations in the methods of limited speech, gesture-based and voice-based nonverbal messages. Although limited speech, gesture-based and voice-based nonverbal messages are limited when using as a single communication method/form in FTF communication between the D/HoH and hearing people, they can be used together concurrently to support each other. For example, gesture-based and voice-based nonverbal messages can be used with limited speech as well as written note/text as a supplement when other communication methods/forms are limited. It significantly shows that a mixed communication method/form can increase the communication possibility in FTF communication between the D/HoH and hearing people. Moreover, a mixed communication method/form is typically used during FTF communication that contains physical (nonverbal) and linguistic (verbal) information at the same time.

CHAPTER FIVE

PRIMARY RESEARCH: INTERACTION DESIGN CREATIVE PRACTICE

Chapter 5: Primary Research: Interaction Design Creative Practice

This chapter investigates a communication solution that address the FTF communication gap between the D/HoH and hearing people through the creative practice of interaction design using a UCD development process.

There are six sections in this chapter:

a. Introduction of Design Steps, Interviews and Thematic Analysis
   This section introduces the design steps of the interaction design creative practice and analysis techniques of the interview.

b. Design Step 1: Defining User Requirements
   This section interviews to investigate and define the user requirements.

c. Desig Step 2: Providing Alternatives
   This section presents design concepts and suggests alternative potential features that satisfy the user requirements.

d. Design Step 3: Alternatives, Testing and Selection
   This section tests the alternative potential features through user feedback and interview.

e. Design Step 4: Prototype Developments
   This section develops a prototype targeted iOS 7 on the iPhone 5.

f. Design Step 5: Evaluation and Modifications
   This section evaluates the developed prototype through the method of interview and provides a revised prototype.

5.1 Introduction of Design Steps, Interviews and Thematic Analysis

The preliminary study has shown that new media communication technologies (SNS and communication apps) are able to bridge the communication gap between the D/HoH and hearing people. However, it postulated that there is still a communication gap in FTF communication between the D/HoH and hearing people, even when using SNS and communication apps. This section introduces the creative practice in this study, which is an interaction design process. The interaction design creative practice aims to investigate a communication solution (from a design perspective) for bridging the FTF communication gap between the D/HoH and hearing people. In addition, this section summarises the interview statements and explains the thematic analysis used in this study.

5.1.1. Introduction of Design Steps

The interaction design creative practice in this study is conducted via a UCD development process. The UCD development process is based on the three UCD principles, as proposed by Gould and Lewis: a. 'Early focus on users and tasks', b. 'Empirical measurement' and c. 'Iterative design' (see 3.2.1 User-centred Design, p.46). Based on these three UCD principles, there are five design steps that are used to conduct the interaction design creative practice in this study.

The five steps are: Step 1. Defining User Requirements, Step 2. Providing Alternatives, Step 3. Alternatives, Testing and Selection, Step 4. Prototype Developments and Step 5. Evaluations and Modifications. See Figure 5.1 below.

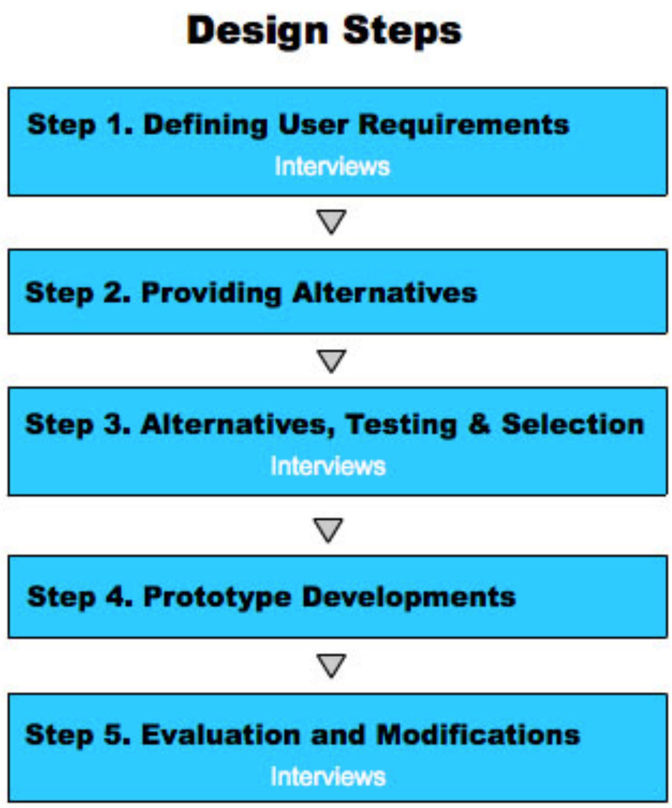


Figure 5.1. Design Steps

- **Step 1. Defining User Requirements**

  The first design step is conducted via interviews that seek to understand users and define their requirements. This design step includes the definitions of who the user is and what the task is.

- **Step 2. Providing Alternatives**

  The second design step provides alternative potential features for this smartphone app. These alternatives aim to fulfil the defined user requirements. This design step includes the analyses of user requirements and potential approaches/technologies that can be used.

- **Step 3. Alternatives, Testing and Selection**

  The third design step is conducted via interviews and aims to test the provided alternatives and decide which features are the most suitable to be developed.

- **Step 4. Prototype Developments**

  The fourth design step develops a prototype to determine the features of this smartphone app. The prototype is presented via digital graphs (for understanding interfaces) and a web-based simulated environment (for experiencing interactions) for user testing and evaluation.

- **Step 5. Evaluation and Modifications**

  The fifth design step consists of interviews with a view to evaluate and modify the developed prototype. Eventually, a revised prototype of a smartphone app is built as the final outcome of this study.

5.1.2 Interview Statements

Interviews are used as the primary method to collect data from end-users for understanding user requirements, testing design concepts and evaluating prototypes. This section gives a summary of the interview statements.

(1) Twenty-seven Interviews in Three Design Steps

Interviews were conducted in the design step 1, 3 and 5. Each design step contains nine interviews with a total of twenty-seven interviews completed. The interviews in the design step 1 were conducted from November 2012 to December 2012, the interviews in design step 3 were conducted from March 2014 to April 2014 and the interviews in design step 5 were conducted from July 2014 to August 2014. Some further discussions took place outside of these time periods because of unexpected issues such as late responses by the interviewees.

(2) Nine Interviewees in Three Specific Groups

Nine interviewees in three specific groups were recruited to participate in the interviews. The three specific groups are: a. Experts, b. D/HoH People and c. Hearing

People. Three experts were recruited from relevant D/HoH organisations in the United Kingdom, with three D/HoH people and three hearing people recruited from the survey respondents in the pilot study. The experts are professionals in the D/HoH field. Because the interview process is time consuming, the three-group interviews allow for the precise and efficient collecting of data, particularly the data from the experts. Details of the nine interviewees are shown in Table 5.1 below.

Groups	Interviewees	Background/Details	Types
Experts	Person 1	• A sign language interpreter (hearing person) • British Sign Language (BSL) degree awarded • More than 14 years of experience • Female / Age: 40-49	Online & Face-to-face Interview
	Person 2	• A communication development officer (hearing person) in the Action on Hearing Loss (a Deaf organisation in the UK), also a sign language interpreter • Issues in Deafness degree awarded • More than 17 years of experience • Female / Age: 50-64	Online Interview
	Person 3	• A manager at the British Deaf Association (Deaf) • More than 32 years of experience • Male / Age: 50-64	Online Interview
Deaf/Hard of Hearing People	Person 4	• A university student • Male / Age: 18-29	Online Interview
	Person 5	• A university student*f* • Female / Age: 18-29	Online Interview
	Person 6	• A college teacher • Male / Age: 30-39	Online Interview
Hearing People	Person 7	• A deaf child's mother • Female / Age: 40-49	Online Interview
	Person 8	• A designer who usually works with a Deaf/Hard of Hearing colleague • Male / Age: 30-39	Online & Face-to-face Interview
	Person 9	• A Deaf person's friend • Male / Age: 30-39	Online & Face-to-face Interview

Table 5.1. Interviewee Details

5.1.3 Interview Procedure and Thematic Analysis

The interviews in this study were mainly conducted by the use of an email-based online semi-structured interview as discussed in Chapter 3, whilst some were conducted via FTF semi-structure interviews. This section explains the interview procedure and the thematic analysis technique that is used.

(1) Interview Procedure

All interviews were conducted by following an interview procedure as the Figure 5.2 shown below.

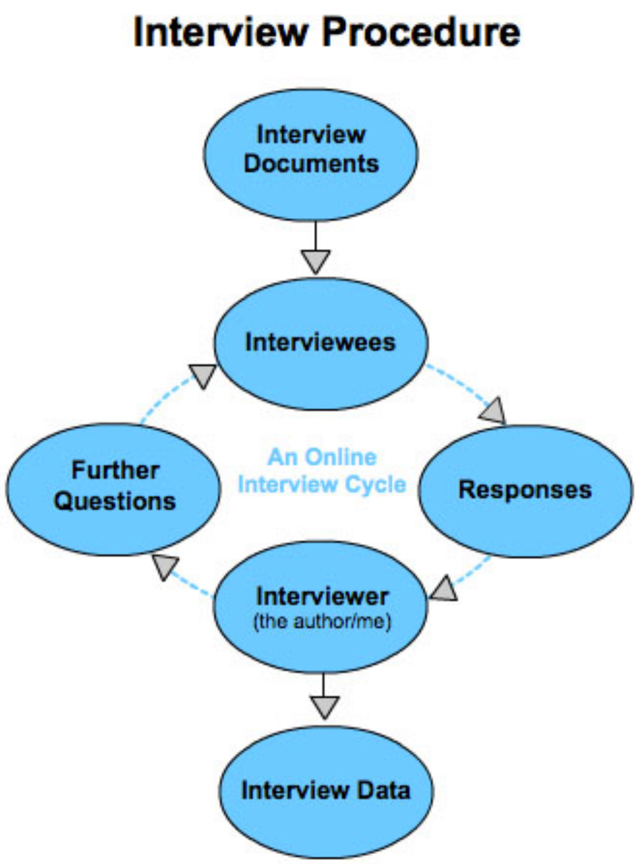


Figure 5.2. Interview Procedure

The interview procedure includes three parts:

- Part 1

  Firstly, three interview documents (Appendix 3, 6 and 9) are prepared for the different design steps (1, 3 and 5). Each document contains a brief introduction of interview purpose and questions used in the interviews.

- Part 2

  Secondly, the interview documents are sent to expecting interviewees via emails (or presented in person). All interviews are based on an online interview cycle (a. Interviewees, b. Responses c. Interviewer and d. Further Questions), see the above Figure 5.2.

- Part 3

  Thirdly, the online interview cycle in each interview is ended when the collected data is sufficient (e.g. repeating the same data points), with at least two rounds of the interview cycle for each interviewee. The interview data was then transcribed into text (Appendix 4, 7 and 10).

(2) Thematic Analysis

All interview data is analysed via a qualitative approach. Qualitative approaches are diverse, complex and nuanced (Holloway and Todres 2003). Erlandson et al. (1993, p.116) indicate there are three main elements for conducting a qualitative data analysis: a. 'Unitizing Data', b. 'Emergent Category Designation' and c. 'Negative Case Analysis'. Thematic analysis is a typical method used to conduct a qualitative research. Braun and Clarke (2006, p.79) indicate 'thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data', which is a foundational method for qualitative data analysis. In addition, thematic analysis has been broadly used in human-computer interaction field for gaining understanding of users and their experiences with technologies (Brown and Stockman 2013; Money, Lines and Elliman 2008; Pykhtina et al. 2012; Tanaka et al. 2012).

Thematic analysis is selected as the method to analyse the interview data in this study, which is based on the below 6-phase guideline of conducting thematic analysis as proposed by Braun and Clarke (2006).

- *Phase 1: Familiarizing yourself with your data*

  Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
- *Phase 2: Generating initial codes*

  Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
- *Phase 3: Searching for themes*

  Collating codes into potential themes, gathering all data relevant to each potential theme.
- *Phase 4: Reviewing themes*

  Checking if the themes work in relation to the coded extracts (Level 1) and entire data set (Level 2), generating a thematic 'map' of the analysis.
- *Phase 5: Defining and naming themes*

  Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
- *Phase 6: Producing the report*

  The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

There are some tools that provide support for data analysis, such as NVivo[12] for qualitative data and SPSS[13] for quantitative data. These tools are particularly useful for managing a large volume of data. These programmes are meant to assist but not

[12] NVivo is a qualitative data analysis computer software package produced by QSR International.

[13] SPSS (Statistical Package for the Social Sciences) is a quantitative data analysis computer software package produced by IBM SPSS Inc..

be a necessary part of the data analysis. The interview data in this study is analysed by means of a manual method based on the above 6-phase guideline. Table 5.2 below shows an example of how the interview data was analysed in accordance with the 6-phase guideline.

<table>
<tr><th>Phase 1: Familiarizing your self with your data</th></tr>
<tr><td>In this phase, all interview data are transcribed into a Word document. All interview data are shown in the Appendix 4, 7 and 10 (three interviews in three different design steps). Below is a sample of interview data.
‘Every deaf or hear of hearing people use different communication ways and have different communication behavious, that brings difficulties. Some of them use sign language and some use lip reading and limited speech. Also, not all deaf and hear of hearing people can use sign language well. Even they use sign language there are different types of sign language. It is also a problem. For example,…’</td></tr>
<tr><th>Phase 2: Generating initial codes</th></tr>
<tr><td>In this phase, all interview data are organised into meaningful groups by using highlighters to indicate potential patterns. In addition, initial codes are generated. All initial codes are shown in the Appendix 5, 8 and 11. Below is a sample of initial codes generating process (in the above Phase 1 sample interview data).
<table>
<tr><th>Interview Data</th><th>Codes</th></tr>
<tr><td>Every deaf or hear of hearing people use different communication ways and have different communication behavious, that brings difficulties. Some of them use sign language and some use lip reading and limited speech. Also, not all deaf and hear of hearing people can use sign language well. Even they use sign language there are different types of sign language. It is also a problem. For example,…</td><td>Code 1: Different communication methods/behaviours used by the D/HoH

Code 2: Not all D/HoH can use sign language

Code 3: Different types of sign language</td></tr>
</table></td></tr>
<tr><th>Phase 3: Searching for themes</th></tr>
<tr><td>In this phase, an initial thematic map is produced for collating codes into potential themes. The potential themes are mainly based on interview questions. A sample of initial thematic maps can be seen in Figure 5.3 (p.102).</td></tr>
<tr><th>Phase 4: Reviewing themes</th></tr>
<tr><td>In this phase, the produced initial thematic map is generated and refined. In the meantime, a final and satisfactory thematic map (developed thematic maps) is produced. In this study, each initial thematic map is generated into several developed thematic maps to discuss specific issues. For example, the initial thematic map (Figure 5.3, p.102) is generated into four developed thematic maps (Figure 5.4, p.103, Figure 5.5, p.106, Figure 5.6, p.108 and Figure 5.7, p.109).</td></tr>
<tr><th>Phase 5: Defining and naming themes</th></tr>
<tr><td>In this phase, each theme is described in detail, which includes significant quotes from participants. A sample of a specific theme ’ Diverse Communication Behaviours’ is discussed in p.104.</td></tr>
<tr><th>Phase 6: Producing the report</th></tr>
<tr><td>In this phase, a final analysis and discussion of all themes is produced, which is related back to the research questions and relevant literature. A sample of a final analysis can be seen in the section 5.2.3 User Requirements, p.110.</td></tr>
</table>

Table 5.2. An Example of Thematic Analysis

The above table shows an example of the thematic analysis process in this study. The detailed discussion of the thematic analysis process in each interview datasets (three different interviews conducted in three different design steps) are presented in the below sections:

- 5.2.2 Interview: Understand Users and User Requirements, p.101
- 5.4.1 Interview: Feedback of Alternative Potential Features, p.123
- 5.6.1 Interview: Evaluation of the Prototype, p.157

5.2 Design Step 1: Defining User Requirements

Understanding user requirements is the first step when developing an interactive product. Rogers, Sharp and Preece (2011, p.355) indicate 'a requirement is a statement about an intended product that specifies what it should do or how it should perform.' This section firstly defines the target user and task of developing the interaction design in this study and then conducts interviews to understand users and their requirements.

5.2.1 Target User and Task

'User' and 'task' are two important development focuses in a UCD process, as indicated in Chapter 3. Defining target user and target task are two necessary parts in the beginning of developing an interactive product. In the interaction design creative practice, the target users are D/HoH people and the target task is FTF communication.

a. Target User: D/HoH People

   D/HoH people are the primary target users and hearing people the secondary users for whom this interaction design (a smartphone app) is developed. This is because the purpose of conducting this interaction design creative practice is to investigate a communication solution that can be used to bridge the FTF communication gap between the D/HoH and hearing people.

b. Target Task: FTF Communication

   FTF communication is the target task of developing this interactive product (a smartphone app). This is because the preliminary study shows that there is still a further communication gap in FTF communication between D/HoH and hearing people even using SNS and communication apps. This smartphone app design aims to address this further communication gap between the D/HoH and hearing people.

5.2.2 Interview: Understand Users and User Requirements

The purpose of the interview is to explore further communication difficulties faced by the D/HoH in FTF communication and specific communication requirements needed by them. In addition, the interviews help to understand the use of SNS and communication apps in FTF communication between the D/HoH and hearing people.

The interviews are conducted via an interview document (Appendix 3), which includes four questions:

- What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)?
- What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)?
- What communication features of SNS or communication apps do you use most often when you communicate with hearing people (Deaf/Hard of Hearing people)?
- What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created?

All interview data (Appendix 4) are organised into meaningful groups and given initial codes (Appendix 5) with reference to the 6-phase thematic analysis guideline '*Phase 2: Generating initial codes*'(see p.97). In addition, the initial codes are collated into four potential themes (based on interview questions) via a thematic map with reference to the 6-phase thematic analysis guideline '*Phase 3: Searching for themes*' (see p.97). See Figure 5.3 below.

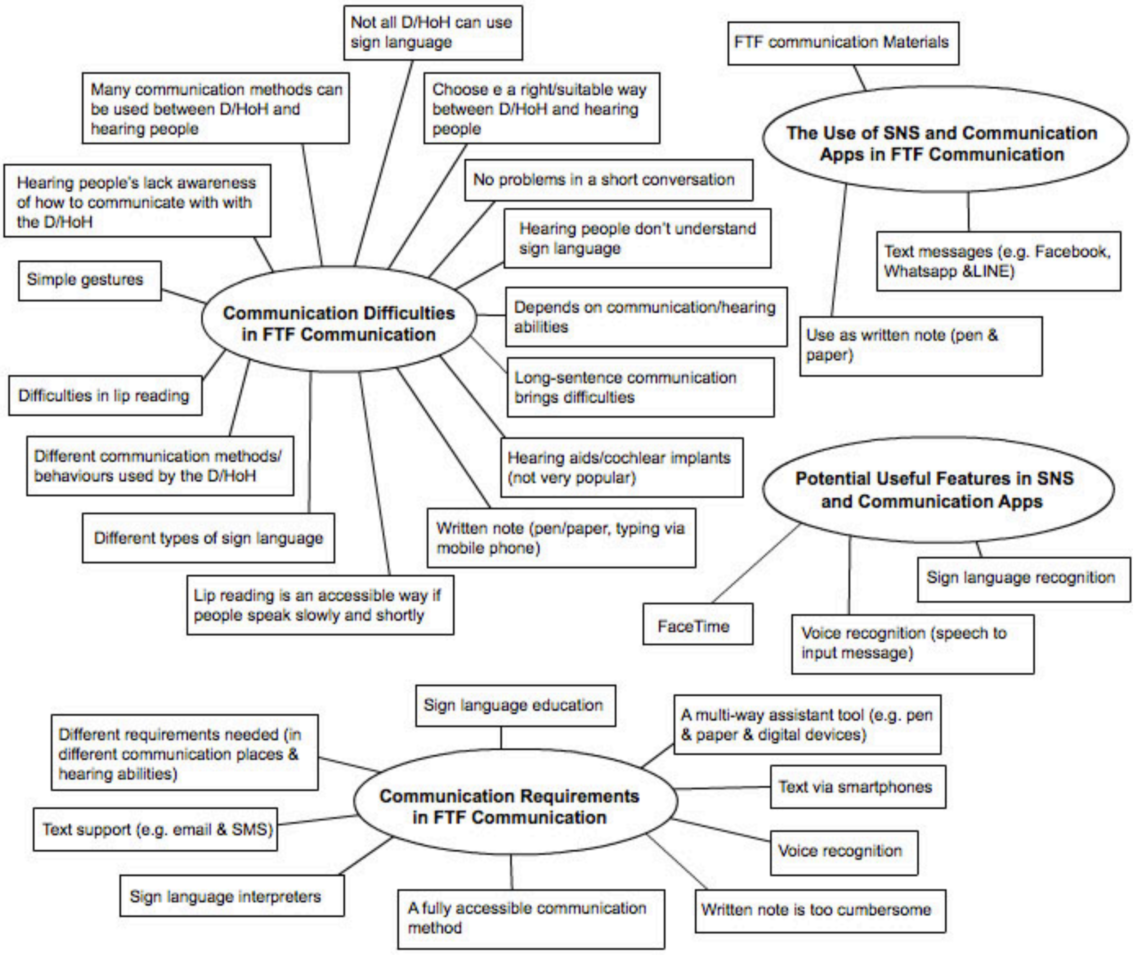


Figure 5.3. Initial Thematic Map (Understand Users and User Requirements)

The initial thematic map contains four potential themes:

- Communication Difficulties in FTF Communication
- Communication Requirements in FTF Communication
- The Use of SNS and Communication Apps in FTF Communication
- Potential Useful Features in SNS and Communication Apps

In addition, the initial thematic map is generated and refined under the above four themes. Each theme will provide a refined thematic map (developed thematic map) to discussing specific findings.

(1) Communication Difficulties in FTF Communication

This section provides a refined thematic map under the potential theme 'Communication Difficulties in FTF Communication', which refers to the 6-phase thematic analysis guideline '*Phase 4: Reviewing themes*' (see p.97). See Figure 5.4 below.

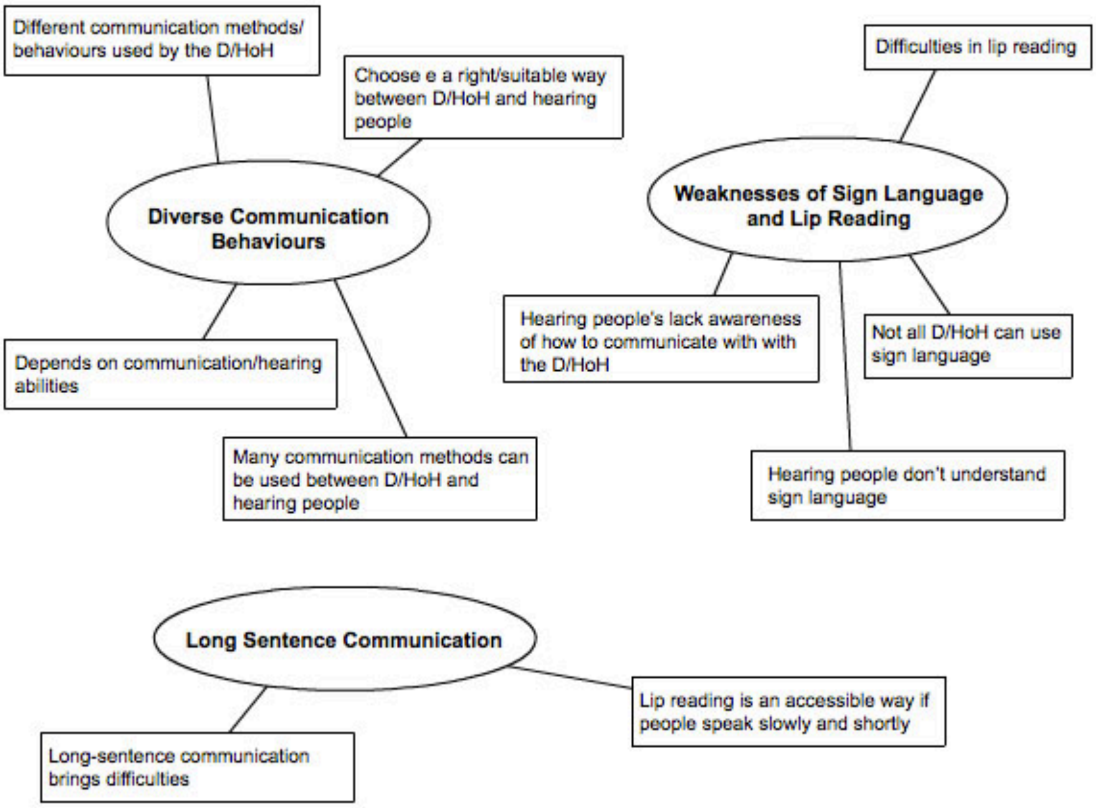


Figure 5.4. Developed Thematic Map (Communication Difficulties in FTF Communication)

The developed thematic map indicates three significant themes concerning communication difficulties that occur during FTF communication between the D/HoH and hearing people.

- Theme 1: Diverse Communication Behaviours
- Theme 2: Weaknesses of Sign Language and Lip Reading
- Theme 3: Long Sentence Communication

The three themes are discussed with reference to the 6-phase thematic analysis guideline '*Phase 5: Defining and naming themes*' (see p.101).

a. Diverse Communication Behaviours

Diverse communication behaviours are significant factors that bring difficulties to the communication between the D/HoH and hearing people. An expert interviewee said ‘every deaf or hard of hearing people use different communication ways and have different communication behavious, that brings difficulties.’ D/HoH people have different levels of hearing ability and communication skills (e.g. sign language and lip reading) that prompts diverse communication behaviours. A hearing interviewee said ‘…most important part to communicate with deaf/hard of hearing people is to find a suitable way, even I don’t know sign language I still can communicate with my deaf friends with no problem…’. Another D/HoH interviewee said ‘if hearing community have knowledge of BSL, I can talk to them directly, otherwise BSL interpreter is needed. If an interpreter is not available, I use pen and paper to write things down; use simply gesture; or type things on technology device such as mobile phone...’.

There are many communication methods that can be used in the communication between the D/HoH and hearing people. However, there is no clear way of communicating way between the D/HoH and hearing people. The communication difficulties are not only affected by D/HoH people’s hearing loss or hearing people’s lack of knowledge of sign language, it is also affected by hearing people’s limited knowledge of how to communicate and interact with D/HoH community. An expert interviewee indicated that one of the communication difficulties in FTF communication is ‘hearing people’s lack awareness of how to communicate with deaf (hard of hearing) people’.

b. Weaknesses of Sign Language and Lip Reading

The survey results in the pilot study have shown that sign language is the primary communication method used by deaf people, and limited speech with lip reading is the primary communication method used by hard of hearing people. However, most of hearing people are not familiar with the use of sign language which contributes to communication difficulties when deaf people try to communicate with hearing people via sign language. Two hearing interviewees mentioned this difficulty because they do not know sign language. Furthermore, limited capability of lip reading in D/HoH people also brings communication difficulties. A D/HoH interviewee said ‘I have difficulties with both lipreading and using my voice’. Although lip reading is a way that D/HoH people use to read speech, it is a very hard skill. An expert interviewee said ‘lip reading is hard, even a very good lip reader only can understand 42%’ and a D/HoH interview said ‘I do lip read but people always talk too fast…’. Sign language and lip reading are two primary methods used by deaf and hard of hearing people, but the interview data significantly shows that these two primary methods also bring communication difficulties between the D/HoH and hearing people. This is because hearing people have not mastered the use of sign language and D/HoH people experience difficulties with lip reading.

c. Long Sentence Communication

A D/HoH interviewee said, ‘I do lip read but people always talk too fast some time sentences is too long to read’; another D/HoH interviewee said, ‘there is no problem when we have short conversation, but it very hard to have a discussion’. An exert interviewee said, ‘most of deaf hard of hearing people can do lip read if people can speak slowly, keep talking sentences short and clear is fine. It’s very hard to lip read long sentences’. A long sentence conversation brings more difficulties than a short conversation in FTF communication between the D/HoH and hearing people. Limited and defective communication methods such as limited sign language with hand/body gestures, limited speech with lip reading and even written notes that consist of simple and short sentence communication between the D/HoH and hearing people, is not preferable to long sentences and complicated communication.

(2) Communication Requirements in FTF Communication

This section provides a refined thematic map under the potential theme ‘Communication Requirements in FTF Communication’. See Figure 5.5 below.

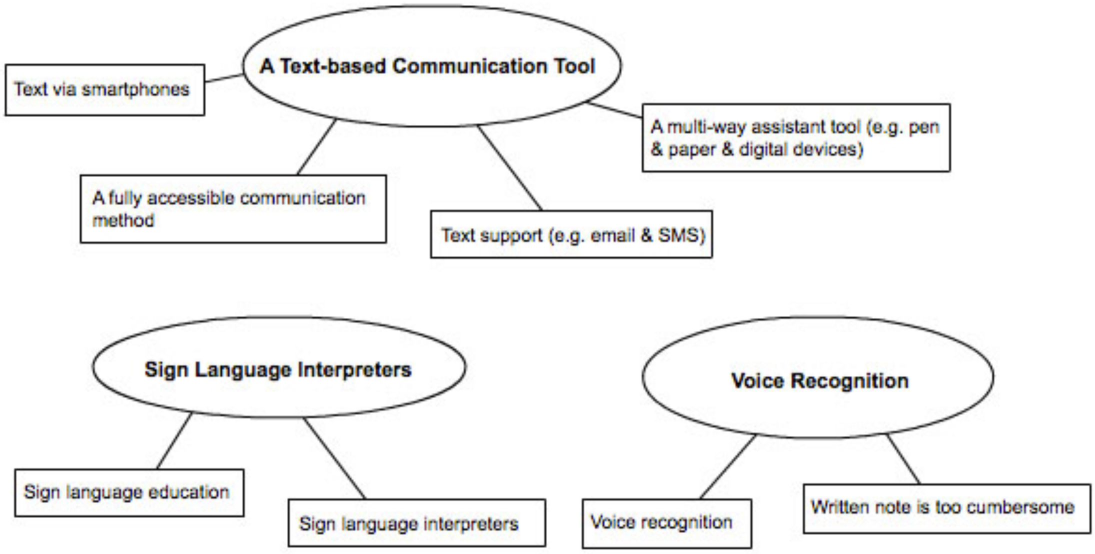


Figure 5.5. Developed Thematic Map (Communication Requirements in FTF Communication)

The developed thematic map shows three significant themes about communication requirements in the FTF communication between the D/HoH and hearing people.

- Theme 1: A Text-based Communication Tool
- Theme 2: Voice Recognition
- Theme 3: Sign Language Interpreters

a. A Text-based Communication Tool

An expert interviewee said, ‘I also use email or text to communicate with deaf/hard of hearing students. That’s a good way between deaf/hard of hearing and hearing people’. A D/HoH interviewee commented, ‘I always use written note/text message when they can’t understand me’ and a hearing interviewee said, ‘I usually talk with my deaf friend via text on my phone, I use facebook and Line.’ Text-based communication is the most frequently used communication method/form between the D/HoH and hearing people in FTF communication when other communication methods (e.g. sign language, limited speech with lip reading and speech) are not available. For example, D/HoH and hearing people can use written notes via a pen and a paper or text typing via digital devices in FTF communication. Text-based communication is the only accessible readily communication methods between the D/HoH and hearing people without any other supports. The interview data shows a text-based communication tool is needed to support the FTF communication between the D/HoH and hearing people.

b. Voice Recognition

All hearing interviewees indicated that speech-to-text translation (voice recognition) is a communication requirement when they communicate with the D/HoH via their phones. A hearing interviewee said, ‘I normally use a pen and a paper or typing on my phone when communicate with deaf people. Speech to input text may be a good way when I use my phone’. A D/HoH interviewee remarked ‘I feel they find writing things down too cumbersome for them. Voice recognition may be a good way.’ As a text-based communication tool is one of communication requirements raised by the interviewees, voice recognition can be used by hearing people as a way to facilitate the process of text typing on smartphones.

c. Sign Language Interpreters

A sign language interpreter is a typical solution to bridge the communication gap between the D/HoH and hearing people. The interviewees commented on this communication requirement that sign language interpreters are not always available for FTF communication between the D/HoH and hearing people. A D/HoH interviewee said, ‘Translator is a prefect way, but s/he can't be with me all the time.’ An expert interviewee indicated digital devices have become an important tool to assist the communication between the D/HoH and hearing people, but sign language interpreters are still needed when having a long conversation. Also another expert interviewee said ‘in meetings or conferences sign language interpreters are still needed’.

(3) The Use of SNS and Communication Apps in FTF Communication

This section provides a refined thematic map under the potential theme ‘The Use of SNS and Communication Apps in FTF Communication’. See Figure 5.6 below.

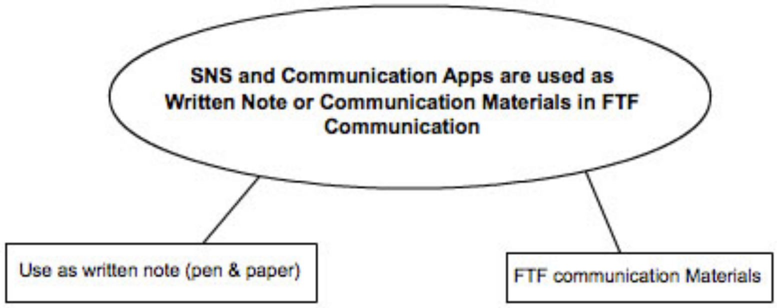


Figure 5.6. Developed Thematic Map (The Use of SNS and Communication Apps in FTF Communication)

The developed thematic map shows one significant theme about the use of SNS and communication apps in the FTF communication between the D/HoH and hearing people.

- Theme 1: SNS and Communication Apps are used as Written Note or Communication Materials in FTF Communication

  Text message (e.g. IM and email) is the most often used communication feature in SNS and communication apps that D/HoH and hearing people use to communicate with each other. All interviewees mention it. Although SNS and communication apps are not designed for FTF communication, D/HoH people still use them in FTF communication. A D/HoH interviewee said, 'I sometime send text messages to friends who are next to me or just in front of me. I also use my phone as a note when I don't have pen and paper'. In addition, an expert interviewee said, 'sometime, I only read information on Facebook, I show my Facebook posts when I talk to people in person'. SNS content and information can be used as communication materials in FTF communication. The interview data shows that SNS and communication apps can be used as written note or communication materials in the FTF communication between the D/HoH and hearing people.

(4) Potential Useful Features in SNS and Communication Apps

This section provides a refined thematic map under the potential theme 'Potential Useful Features in SNS and Communication Apps'. See Figure 5.7 below.

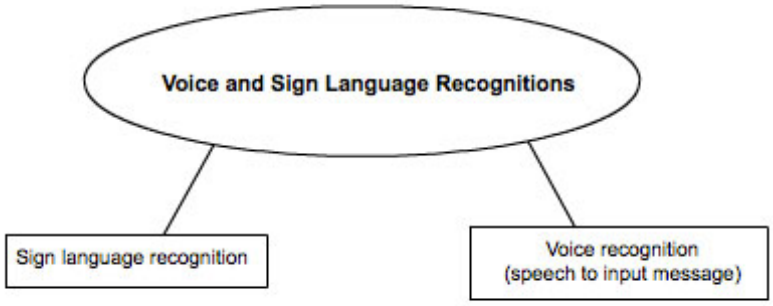


Figure 5.7. Developed Thematic Map (Potential Useful Features in SNS and Communication Apps)

The developed thematic map shows one significant theme about the potential useful features in SNS and communication apps that can be used to support FTF communication between the D/HoH and hearing people.

- Theme 1: Voice and Sign Language Recognitions

  All interviewees mentioned about voice recognition (speech-to-text or speech-to-sign) and some interviewees commented that sign language recognition (sign-to-text or sign-to-speech) could be a useful feature if it could be added into SNS and communication apps. A D/HoH interviewee said, 'Voice recognition, hearing people can keep their speech language naturally'. Another D/HoH interviewee said, 'people speak to their phone and I can immediately read what they speak in text on my phone through voice to text translation'. A hearing interviewee mentioned about Siri (the iPhone voice recognition) and remarked that it could be used by hearing people to input text messages via speech. Moreover, a D/HoH interviewee made a comment about sign language recognition and said 'Sign to text support, then I can use sign language'. Voice and sign language recognition are also the existing D/HoH communication solutions as discussed in Chapter 2. In addition, the interviewees mentioned that FaceTime (a iPhone video-based communication app) might be a useful feature, but it is not considered here because the potential useful features are specifically for FTF communication in person.

5.2.3 User Requirements

According to '*Phase 6: producing the report'* in the 6-phase guideline of thematic analysis (see p.101), this section gives a final analysis of the interview data relating back to the research questions and relevant literature. The target user and task of designing this smartphone app have been defined as D/HoH people and FTF communication. This smartphone app design aims to provide a communication solution that can be used to bridge the FTF communication gap between the D/HoH and hearing people.

The most significant difference between this smartphone app and other SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) is that this smartphone app is specifically designed for FTF communication, whilst others are mainly for non-FTF communication. Chapter 2 has shown that physical interaction with nonverbal messages is a significant element in FTF communication, which is excluded from CMC. The concept of this smartphone app is to provide an innovative communication method that uses CMC as part of FTF communication. Based on the design concept, physical interaction with nonverbal messages (e.g. eye contact and facial expressions) will be an important design aspect in the consideration of user requirements.

The interview data has shown that: a. diverse communication behaviours, b. weaknesses of sign and lip reading and c. long sentence communication, are three main difficulties in FTF communication between the D/HoH and hearing people. Furthermore, the interview data shows that a text-based communication tool, voice recognition and sign language interpreters are the main three communication requirements in FTF communication between the D/HoH and hearing people. In addition, the interview data shows SNS and communication apps are used for written notes or communication materials in FTF communication between the D/HoH and hearing people, whilst voice and sign language recognitions are two useful features (if these could be added into SNS and communication apps).

According to the relevant literature review in Chapter 2 and the above interview data, there are two user requirements defined in this study for developing this smartphone app: a. A solution to support and integrate different communication behaviours/methods that can be used in FTF communication between the D/HoH and hearing people and b. A solution to conduct and incorporate physical interaction with nonverbal messages in FTF communication between the D/HoH and hearing people.

a. A solution to support and integrate different communication behaviours/methods in FTF communication between the D/HoH and hearing people

   Deaf, hard of hearing and hearing people use different communication methods that lead to diverse communication behaviours. The diverse communication behaviours are the cause of difficulties in FTF communication between the D/HoH and hearing people. This smartphone app design aims to provide a solution in FTF communication that supports and integrates different communication methods used by the D/HoH and hearing people. This solution will allow the D/HoH and hearing people to use the communication methods they normally use. For example, hearing people still can use speech. This smartphone app is not designed to replace the primary communication methods used by the D/HoH and hearing people, but be an assistant communication tool to support the primary communication methods used by the D/HoH and hearing people. When the primary communication methods are not accessible this smartphone app provides an assistive communication solution.

b. A solution to conduct and incorporate physical interaction with nonverbal messages into the FTF communication between the D/HoH and hearing people

   CMC and FTF communication are two different types of communication. Chapter 2 has shown that physical interaction with nonverbal messages is a significant element in FTF communication. However, physical interaction with nonverbal messages is absent in the use of CMC (e.g. SNS and communication apps). This smartphone app design aims to provide an innovative method of communication that can prompt users to conduct and incorporate physical interaction with nonverbal messages in FTF communication when using this smartphone app. The design concept of this smartphone app is to use CMC as a communication solution to assist FTF communication between the D/HoH and hearing people.

These are two main user requirements for designing this smartphone app. The next section will provide alternative potential features that can match these user requirements.

5.3 Design Step 2: Providing Alternatives

There are two user requirements defined for developing this smartphone app:

- A solution to support and integrate different communication behaviours/methods in FTF communication between the D/HoH and hearing people

- A solution to conduct and incorporate physical interaction with nonverbal messages in FTF communication between the D/HoH and hearing people

Top-down and bottom-up are two strategies of thinking and conducting a development process. The top-down approach in this study can be understood as a development process that starts by understanding user requirements; and bottom-up approach can be understood as a development process that starts by understanding potential approaches/technologies. The user requirements have been defined in the last section. This section reviews and analyses potential approaches/technologies that can be used to support the development of this smartphone app. Finally, this section provides alternative potential features of this smartphone app for achieving the user requirements.

5.3.1 Potential Approaches/Technologies for this Smartphone App Development

In order to achieve the two user requirements, potential approaches/technologies are reviewed and analysed for developing this smartphone app. The review and discussion of potential approaches/technologies include three aspects: a. Ways of Inputting Messages, b. Ways of Transmitting Messages and c. Ways of Prompting Physical Interaction with Nonverbal Messages.

Ways of inputting and transmitting messages are two essential parts for communicating when using this smartphone app. This smartphone app aims to act as an accessible communication medium between the D/HoH and hearing people that allows them to use different ways to express information. In addition, ways of prompting physical interaction with nonverbal messages is the most significant design feature as the app is specifically designed for FTF communication.

(1) Ways of Inputting Messages

Text typing is a common way used to input messages on smartphones. Text typing is designed as a primary way for inputting messages in this smartphone app. There are three reasons for this:

- The pilot study shows text messages/written notes (on paper, cell phone or computer) is one of the primary communication methods/solutions used between the D/HoH and hearing people when sign language interpreters are not available.

- The design step 1 shows a text-based communication tool is one of communication requirements needed in FTF communication between the D/HoH and hearing people.

- The previous discussion of D/HoH communication possibilities and methods shows that written note/text is the only communication method/form that can be readily used between the D/HoH and hearing people in FTF communication. This is due to there being limitations in the methods of limited speech, gesture-based and voice-based nonverbal messages.

For these reasons, text is designed as the main communication medium used in this smartphone app to support and integrate different communication methods used by the D/HoH and hearing people. Ideally, common and native communication methods (sign language and speech) used by the D/HoH and hearing people should be translated into text for bridging the communication gap between the D/HoH and hearing people. Sign language and voice recognition are two technologies that support sign language-to-text and speech-to-text translations. Voice recognition technology is designed to be involved as part of the inputting message function in this smartphone app because existing voice recognition is a highly developed technology. In contrast, sign language recognition technology is not incorporated because existing sign language recognition is still an incomplete and limited technology.

(2) Ways of Transmitting Messages

Ways of transmitting messages is another important aspect of designing this smartphone app especially as it aims to act an as accessible communication medium (tool) in FTF communication between the D/HoH and hearing people. As this smartphone app is specifically designed for FTF communication, the ways of transmitting messages in this smartphone app may be different to common communication apps.

Traditional SMS transmission (GSM[14]) and Internet transmission (3G/4G and Wifi) are two existing connection technologies for transmitting messages between two or more smartphones that are typically used in common communication apps. Bluetooth and near field communication (NFC) are two other wireless transmission technologies that support data transmission over short distances. Table 5.3 below compares these four transmission technologies in four transmission conditions: a. Short-distance Transmission Only, b. Payment Requirement, c. Phone Number/Account Requirement and d. Reception Requirement.

	Transmission Conditions			
Transmission Technologies	Short-distance Transmission Only	Payment Requirement	Phone Number/Account Requirement	Reception Requirement
GSM (Traditional SMS)		√	√	√
3G/4G/Wifi (Internet)		√*	√	√
Bluetooth	√			
NFC	√			
* Free Wifi is also available in some places.				

Table 5.3. Comparison of Transmission Technologies

Transmission distance is the main difference between GSM/3G/4G/Wifi and Bluetooth/NFC. Bluetooth and NFC only support short-distance transmission. For example, Bluetooth 4.0 supports up to a 50 meter transmission distance, whilst NFC supports less than a 4 centimetres transmission distance or typically transmits data by

[14] GSM is a global system for mobile communications, which is a standard to describe protocols for second-generation (2G) digital cellular networks used by mobile phones.

simply touching two devices. In addition, payment, phone number/account and reception requirements are further differences. Bluetooth and NFC are allowed to transmit messages without these required conditions. Recently, (2014) most smartphones support Bluetooth, whilst NFC is only available on recent high-end smartphones.

According to the above comparison of the four transmission technologies, Bluetooth and NFC seem to be potential connection technologies that can be applied in this smartphone app for transmitting messages. The reason for this is because this smartphone app is specifically designed for FTF communication and Bluetooth and NFC are specifically used for a short distance transmission. Furthermore, the three transmission requirements (payment, phone number/account and reception requirements) are not required in the use of Bluetooth and NFC and this could make message transmission easier.

(3) Ways of Prompting Physical Interaction with Nonverbal Messages

Physical interaction with nonverbal messages is a significant element in FTF communication, which is missing in CMC. People always concentrate on their smartphone screens and ignore physical interaction with nonverbal messages when they are communicating via CMC (SNS and communication apps). This smartphone app aims to design a specific method that can prompt users to combine physical interaction with nonverbal messages in communication when they are using this smartphone app. For example, a design that can encourage or force users to shift their concentration from their smartphone screens to the person they are communicating with.

Transmitting messages via NFC could be used as a way to prompt users to combine physical interaction with nonverbal messages in FTF communication between the D/HoH and hearing people. The reason for this is because NFC technology provides a specific way to transmit data by bringing two phones in close proximity to each other or simply by touching two phones. This specific action leads to physical interactions between two phone holders when transmitting messages.

According to the above discussions of potential approaches/technologies in the following three aspects: a. Ways of Inputting Messages, b. Ways of Transmitting Messages and c. Ways of Prompting Physical Interaction with Nonverbal Messages, there are three initial design concepts raised for developing this smartphone app:

- Text typing and voice recognition will be designed as two ways to input messages in this smartphone app.

- NFC connection technology will be designed as a way to transmit messages in this smartphone app.

- The action of transmitting messages via NFC will be designed to conduct physical interaction with nonverbal messages in this smartphone app.

5.3.2 Alternatives Potential Features of this Smartphone App

According to the above three initial design concepts, this section provides alternative potential features of this smartphone app. The alternative potential features include two parts: a. Ways of Inputting Messages and b. Way of Transmitting Messages and Conducting Physical Interaction.

(1) Ways of Inputting Messages

Text typing and voice recognition are selected as the two ways of inputting messages used in this smartphone app. Chapter 2 has shown that speed of input in CMC is a significant difference between CMC and FTF communication since text typing in CMC takes longer time than speech in FTF communication. In this smartphone app the way of inputting messages is designed to diminish this difference. Voice recognition is a technique that allows hearing people to input messages quicker via speech, but it is not an accessible way for the D/HoH. This smartphone app design aims to provide a quicker and easier way for the D/HoH to input messages by increasing the speed of text typing.

There are two potential features of inputting messages provided in this smartphone app:

- Prediction Supports in Text Typing and Voice Recognition
- Categorisation Supports in Text Typing

a. Prediction Supports in Text Typing and Voice Recognition

   Predictive message is a specific feature designed in this smartphone app to support text typing and voice recognition. The predictive message feature helps users input messages easily and quickly by giving predictive words and sentences. Predictive words are offered when the first few letters of a word are being typed, whilst predictive sentences are offered when the first few words of a sentence are being typed. The predictive word and sentence database is generated by recording the most frequently used messages in this smartphone app and used to improve its predictive capabilities. See Figure 5.8 below.

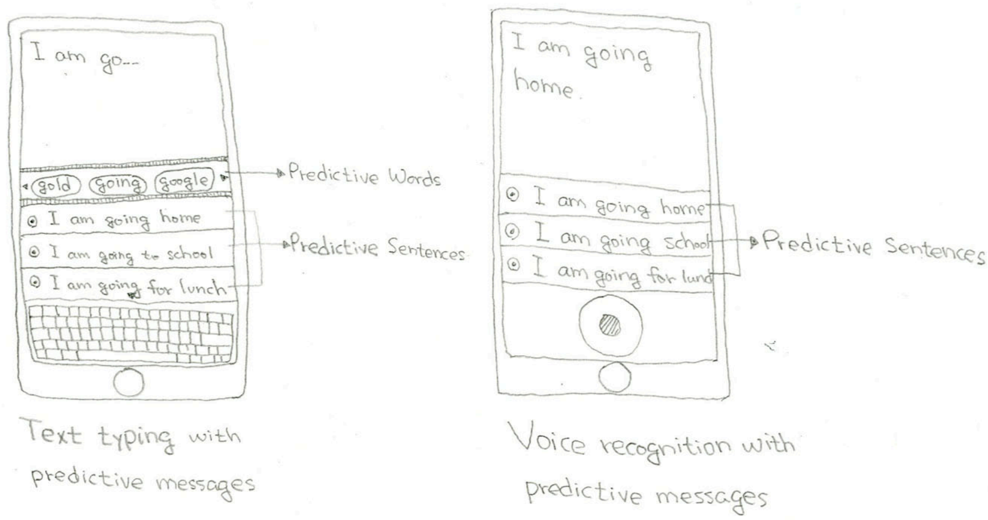


Figure 5.8. Prediction Supports in Text Typing and Voice Recognition

b. Categorisation Supports in Text Typing

Categorisation support is another feature designed in this smartphone app to facilitate the communication process. The categorisation support feature allows the user to organise the predictive message database into different categories (e.g. Leisure, School, Business, Favourite and All). Through this feature, users can select specific predictive message categories to increase the accuracy of the predictive messages to match their specific communication topics. See Figure 5.9 below.

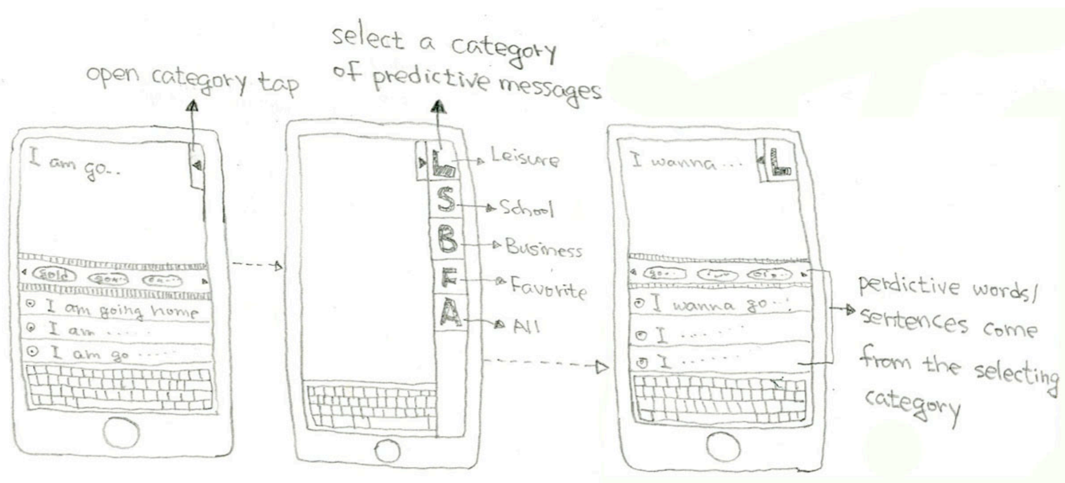


Figure 5.9. Categorisation Support

(2) Ways of Transmitting Messages and Conducting Physical Interaction

Physical interaction with nonverbal messages is a significant element in FTF communication. This smartphone app seeks to provide a specific way to transmit messages between users that can prompt users to conduct physical interaction with nonverbal messages during the use of this smartphone app.

There are three potential features of transmitting messages provided in this smartphone app that can be associated with conducting physical interaction with nonverbal messages:

- Communication via a Single Phone without Connection Technology
- Communication via Two Phones with NFC Connection Technology
- Communication via Two Phones with Real-time Text Transmission Support

a. Communication via a Single Phone without Connection Technology

Communication via a single phone without connection technology is a feature that aims to prompt users to conduct physical interaction with nonverbal messages during communication. Communication via a single phone means that users use only one phone to communicate with each other. Users need to 'show' messages to the people they communicate with instead of 'sending' messages. Showing messages via a single phone without connection technology is more direct and intuitive than sending messages via two phones through connection technologies (e.g. GSM, 3G/4G and Wifi), especially when people are close to each other. The significant concept of this feature is the action of 'showing messages' that allows prompting users to conduct physical interaction with nonverbal messages. People shift their attention from their phone screens to the people they communicate with at the moment when people are executing the action of showing messages.

Table 5.4 below shows a scenario that how the D/HoH communicate with hearing people through this feature.

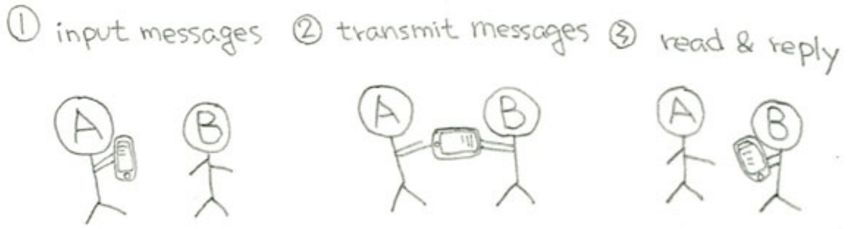
Scenario
Person A: D/HoH People Person B: Hearing People

Step 1: Person A inputs messages via this app on his/her smartphone. **Step 2:** Person A shows messages to Person B via his/her smartphone. **Step 3:** Person B reads and replies to messages via Person A's smartphone.

Table 5.4. Communication Scenario using a Single Phone

b. Communication via Two Phones with NFC Connection Technology

Communication via two phones with NFC connection technology is another feature designed in this smartphone app that aims to prompt users to conduct physical interaction with nonverbal messages. Communication via two phones means that users use two phones to communicate (transmit messages from one phone to another via NFC connection technology). The concept of this feature is the action of two phones touching or bringing two phones into close proximity via NFC. This concept is similar to the feature (showing messages via a single phone without using connection technology) and can also prompt users to conduct physical interactions with nonverbal messages during communication. Physical interaction with nonverbal messages automatically occurs when people are touching their phones or bringing their phones into close proximity.

Table 5.5 below shows a scenario that how D/HoH communicate with hearing people through this feature.

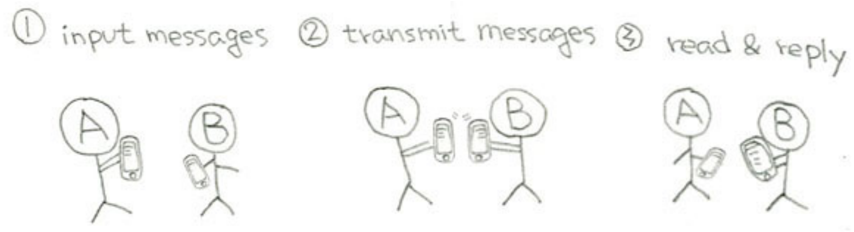
Scenario
Person A: D/HoH People Person B: Hearing People
 **Step 1:** Person A inputs messages via this app on his/her smartphone. **Step 2:** Person A transfer messages from his/her smartphone to Person B's Smartphone via NFC (two phones touching or in close proximity). **Step 3:** Person B reads and replies to messages via his/her own smartphone.

Table 5.5. Communication Scenario using Two Phones

c. Communication via Two Phones with Real-time Text Transmission Support

Speed of input in CMC is a significant difference between CMC and FTF communication. This feature aims to reduce the time gap between CMC (non-real time) and FTF (real-time) communication. Real-time text transmission is a way that allows text to be instantly transmitted as it is being typed. The recipient can immediately read the message whilst it is being typed by the other person, without having to wait. In the meantime, the recipient can type their reply text whilst reading the incoming message.

Figure 5.10 below shows how D/HoH communicate with hearing people through this feature.

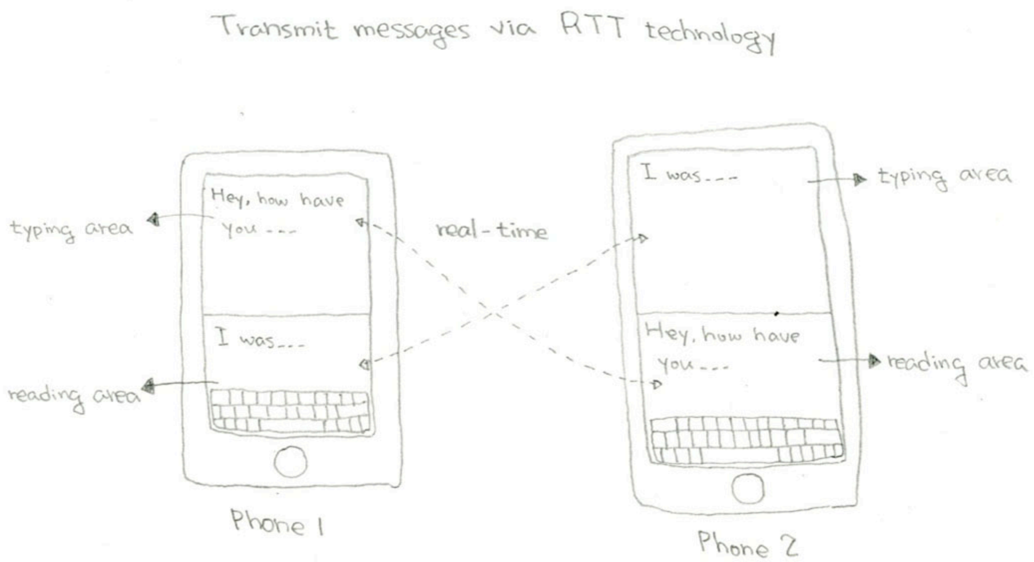


Figure 5.10. Real-time Text Transmission

The above illustration highlights the design concepts and presents the potential alternative features. These potential alternative features will be tested via the method of interview, which will be discussed in the next section.

5.4 Design Step 3: Alternatives, Testing and Deciding

The alternative potential features of this smartphone app have been presented through paper-based sketches. This section conducts interviews to test the concepts of these potential features. In addition, this section discusses and determines suitable features to be designed in this smartphone app.

5.4.1 Interview: Feedback of Alternative Potential Features

The purpose of the interview is to test the concepts of the provided potential features and ascertain feedback from the target users. The interviews were conducted via an interview document (Appendix 6). The three main questions are set out below:

- What do you think about the alternative potential features of this smartphone app?
- Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication?
- Other suggestions for this app?

All interview data (Appendix 7) are organised into meaningful groups and given initial codes (Appendix 8). In addition, the initial codes are collated into three potential themes (based on interview questions) via a thematic map. See Figure 5.11 below.

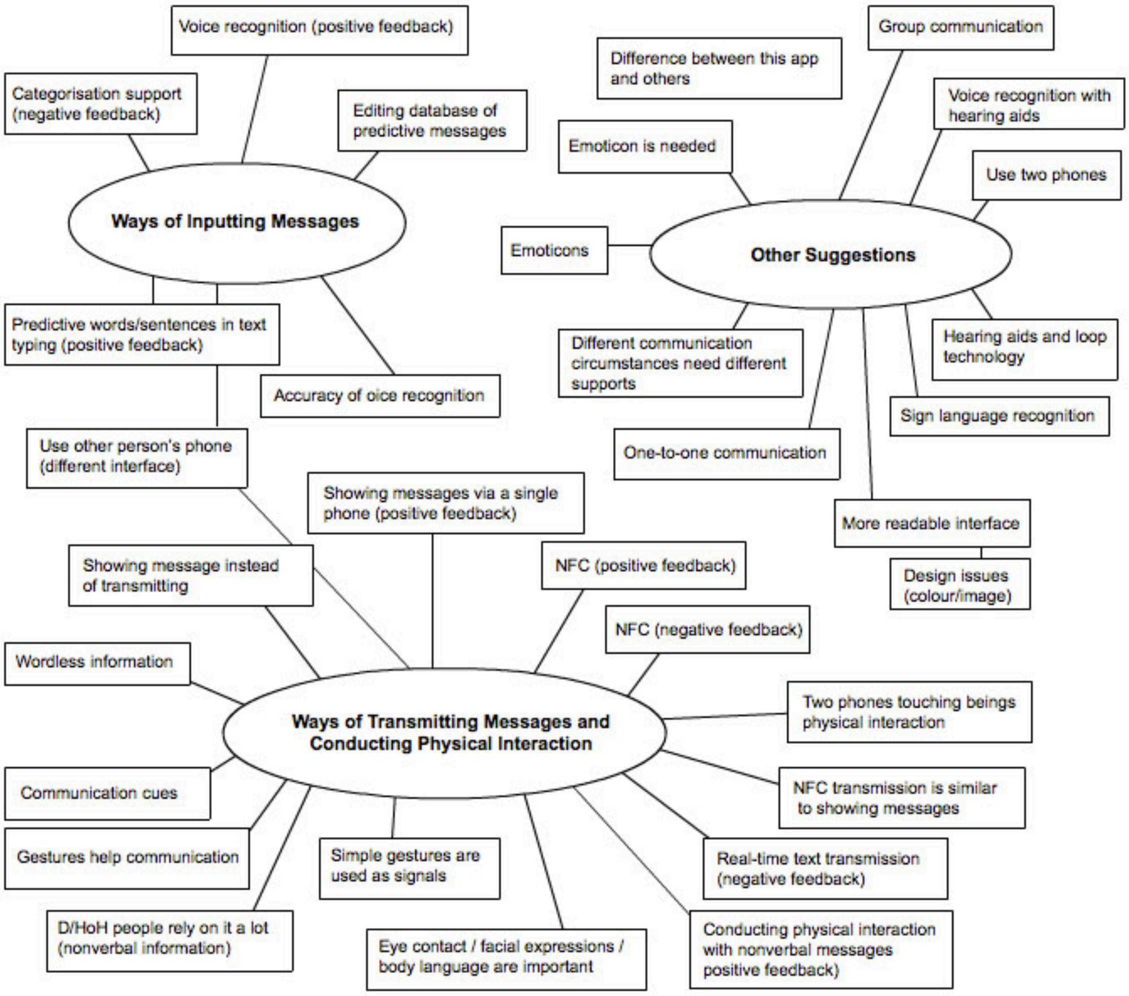


Figure 5.11. Initial Thematic Map (Feedback of Alternative Potential Features)

The initial thematic map contains three potential themes:

- Ways of Inputting Messages
- Ways of Transmitting Messages and Conducting Physical Interaction
- Other Suggestions

In addition, the initial thematic map is generated and refined under the above three themes. Each theme will provide a refined thematic map (developed thematic map) to discussing specific findings.

(1) Ways of Inputting Messages

This section provides a refined thematic map under the potential theme 'Ways of Inputting Messages'. See Figure 5.12 below.

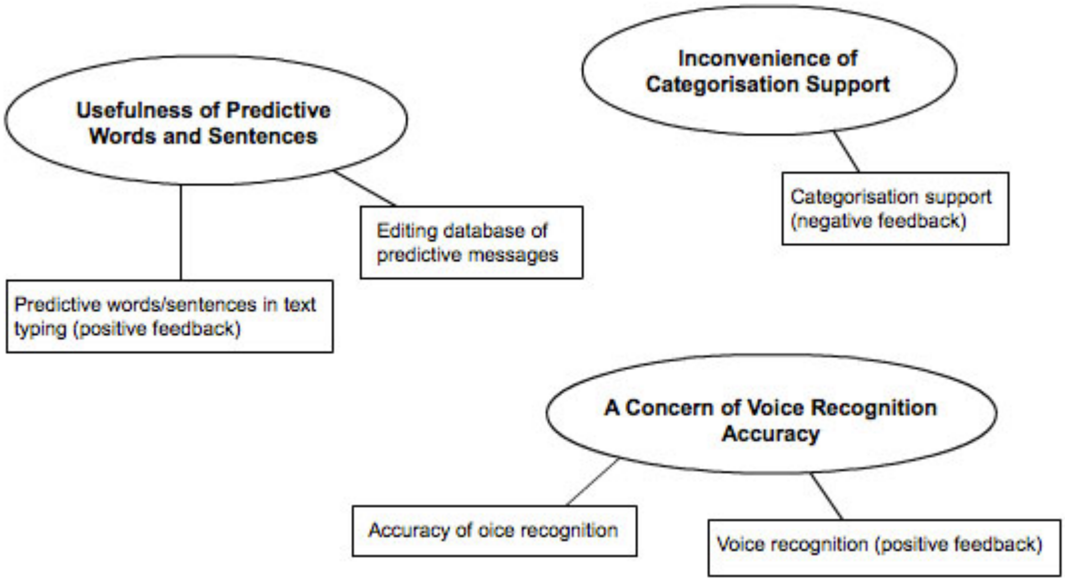


Figure 5.12. Developed Thematic Map (Ways of Inputting Messages)

The developed thematic map shows three significant themes about the provision of the two featured methods of inputting messages (a. prediction supports in text typing and voice recognition and b. categorisation supports in text typing):

- Theme 1: Usefulness of Predictive Words and Sentences
- Theme 2: Inconvenience of Categorisation Support
- Theme 3: A Concern of Voice Recognition Accuracy

a. Usefulness of Predictive Words and Sentences

The interviewees agreed that text typing (for D/HoH users) and voice recognition (for hearing users) are two useful features of inputting messages used in this smartphone app, especially the support of predictive words and sentences. An expert interviewee said, 'Yes, I do agree text typing and voice recognition are two useful ways…I think the predictive text suggestion is a very good feature'. A

D/HoH interviewee said, ‘It’s useful when I can’t use sign language. I think the predictive words and sentences support is great’. In addition, a hearing interviewee said, ‘I think voice recognition is a useful way when I need to communicate with deaf/hard of hearing people…I can use speech instead of type it’s a quicker way…’.

b. Inconvenience of Categorisation Support

Most of the interviewees indicated the feature of categorisation supports in text typing is unnecessary and redundant. An expert interviewee said ‘I am not sure about the categorisation support feature. I feel it is complicated’, another expert interviewee said ‘I don’t think categorizing predictive messages in different categories is necessary’ and a hearing interviewee said, ‘The original idea is good. But, I feel it’s not very convenient to choose a category of predictive message database everytime when I input messages, especially shifting from one category to another during typing’. However, a D/HoH interviewee indicated some part of this feature is useful, as he said, ‘…you can edit database of predictive messages that would be good, but people don’t need to select a category when they type it automatically, make it simple…’.

c. A Concern of Voice Recognition Accuracy

The interviewees indicated a concern about the accuracy of the voice recognition feature. A hearing interviewee said, ‘…the only concern I have is the accuracy of voice recognition. Voice recognition on my iPhone works quite good for a single word or a simple or short sentence but it becomes terrible sometimes when I try to speak a long sentence’. In addition, the interviewees indicated voice recognition might not work well in noisy environments. A D/HoH said, ‘voice recognition is not as accurate as they’d like so the message come up incorrectly. It does not help when you’re in noise places…’.

(2) Ways of Transmitting Messages and Conducting Physical Interaction

This section provides a refined thematic map under the potential theme 'Ways of Transmitting Messages and Conducting Physical Interaction'. See Figure 5.13 below.

Figure 5.13. Developed Thematic Map (Ways of Transmitting Messages and Conducting Physical Interaction)

The developed thematic map shows five significant themes about the provided three features of transmitting messages (a. communication via a single phone without connection technology, b. communication via two phones with NFC connection technology and c. communication via two phones with real-time text transmission support):

- Theme 1: Importance of Physical Interaction with Nonverbal Messages
- Theme 2: Usefulness of Showing Messages via a Single Phone

- Theme 3: A Concern of Showing Messages via a Single Phone
- Theme 4: Redundancy of Transmitting Messages via NFC
- Theme 5: Uselessness of Real-time Text Transmission

a. Importance of Physical Interaction with Nonverbal Messages

The interviewees indicated physical interaction with nonverbal messages (e.g. eye contact, gestures) is a very important part in FTF communication between the D/HoH and hearing people. An expert interviewee said, '…gestures can help communication smoothly'. A D/HoH interviewee said, 'they are part of my language I use them all the time, even people don't know sign language they can understand a bit through my gestures'. The interviewees gave positive feedback with regard to the concept of conducting physical interaction with nonverbal messages. An expert interviewee said, 'I do agree the idea of conducting physical interaction is very important for deaf communication, deaf people rely on facial expressions a lot…'. A D/HoH interviewee said, '…physical interaction and nonverbal messages is quite important for us, especially to see hearing people's face and their mouth…'.

b. Usefulness of Showing Messages via a Single Phone

An expert interviewee said, '…the best part of this app is, this app is designed for face-to-face communication…'. The interviewees agreed that showing messages via a single phone without using connection technology (e.g. 3G and Wifi) is an easy and quick way to express information when people are close to each other. A D/HoH interviewee said 'It is truly helpful to communicate with hearing people. And also easily to show the screen to them…'. An expert interviewee said, 'Written notes (pen & paper) is a common way used between deaf or hard of hearing and hearing people when sign language is not available. Showing messages via a phone is like written notes, but provide an easier way…'.

c. A Concern of Showing Messages via a Single Phone

Although the interviewees indicated that showing message via a single phone is a useful feature, they were concerned that it might be inconvenient when replying to messages through other people's phones. This is a concern because the inputting interface might be different to their own phone. A D/HoH interviewee said, 'Sometime other people that I share my phone with to convey conversation, they tends not able to use my phone well as their phones are different to mine so their response slower than they would've used their phone. We end up use our own phone…'. In addition, personal predictive messages are not supported when using other people's phones, as a D/HoH interviewee said, '…personal predictive words and sentences are not available on other person's phone. I also don't want other people see my person predictive messages.'

d. Redundancy of Transmitting Messages via NFC

The interviewees agreed that transmitting messages via two phones through NFC connection technology (two phones touching) could prompt people to physically interact with each other in FTF communication. However, the interviewees indicated that this NFC transmission feature is not necessary in FTF communication. A D/HoH interviewees said, 'It is no need to do this, … I would like to send massages directly or see the screen is quicker. This function looks like not necessary'. A hearing interviewees said, 'When two people are close I think NCF is unnecessary. They can just show messages to each other'. The interviewees indicated the 'showing' messages feature on this smartphone app could replace the 'sending (transmitting)' messages feature when people are close to each other.

e. Uselessness of Real-time Text Transmission

The interviewees agreed that this feature could reduce the time gap between CMC and FTF communication, but they indicated that the time issue might not be a serious issue in FTF communication. An expert interviewee said, 'do we really need it? When you talk with a people who stand right in front of you, imagine it…I don't think real-time text transmission is needed...'. The interviewees indicated real-time text transmission is not a useful feature. An expert interviewee said, 'In a face-to-face communication, people should look at each other, not look at their screens. Real-time text feature might force people looking at their phone screens all the time.' The interviewees commented that real-time text transmission feature would reduce opportunities to undertake physical interaction because people's eyes would look on their phone screens. In addition, a D/HoH interviewee said, '…sometime you type away and then realise you do not want to show this particular message to someone (slip up) and this could produce an awkward situation...'.

(3) Other Suggestions

This section provides a refined thematic map under the potential theme 'Other Suggestions'. See Figure 5.14 below.

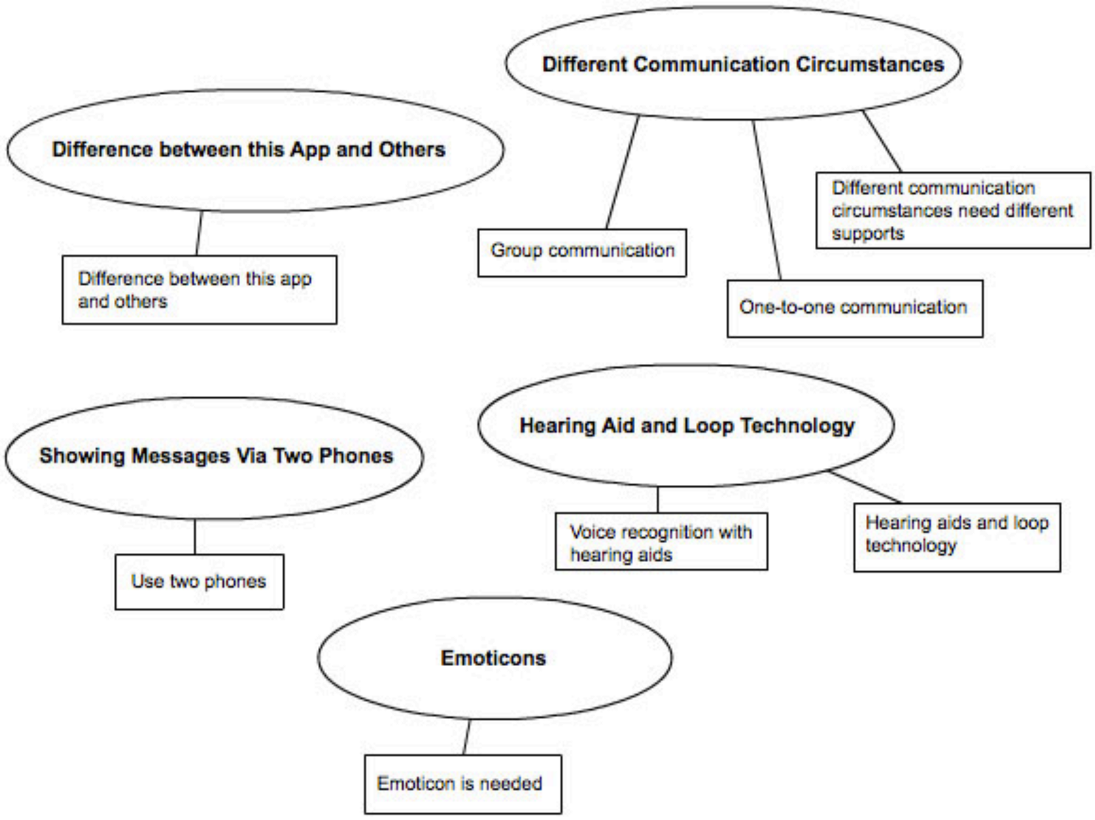


Figure 5.14. Developed Thematic Map (Other Suggestions)

The developed thematic map shows five significant themes with regard to other suggestions for this smartphone app:

- Theme 1: Difference between this App and Others
- Theme 2: Different Communication Circumstances
- Theme 3: Showing Messages Via Two Phones
- Theme 4: Hearing Aid and Loop Technology
- Theme 5: Emoticons

a. Difference between this App and Others

The interviewees inquired about the differences between this smartphone app and other apps. A hearing interviewee said, ‘Some apps also support predictive words when I am typing. Also the voice recognition is not a new function.’ An expert interviewee commented, ‘what is the difference between this app or I just use a note app to show message?’. The interviewees said that there is no clear difference between this app and others as they already use very similar functions via other apps (e.g. SMS and note). An interviewee said ‘I can just type SMS messages and show to my friends instead of send it’. The interviewees expected further development of this smartphone app. For example, an interviewee suggested that a more readable interface is needed to support the showing messages feature.

b. Different Communication Circumstances

The interviewees indicated different communication circumstances when using this app such as in a one-to-one conversation and a group communication. They indicated that the way of showing/transmitting messages designed in this app, seems to only support one-to-one communication. An expert interviewees said, ‘If I am in a group communication for example do I need to show messages to each people one by one or do I have to touch all people’s phone when I use NFC to transmit messages? it’s inconvenient!...’. The interviewees indicated D/HoH people need different kinds of communication support for different circumstances, which includes communicating in difference places. For example, voice recognition becomes useless in noisy environments.

c. Showing Messages Via Two Phones

Although the interviewees indicated that transmitting messages via two phones with NFC technology is unnecessary, they also said that using two phones could be a solution to solve the concern of different inputting interfaces when using another person's phone (communication via a single phone). A D/HoH interviewee said, 'use two phones transmitting messages via NFC could be a way to solve the problem that people can use their own phones'. In addition, the interviewees suggested that showing messages via two phones without connection technology could be better way to make use of advantages of the ways of transmitting messages designed in this app (a. communication via a single phone without connection technology and b. communication via two phones with NFC connection technology).

d. Hearing Aid and Loop Technology

The interviewees mentioned hearing aids and loop technology. They suggested that it could be combined with the voice recognition feature in this smartphone app. A D/HoH interviewee said, 'If it can connect with my hearing aids I think it is good then I can hear what they are saying if it is not clear I also can read text translated from voice recognition'. The interviewees furthermore indicated that if this app could combine with hearing aids and loop technology, it could be used to support different types of communication. An expert interviewee said, 'It also could support group communication e.g. a hearing person talk to their phone via voice recognition and then all deaf people can hear through their hearing aids. Or solve the problem when communicate in a noisy place'.

e. Emoticons

The interviewees commented that an emoticon could be part of text typing in this smartphone app. A hearing interviewee said, 'I use sticker messages a lot on

LINE and Facebook. Some stickers also contain words e.g. 'Yes', 'No', 'Oh My God!'. It's a very interesting way to express information through images especially for short reply and expressing emotion information'. In addition a D/HoH interviewee said, '…emoji is a way use to send emotional or particular information, instead of typing'.

5.4.2 Discussions of User Feedback in the Provided Potential Features

The above section has summarised the interview data with regard to three aspects (a. Ways of Inputting Messages, b. Ways of Transmitting Messages and Conducting Physical Interaction and c. Other Suggestions), with significant themes. This section gives a further discussion of these themes.

(1) Ways of Inputting Messages

The above section has summarised user feedback about the ways of inputting messages in the three themes below. This section gives a further discussion of these themes and modifies the provided potential features.

- Theme 1: Usefulness of Predictive Words and Sentences
- Theme 2: Inconvenience of Categorisation Support
- Theme 3: A Concern of Voice Recognition Accuracy

This smartphone app is not designed to replace the primary communication methods used by the D/HoH and hearing people but rather to assist those primary communication methods when they are not available. The method of text typing is specifically designed for D/HoH users, whilst voice recognition feature is specifically designed for hearing users. The interview data shows that these two ways of inputting messages are useful, especially the support of predictive words/sentences.

The interview data shows that there is a concern about the accuracy of voice recognition. However, the purpose of this study is not to improve existing technology of voice recognition as the development of voice recognition technology is out of the scope of this study and the literature chapter has already shown that the existing voice recognition technologies are highly developed. The voice recognition in this app is designed to combine with a correcting support and a basic text typing interface that allows users to correct incorrect results. It helps to reduce the existing concerns mentioned in the interviews. As a result of the user feedback, the provided potential feature 'prediction supports in text typing and voice recognition' is slightly modified as two ways of inputting messages in this app: a. text typing with predictive support and b. voice recognition with correcting support.

In addition, the interview data shows that the categorisation support feature is problematic. However, an interviewee indicated that it would be a good feature if users can create and edit the predictive message database on their smartphones. According to the user feedback, the provided potential feature 'categorisation supports in text typing' is modified as a new way of inputting messages in this app, which is named 'Stored Messages with Categorising Support'. This could be work with the predictive text feature. The stored messages with categorising support would allow users to create and save messages (in different categories) in advance. Users can then recall and use these stored messages without having to type the whole sentence when communicating.

As referred to in the above discussion, three ways of inputting messages were selected as part of the design of this smartphone app: a. text typing with predictive support, b. voice recognition with correcting support and c. stored messages with categorising support.

(2) Ways of Transmitting Messages and Conducting Physical Interaction

The above section has summarised user feedback about the ways of transmitting messages and conducting physical interaction in the five themes below. This section gives a further discussion of these themes and modifies the provided potential features.

- Theme 1: Importance of Physical Interaction with Nonverbal Messages
- Theme 2: Usefulness of Showing Messages via a Single Phone

- Theme 3: A Concern of Showing Messages via a Single Phone
- Theme 4: Redundancy of Transmitting Messages via NFC
- Theme 5: Uselessness of Real-time Text Transmission

The interview data shows the importance of physical interaction with nonverbal messages that can help smooth the FTF communication between the D/HoH and hearing people. The interviewees indicated that the feature of showing messages via a single phone (without connection technology) is a useful, easy and quick way to convey information when people are close to each other. However, there is a concern that by showing messages via a single phone that has a different inputting interface, it could cause inconvenience for the person who is using the other person's phone. Also predictive messages are not necessarily supported on other people's phones.

In order to address this concern, this smartphone app is designed to be used in a way that corresponds to the three expected communication scenarios below:

- Scenario 1: This smartphone app is expected to be installed only on D/HoH people's phones.

  Hearing people might not install this smartphone app on their phones because they do not expect to communicate with the D/HoH. This expected scenario aims to reduce the inconveniences if hearing people must install this app on their phones for communicating with the D/HoH.

- Scenario 2: D/HoH people are expected to only use the features of text typing and stored messages via their own phones.

  The reason for this is that text typing (with predictive support) and stored messages (with categorising support) are the only two ways of inputting messages designed in this smartphone app that are accessible for D/HoH people. D/HoH users are unable to use the feature of voice recognition because of their speech limitation caused by their hearing loss.

- Scenario 3: Hearing people are expected only to use the voice recognition feature via D/HoH people's phones.

This is because speech is the primary communication method used by hearing people. This scenario aims to let hearing users keep the same communication method they usually use through the feature of voice recognition (with correcting support). The correcting support in the voice recognition contains a basic typing interface where hearing users can correct the incorrect results from voice recognition. This basic typing interface does not include predictive words/sentences supports because of the privacy issue of personal predictive messages.

Furthermore, the interview data shows that the feature of transmitting messages via two phones with NFC connection technology is unnecessary. The interviewees indicated there is no actual difference between the ways of transmitting messages (via NFC connection technology) and showing messages (without connection technology), when people are close to each other. People can only use the method of 'showing' messages instead of the way of 'transmitting' messages. Table 5.6 below compares the ways of communicating through NFC transmitting messages and physically showing messages via the previous four transmission conditions (see Table 5.3, p.115). It also shows there is no difference in the four transmission conditions between these two ways of communicating.

	Transmission Conditions			
Communication Ways	Short-distance Transmission Only	Payment Requirement	Phone Number / Account Requirement	Reception Requirement
NFC Transmitting Messages	√			
Physically Showing Messages	√			

Table 5.6. Comparison of NFC Transmitting Messages and Physically Showing Messages

From the user feedback and the comparison of these two methods of communication, the feature 'communication via two phones with NFC connection technology' is not part of the design in this smartphone app.

In addition, the interview data shows that the feature of real-time text transmission is useless because it will reduce opportunities to prompt physical interaction with nonverbal messages when users are using this feature. Time is also not such a serious problem in FTF communication. According to the user feedback, the provided potential feature 'communication via two phones with real-time text transmission support' is not relevant to the design of this smartphone app.

As the above discussion indicates, the method of showing messages (without connection technology) is designed as the way to convey information in this smartphone app between the D/HoH and hearing people. This is mainly based on the above three expected communication scenarios.

(3) Other Suggestions

The above section has summarised user feedback about other suggestions of this smartphone app in the five themes below. This section gives a further discussion of these themes and modifies the provided potential features.

- Theme 1: Difference between this App and Others
- Theme 2: Different Communication Circumstances
- Theme 3: Showing Messages Via Two Phones
- Theme 4: Hearing Aid and Loop Technology
- Theme 5: Emoticons

The interview data shows there is no a clear difference between this smartphone app and other apps (e.g. SMS and note). For example, people can already show messages to the people they communicate with via SMS or a note app. It is very similar to the feature of showing messages in the design carried out for this app. However, the main difference between this smartphone app and others is the usability. Usability is qualified by how easy it is to use a product for a specific task. Jones and Marsden (2005) indicates, in interaction design, there is a design shift from technology perspective to usability perspective. Usability is a specific and significant focus when developing an interactive product. For example, SMS is not designed for FTF communication, but people can still use SMS to show messages. However, the use of SMS to show messages is not as effectives as using the showing message feature designed in this app. This is because this app is specifically designed for FTF communication but SMS is not.

The interview data also shows D/HoH people need different types of support for communication in different circumstances (e.g. one-to-one communication and group communication). However, this smartphone app is designed as a communication tool specifically for one-to-one common (informal) conversation in FTF communication. One-to-one common (informal) conversation refers to basic daily communication between two people but no other types of communication such as a group communication, workshops, seminars and conferences. One of the reasons for this is that potentially further communication supports could be provided for the D/HoH in particular communication circumstances, such as sign language interpreters in schools and loop technology in meeting rooms. Another reason is that this smartphone app aims to address communication problems in particular communication circumstances (one-to-one common/informal FTF conversation). However, this app can also be used to support other communication circumstances because one-to-one conversation is a basic communication element in most types of communication.

Furthermore, the interview data confirms that showing messages via two phones (without connection technology) can be a solution to address the concern of using other people's phones (different inputting interface and personal predictive messages). Although this concern can be solved through the above three expected communication scenarios in the use of this app, showing messages via two phones could also take place in the following two situations: a. when hearing users install this app on their own phones and b. when two D/HoH users communicate with each other. Depending on different communication situations, showing messages via a single phone and two phones are two possible ways to convey information between users when using this smartphone app.

In addition, the interview data shows that hearing aid and loop technology could be combined with voice recognition to support different communication circumstances/requirements (e.g. group communication) or different communication environments (e.g. noisy places). A hearing aid is a digital device that amplifies sounds to increase the hearing abilities of the D/HoH, with loop technology being a useful support for hearing aids. Loop technology serves as a wireless loudspeaker to deliver clear sounds directly to a hearing aid. A hearing aid with loop technology is a typical communication solution for the D/HoH and is commonly used in specific places like meeting rooms, lecture halls and public locations (e.g. train stations). The concept of combining this app with hearing aid loop technology is that hearing users can deliver sounds directly to a D/HoH person's hearing aid through the feature of voice recognition designed in this app. For example, there is a smartphone app called *TruLink Hearing Control* that provides a very similar feature. However, hearing aid loop technology is not applied in this app because it only supports hard of hearing people who wear hearing aids. Most deaf people do not wear hearing aids because of their profound hearing loss and some hard of hearing people do not wear hearing aids because of their mild hearing loss. For example, a report (Action On Hearing Loss 2011) shows that there were more than 10 million D/HoH people in the UK in 2011, but only 2 million of them wore hearing aids, whilst 1.4 million D/HoH people used them regularly.

According to the above discussion, this smartphone app is further defined as a communication tool specifically used for one-to-one common (informal) conversation in FTF communication that supports showing messages via a single phone or two phones, whilst hearing aids loop technology is not used in this app. In addition, the interviewees who mentioned emoticons, indicated that it could be combined with the text typing feature of this smartphone app. The original concept was of not using emoticons in this app as it is specifically designed for FTF communication, in an attempt to prompt users to express emotional information through physical interaction with nonverbal messages. This issue will be given a further discussion in the following development process.

5.4.3 Design Features of this Smartphone App

The above section has discussed user feedback about the provided potential features in terms of three aspects: a. ways of inputting messages, b. ways of transmitting messages and conducting physical interaction and c. other suggestions. According to the discussions, this smartphone app is designed to provide three ways of inputting messages and two ways of showing messages for users. The three ways of inputting messages are: a. Text Typing with Predictive Support, b. Stored Messages with Categorising Support and c. Voice Recognition with Correcting Support; and the two ways of showing messages are: a. Showing Messages via A Single Phone and b. Showing Messages via Two Phones.

(1) Three Ways of Inputting Messages

This smartphone app aims to provide three ways of inputting text messages that both D/HoH and hearing users can use to communicate with each other. These three ways of inputting messages endeavour to facilitate the communication process by increasing the speed of text typing.

a. Text Typing with Predictive Support

Text typing is a basic way of inputting messages broadly used in CMC (e.g. SMS, IM and email). It is an accessible communication method between the D/HoH and hearing people: parts of this research have shown that written notes/text is the only readily accessible communication method used between the D/HoH and hearing people. Also, the interviewees indicated that a text-based communication tool is a communication requirement in FTF communication. Text typing is designed as the primary way of inputting messages in this smartphone app that is specifically designed for D/HoH users. The text typing feature in this app is similar to most text typing features in other apps, but it includes a predictive support that allows users to input messages more quickly by providing suggested words and sentences. Although some other apps provide a similar feature to suggested words, the suggested sentence support is a further feature designed in this app for increasing the speed of text typing, rather than just providing suggested words.

b. Stored Messages with Categorising Support

Stored messages with categorising support is another way of inputting messages in this app that is specifically designed for D/HoH users. This feature also aims to increase the speed of inputting messages by using existing messages that users created before and saved in advance. Users can organize their stored messages into different categories via the categorising support that helps users to select a particular message more quickly. The method of storing messages with categorising support was modified from one of the provided potential features ‘categorisation support in text typing’. It is a new way of inputting messages that is specifically designed for this app, that other apps do not have. For example, when a D/HoH user attempts to communicate with a hearing person, they only need to select a stored message instead of typing text.

c. Voice Recognition with Correcting Support

Voice recognition with correcting support is a method of inputting messages in this app specifically designed for hearing users. This feature seeks to allow hearing users to keep their primary communication method of speech. The voice recognition feature in this app includes a correcting support (with a basic text-typing interface) that allows hearing people to modify incorrect results from voice recognition, as well as allowing hearing users to input messages via text typing. The basic text-typing interface in the voice recognition feature does not include the support of predictive words and sentences. This decision was made to avoid the privacy issue associated with personal predictive messages when using other people’s phones. It is an independent typing interface only used in the voice recognition feature in this app.

(2) Two Ways of Showing Messages

This smartphone app aims to provide two ways of showing messages to enable D/HoH and hearing user to communicate with one another. Showing messages is a specific method designed for this app to convey information (communicate) between two users in FTF communication. Its purpose is to prompt users to conduct physical interaction with nonverbal messages during communication.

a. Showing Messages via A Single Phone

Showing messages via a single phone without connection technology (e.g. 3G and Wifi) is designed as the primary way to convey information (communicate) between a D/HoH and a hearing person by using the D/HoH person's phone. The feature of showing messages via a single phone is expected to be used in the three communication scenarios below:

- Scenario 1: This smartphone app is expected to be installed only on D/HoH people's phones.

- Scenario 2: D/HoH people are expected to only use the features of text typing and stored messages via their own phones.

- Scenario 3: Hearing people are only expected to use the feature of voice recognition (including a basic text typing function) via D/HoH people's phones.

b. Showing Messages via Two Phones

Although this smartphone app is specifically focused on addressing the communication gap between the D/HoH and hearing people, showing messages via two phones without connection technology (e.g. 3G and Wifi) is designed as a further way to convey information (communicate) between a deaf and a hard of hearing person. This is because part of this research shows that the primary communication methods used by deaf and hard of hearing people are different. There is also a communication gap between deaf and hard of hearing people. The feature of showing messages via two phones is a solution to bridge this gap. It allows a deaf and a hard of hearing user to communicate with each other by using their own phones. This implies that both of them can use their personal predictive messages and stored messages. In addition, showing messages via two phones can also be used between a D/HoH and a hearing person if the hearing person has installed this app on his/her phone.

5.5 Design Step 4: Prototype Developments

As a result of the user feedback and the above discussions, it was decided to design three ways of inputting messages and two ways of showing messages in this smartphone app. This section firstly studies a smartphone app design policy in the case of iOS 7 on an iPhone 5, and then presents design features of this smartphone app through a prototype development.

5.5.1 A Smartphone App Design Policy: iOS 7 on iPhone 5

There are various types of smartphones produced by different phone manufacturers (e.g. Apple, Samsung and HTC) running different operating systems (OS). A Nielsen report (2013) shows that Apple iOS and Google Android are the two predominant OSs running on smartphones. Selecting a particular smartphone and OS is an essential part of developing an app because different types of smartphones and OS have different design requirements. The Apple iOS 7 on the iPhone 5 is chosen as the case study for developing this smartphone app. The reason for choosing iOS 7 on iPhone 5 is because it is the latest version at the time of research (mid-2013). The purpose of this case study is to underpin the interaction design creative practice of the study. It is an example used for testing the design concept developed as part of the creative practice in this research and does not reflect on the quality of the Apple iOS 7 on the iPhone 5.

Interaction design is concerned with developing efficient and effective interfaces in presenting functions (Rogers, Helen and Preece 2011). Interface design is one of the most important parts of developing an interactive product (e.g. a smartphone app). An efficient and effective interface can be designed by following the 'Eight Golden Rules of Interface Design' proposed by Shneiderman in 1998 (Shneiderman and Plaisant 2010).

- *Strive for Consistency*
- *Enable Frequent Users to Use Shortcuts*
- *Offer Informative Feedback*
- *Design Dialog to Yield Closure*

- *Offer Simple Error Handling*
- *Permit Easy Reversal of Actions*
- *Support Internal Locus of Control*
- *Reduce Short-term Memory Load*

In addition, Gong and Tarasewich (2004) propose seven suggestions specifically for designing interfaces on mobile devices (e.g. smartphones).

- *Design for Multiple and Dynamic Contexts*
- *Design for Small Devices*
- *Design for Limited and Split Attention*
- *Design for Speed and Recovery*
- *Design for "Top-down" Interaction*
- *Allow for Personalisation*
- *Design for Enjoyment*

These rules aim to help designers to develop interfaces that are usable and user friendly.

Smartphone interfaces can be classified into two types: Graphical User Interface (GUI) and Natural User Interface (NUI). GUI is an interface integrated by graphical elements. It is a versatile interface primarily used to support all manner of computer-based activities that allow people to interact with digital devices through visual icons and indicators. NUI is an invisible interface that relies on natural ways of interaction. NUI allows people to interact with digital devices through intuitive actions such as voice, finger(s), hand(s) and body. Both GUI and NUI essentially coexist together and cooperate for users to operate a system or a smartphone app. Table 5.7 below shows how, typically, GUI and NUI are utilized on smartphones:

GUI	NUI
• Icons/Images • Bars • Menus • Window/Content View • Virtual Keyboard	• Multi-touch Screen • Speech recognition • Motion Sensor (accelerometer) • Proximity Sensor • Ambient Light Sensor

Table 5.7. Smartphone GUI and NUI

The Apple Company provides iOS human interface guidelines for app designers, which include guides on both GUI and NUI.

(1) A Review of GUI in IOS7 on iPhone 5

a. A Screen Size and Resolution

Screen size and resolution is one of the most important elements that affect smartphone interface design (Linghao and Ying 2010). The iPhone 5 uses a 4-inch retina display with 1136x640-pixel resolution at 326 pixels per inch (ppi), see the Figure 5.15 below.

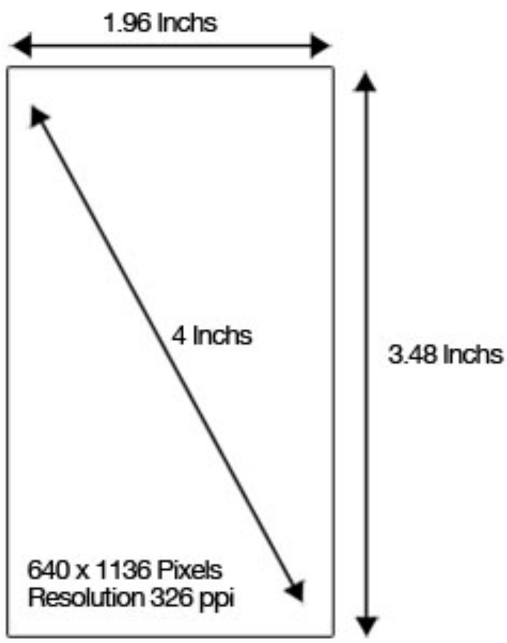


Figure 5.15. iPhone 5 Retina Display Area

Retina display is a screen with a high pixel density such that the human eye is unable to discern individual pixels at a typical viewing distance. Based on this 4-inch retina display, the suggested text size should never be smaller than 11 point (pt) and text size for the main body content is suggested to use a font size of 17 pt.

b. GUI Elements

Table 5.8 below shows the size guidelines for icons, images and bars in iOS7 on iPhone 5.

Category	Size
App Icon An icon used on the home screen to open an app.	120 x 120 pixels (px)
Launch Image The first image displays when an app starts up.	640 x 1136 px
App Store Icon An icon used in the App Store.	1024 x 1024 px
Spotlight Icon Icon used to show the result of a spotlight search.	80 x 80 px
Settings Icon Icons used on the settings page.	58 x 58 px
Height of Status Bar	40 px
Height of Navigation Bar & Navigation Bar Icon (optional)	About 88 px & 40 X40 px
Height of Tab Bar & Tab Bar Icon (optional)	About 98 px & 50 x 50 px

Table 5.8. Size Guidelines for Icons, Images and Bars in iOS7

More details of the GUI elements iOS7 on iPhone 5 (e.g. bars, content views, controls and temporary views) can be seen in Appendix 15.

(2) A Review of NUI in iOS7 on iPhone 5

a. A Multi-touch Screen with Finger Gestures

A multi-touch screen is the most significant interface on a smartphone that offers touch-based operations. The touch-based operations have brought intuitive experiences to users, with many finding it simpler to use than key-based operations (Linghao and Ying 2010 and Tanimura and Ueno 2013). The multi-touch screen in iOS 7 on iPhone 5 provides seven standard finger gestures for operating apps, see the Table 5.9 below.

<table>
<tr><td>
Tap
To press or select a control or item.</td><td>
Drag
To scroll or pan—that is, move side to side.</td></tr>
<tr><td>
Flick
To scroll or pan quickly.</td><td>
Swipe
With one finger, return to the previous screen.</td></tr>
<tr><td>
Double Tap
To zoom in and centre a block of content or an image.</td><td>
Pinch
Pinch open to zoom in; pinch close to zoom out.</td></tr>
<tr><td colspan="2">
Touch and Hold
In editable or selectable text, to display a magnified view for cursor positioning.</td></tr>
</table>

Table 5.9. A Multi-touch Screen with Finger Gestures on iPhone 5

b. Intelligent Sensor Technology

Intelligent sensor is an important technology used in smartphones that affect smartphone interface design (Linghao and Ying 2010). Intelligent sensor technologies in iOS 7 on iPhone 5 includes proximity, ambient light and accelerometer sensors (see the Table 5.10 below). The proximity and ambient light sensors are typically used for saving the phone battery and the accelerometer sensor typically used to support motion control, particularly in games. The accelerometer sensor will be used to support the feature of showing messages designed in this app.

Proximity Sensor	Ambient Light Sensor	Accelerometer sensor
A proximity sensor is a sensor able to detect nearby objects for dimming screen brightness when a phone is close to an ear during a call.	An ambient light sensor is a sensor able to detect surrounding lights for adjusting screen brightness.	An accelerometer sensor is a motion sensor that allows the user to easily switch a phone screen between portrait orientation and landscape orientation by rotating the phone.

Table 5.10. Sensors on iPhone 5

5.5.2 Prototyping: Design Features

Designing a user interface, defining the interaction and implementing the behaviour are the three main steps when developing a smartphone app, as described by the Apple Company. Designing a user interface is a step to translate concepts/features of an app into a graphical presentation. Defining the interaction is a step to describe actions between users and interfaces, and how users can interact with an interface. Implementing the behaviour is a step to combine the interface and interaction by using a writing code (a fully functional app). The first and second steps are typically performed by designers and the third step typically performed by programmers. As the author is a designer and the main purpose of this research is to prove the design concept, a fully functional app is out of the scope of this study. The prototype in this study includes graphical interfaces with exact size and interfaces. These graphical interfaces are also presented via a web-based environment that allows users to experiences simulated interactions.

(1) Graphical Interfaces

a. Naming

Naming a smartphone app is an important part of developing an app. A good name can help users quickly understand the features and easily remember it. Table 5.11 below presents ten potential names for this smartphone app. All these potential names will be tested in the design step 5, with one chosen as suitable to represent this smartphone app. The ten names have not been used for other apps in the UK Apple App Store up to June 2014. However, some may be used for Android apps or outside of the UK.

Name	Concept
1. RoTalk	'RoTalk' is composed of two words 'Rotate' and 'Talk'. This specific term aims to present the significant feature of this app—talking to people by showing messages through rotating phones. This feature brings nonverbal messages into communication as part of face-to-face communication between D/HoH and hearing people.
2. Talk2Me	The name Talk2Me aims to inform hearing people that they can 'talk to me (D/HoH people)' by using this app.
3. Show4Talk	The name Show4Talk aims to express the specific feature of this app: showing spoken messages.
4. Show&Talk	Same as above.
5. Show2Talk	Same as above.
6. 2Chat	The name 2Chat can be explained as 'second chat', 'two chat' and 'to chat', as this app is a 'second' communication method for D/HoH people. This app is mainly used for 'two' people communication and supports D/HoH people 'to' chat with hearing people.
7. EyesChat	EyesChat is a metaphor for this app, as eye contact is an important part of nonverbal messaging in face-to-face communication, with this app designed for face-to-face communication between D/HoH and hearing people.
8. F2FTalk	F2F is an abbreviation of face-to-face because this app is specifically designed for face-to-face communication between D/HoH and hearing people.
9. FaceChat	Same as above.
10. EZChat	EZChat is pronounced as easy chat because this app aims to provide an easy way to communicate between D/HoH and hearing people.

Table 5.11. Potential Names

b. Three Ways of Inputting Messages

Table 5.12 below presents interfaces of the feature 'Text Typing with Predictive Support'. The homepage interface combines a virtual keyboard, a message display area and a tab bar in between. It does not provide a 'send' button for sending messages because this app provides another way to convey information between users (showing messages). The detailed interface shows how predictive words and sentences are presented. In order to leave enough space to display the typed messages, only three predictive words and three predictive sentences are provided when users are typing on this interface.

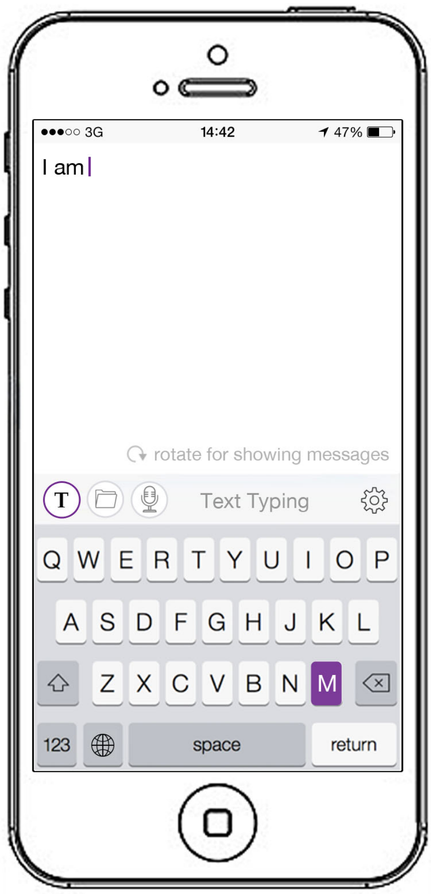
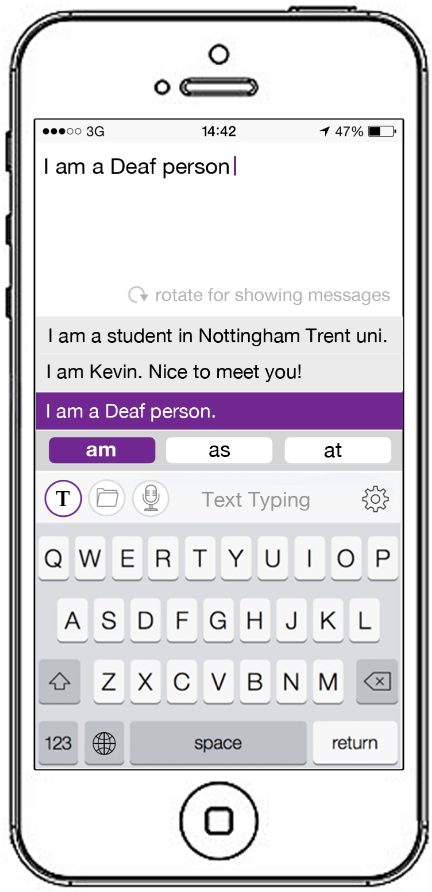
<table>
<tr><th colspan="2">Way 1: Text Typing with Predictive Support</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Homepage Interface
Type messages via the keyboard (dark background space).</td><td>Detailed Interface
Select a predictive a word and sentence (dark background space).</td></tr>
</table>

Table 5.12. Text Typing Interfaces

Table 5.13 below presents the interfaces of the feature ‘Stored Messages with Categorising Support’. The homepage interface combines a category list (users can edit stored messages in different categories), a message display area and a tab bar in between. The detailed interface shows how users select a stored message from a category.

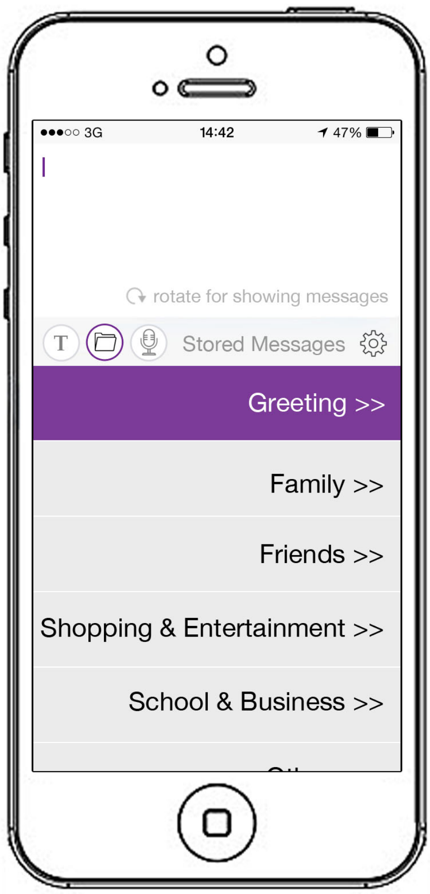
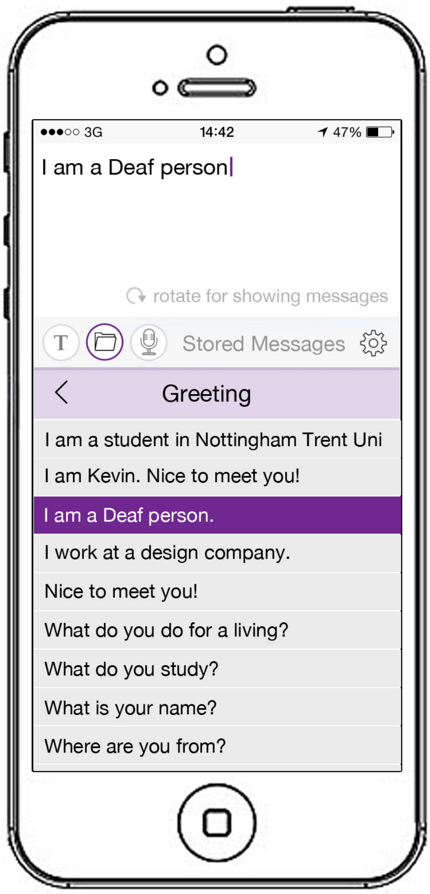
<table>
<tr><th colspan="2">Way 2: Stored Messages with Categorising Support</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Homepage Interface
Select a stored message category (dark background space).</td><td>Detailed Interface
Select a stored sentence from the selected category (dark background space).</td></tr>
</table>

Table 5.13. Stored Message Interfaces

Table 5.14 below presents the interfaces of the feature ‘Voice Recognition with Correcting Supports’. The homepage interface combines a record button, a message display area and a tab bar in between. The detailed interface (correcting interface) shows the results of voice recognition, which includes a virtual keyboard. Hearing users can also use text typing to input messages, but the predictive words and sentences are not supported in this text typing interface.

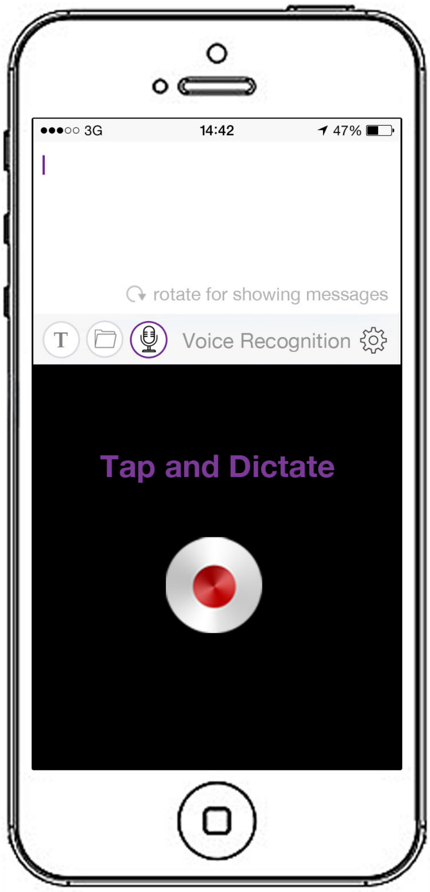
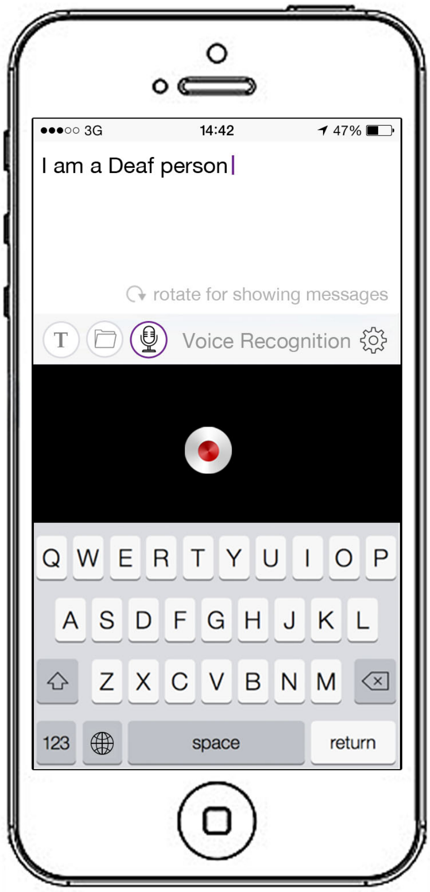
<table>
<tr><th colspan="2">Way 3: Voice Recognition with Correcting Support</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Homepage Interface
Tap the record icon and dictate the message.</td><td>Detailed Interface
Voice recognition results. Correct it via the keyboard if needed.</td></tr>
</table>

Table 5.14. Voice Recognition Interfaces

c. Two Ways of Showing Messages

Showing messages via a single phone or two phones are the two ways to convey information (communicate) between two users in FTF communication when using this smartphone app. 'Rotating' is a specific feature designed in this app for showing messages (via the an accelerometer sensor). Rotating the orientation of a phone is an action that triggers this design feature. Users are restricted to input messages in the portrait orientation and show messages in the landscape orientation. The inputting message interface automatically transforms to the showing message interface when users rotate their phones from portrait to landscape orientation. See the Figure 5.16 below

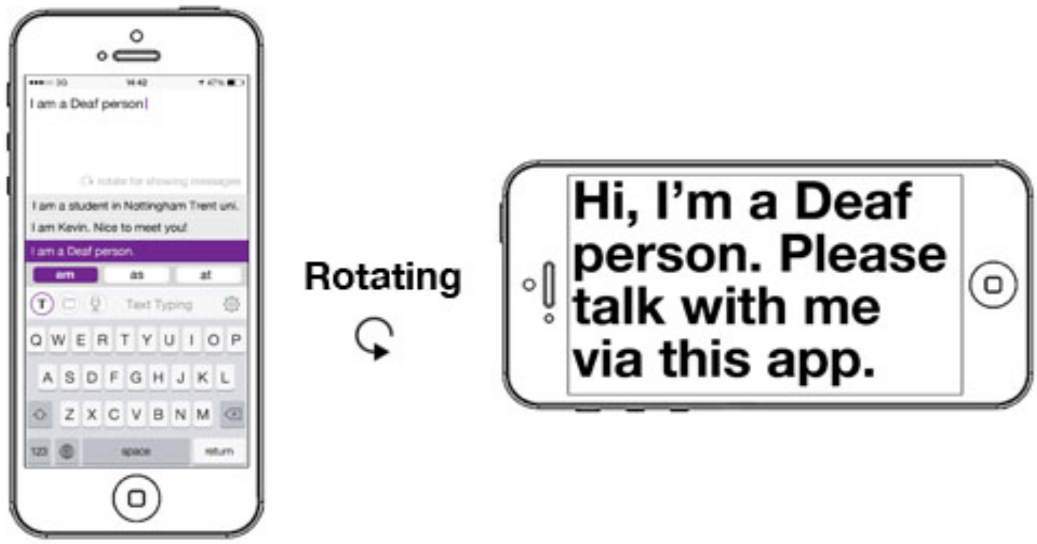


Figure 5.16. Rotation for Showing Messages 1

The shown message interface in landscape orientation contains a bigger text size with a full screen display. This is a specific design for this app to increase the usability. A full screen display means a single display area without any other visible interface (e.g. navigation bar, tab bar or toolbar). A bigger text size with a full screen display provides a better experience when users are reading messages via a smartphone screen. This specific design is what the author argued for previously that usability is the main difference between this smartphone app and other apps. This app is specifically designed for FTF communication, whereas others are not.

Legible text size is the most important aspect when showing messages in landscape orientation. If users cannot read the text, it does not matter how significant the feature is. Reading messages whilst someone else holds the phone is different to reading messages on your own phone because the reading distance from a person's eyes to the other person's phone (held by the other person) is larger than the distance from a person's eyes and his/her own phone. There are four readable text sizes (with a maximum 100 cm reading distance) designed in this app for the feature of showing messages: 68 pt, 56 pt, 48 pt and 40 pt. The maximum length for a (showing) message depends on text size, with the message restricted to a single page.

For a text size of 68 pt that allows 48-character messages in 4 rows, see Figure 5.17 below.

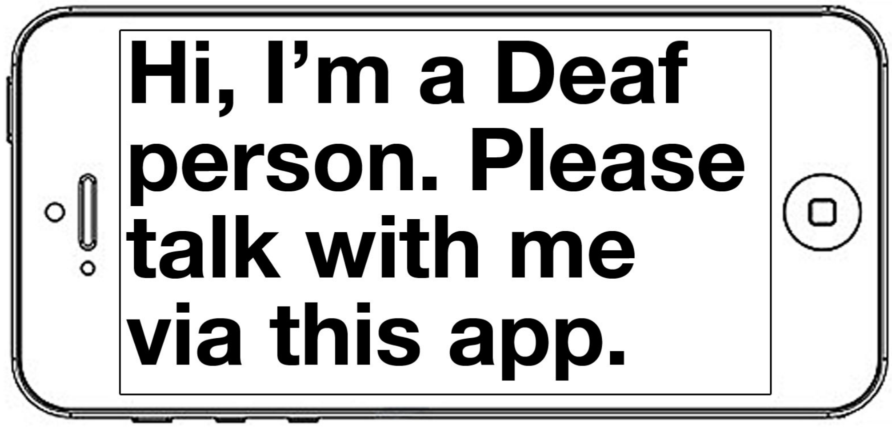


Figure 5.17. A Text Size of 68 pt

For a text size of 56 pt that allows 75-character messages in 5 rows, see Figure 5.18 below.

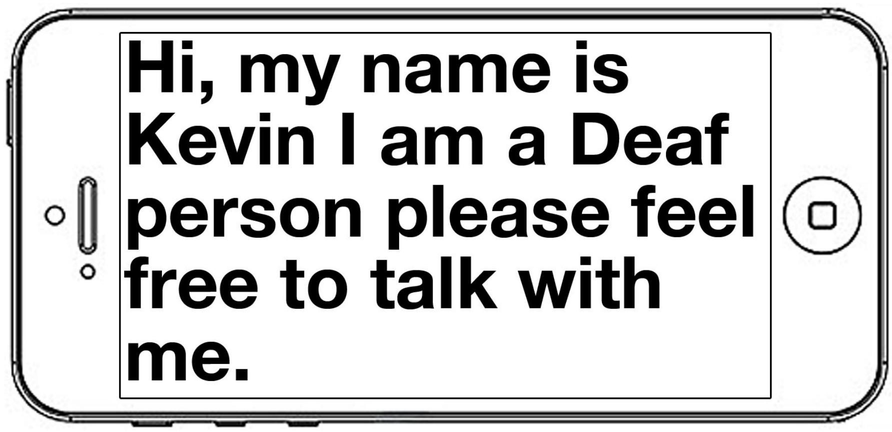


Figure 5.18. A Text Size of 56 pt

For a text size of 48 pt that allows 108-character messages in 6 rows, see Figure 5.19 below.

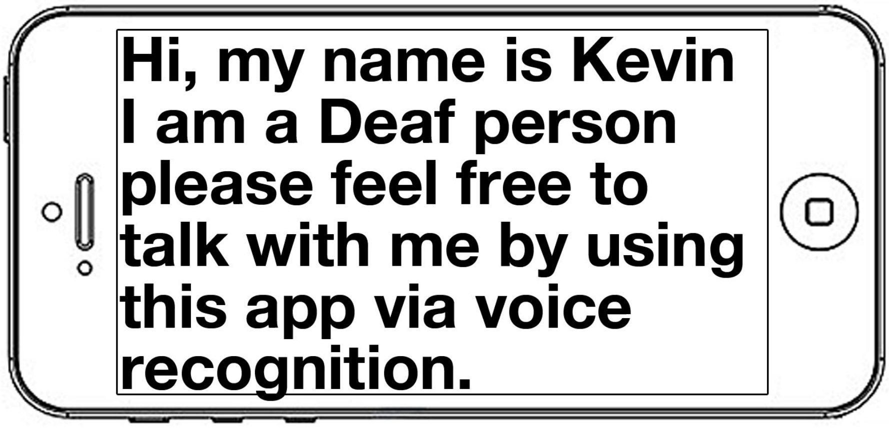


Figure 5.19. A Text Size of 48 pt

For a text size of 40 pt that allows 147-character messages in 7 rows, see Figure 5.20 below.

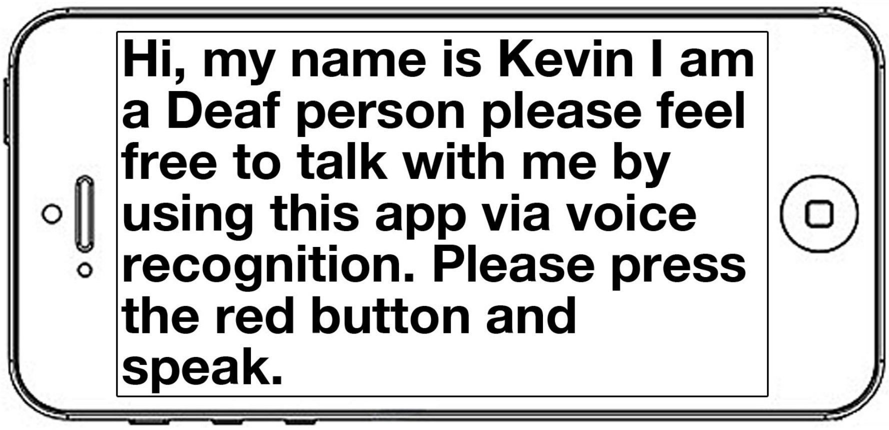


Figure 5.20. A Text Size of 40 pt

There are two ways of showing messages when using this smartphone app. One is showing messages via a single phone that is specifically used between a D/HoH and a hearing person, see Table 5.15 below.

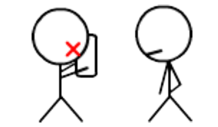
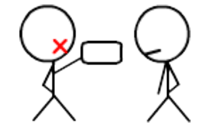
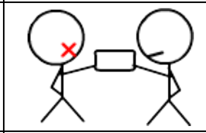
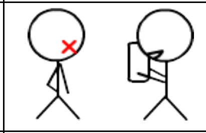
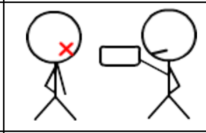
Step 1	Step 2	Step 3	Step 4	Step 5
				
A D/HoH person inputs messages via text typing or stored messages.	The D/HoH person shows messages to a hearing person.	The hearing person reads messages and takes the phone.	The hearing person inputs messages via voice recognition.	The hearing person shows messages back to the D/HoH person.

Table 5.15. Scenario for Showing Messages via A Single Phone

The other is showing messages via two phones that is specifically used between a deaf and a hard of hearing person, see Table 5.16 below.

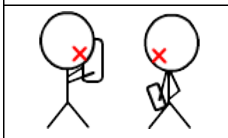
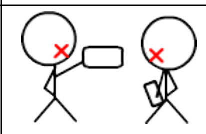
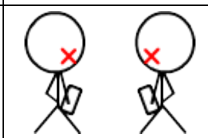
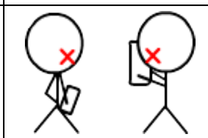
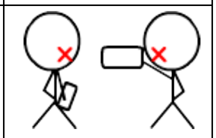
Step 1	Step 2	Step 3	Step 4	Step 5
				
A deaf person inputs messages via text typing or stored messages.	The deaf person shows messages to a hard of hearing person.	Both the deaf and hard of hearing people use their own phones.	The hard of hearing person also inputs messages via text typing or stored messages.	The hard of hearing person shows messages back to the deaf person.

Table 5.16. Scenario for Showing Messages via Two Phones

(2) Interfaces in a Web-based Environment

The above section has presented the graphical interfaces of this smartphone app that explains the design features. However, the users are unable to experience the interactions when using this app through these graphical interfaces. In order to provide a better prototype for usability testing that allows users to experience these interactions, the graphical interfaces are built in a web-based simulated environment (via basic HTML) for users to experience this smartphone app interactively by the use of a mouse. It is available online via the link http://adonischang.com/web-based/index.html. See Appendix 18.

5.6 Design Step 5: Evaluations and Modifications

The design features of this smartphone app have been presented via a visual-based prototype as well as in a web-based simulated environment. This section evaluates the prototype via interviews. In addition, this section modifies the prototypes in the light of the user feedback.

5.6.1 Interview: Evaluation of the Prototype

The purpose of the interview is to evaluate the prototypes to ascertain feedback from the end users. The interviews were conducted via an interview document (Appendix 9), which includes a visual-based prototype and graphical interfaces in a web-based simulated environment. All interview data (Appendix 10) are organised into meaningful groups and given initial codes (Appendix 11). An initial thematic map is not produced in this interview dataset because the dataset has only one potential theme 'user feedback about the prototype'. However, a developed thematic map is produced under the potential theme.

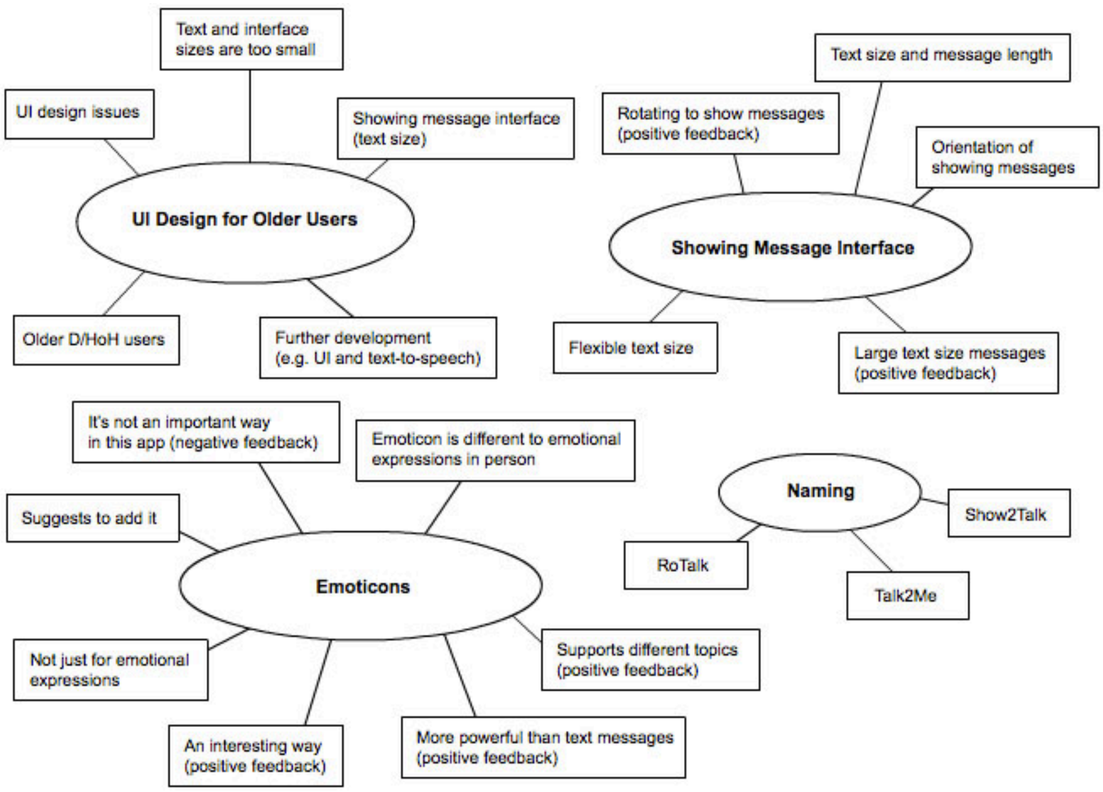


Figure 5.21. Developed Thematic Map (Evaluation of the Prototype)

The developed thematic map shows four significant themes with regard to the user feedback about the prototype:

- Theme 1: UI Design for Older Users
- Theme 2: Showing Message Interface
- Theme 3: Emoticons
- Theme 4: Naming

a. UI Design for Older Users

The interviewees indicated the UI design in this app might too small for older people. An expert interviewee said, 'You must be aware that most of deaf /hard of hearing are the elderly. Your UI design may need to consider about them'. Another expert interviewee said, '…the font size of stored message is too tiny I think it would bring problems to older deaf people.' The interviewees indicated that the UI in showing messages is very clear as the text size is big enough to read, but the UI in inputting messages is too small. An expert interviewee said, 'If the UI could be improved this app would be much better'. In addition, the interviewees indicated some older people might prefer to use an extra-wide keyboard via their phones in a landscape orientation.

b. Showing Message Interface

The interviewees indicated that showing messages via a big text size in landscape orientation is a good design in FTF communication. An interviewee said 'I think showing message is a good and creative idea for the people who are deaf or hard of hearing'. However, the interviewees were concerned about the limitation of message length. An expert interviewee said, 'I think the 48-character long message might be too short. If the message is longer the limitation what happens? Can I user a scroll bar?'. The interviewees mentioned the possibility of using a scroll bar when messages are longer than the message length limitation. One interviewee commented, 'Can users decide the text size themselves? If I need type a long sentence I might choose a smaller size because the restriction of message length.' The interviewees furthermore suggested that text-to-voice translation could be additional support when showing messages. A hearing interviewee said, 'It could an extra function that supports voice messages for hearing people. When shows messages in landscape orientation the message also can be pronounced'.

c. Emoticons

Emoticons were not designed as part of this app because the original concept of this app is to prompt users to express emotional information through physical interaction, instead of via the use of emoticons. However, the interviewees suggested that emoticons should be added as a way of inputting messages in this app. An expert interviewee said, 'You could add emoticon as part of text typing. It is a common way all people use it, not just for deaf people'. A hearing interviewee said, 'Add it! It's not just for emotional expressions sometime an emoji means a lot rather than words'. Another interviewee added, 'emoticon is still different to emotional expressions in face-to-face communication'.

d. Naming

Talk2Me, RoTalk and Show2Talk were the three names chosen by the interviewees as the best names to represent this smartphone app.

5.6.2 Modification of the Prototype

According to the user feedback of the prototype, this section gives a further discussion of the user feedback and provides further (or revised) design features to this smartphone app. The further (or revised) features include four parts: (1) A Large Mode for The Elderly, (2) Flexible Text Size and Text-to-Voice Support for Showing Messages, (3) Restriction of Inputting Messages in Portrait Orientation and (4) Emoticon Support.

(1) A Large Mode for the Elderly

The interview data shows the UI design in the prototype needs to be considered with regard to older users as most of D/HoH people are the elderly (also a report from *Action On Hearing Loss* states that, in 2011, more than half of all D/HoH people in the UK are elderly). A smartphone is becoming a prevalent digital device in our daily lives, but most smartphones are not specifically designed for older people and causes difficulties for them (Harada, et al 2013; Leitao and Silva 2012; Kurniawan 2008; Nicolau and Jorge 2012; Ziefle 2010). The main difficulty is that common text, interface and keyboard sizes are too small for older people to read and operate it (Harada et al 2013; Leitao and Silva 2012; Kurniawan 2008). Another difficulty is that the gestures necessary for using a smartphone touch screen (e.g. tap and swipe) are awkward, because older people's fingers are sometimes too dry to detect a touch-sensitive display as well as the problem with their declining motor abilities and hand tremors (Harad et al 2013; Moreover, Kurniawan 2008; Nicolau and Jorge 2012).

Older people need a friendlier smartphone UI. Although some smartphones have provided assistance supports for older users, it remains limited. For example, iOS7 on iPhone 5 (the case study of the creative practice) provides a feature that allows users to increase text size for some content such as email, contacts, calendars, messages and notes. Furthermore, it provides assistant technologies for users who have physical and motor disabilities (e.g. the features of AssistiveTouch and Home-clicks Speed). However, the feature and assistant technologies provided by iOS 7 on iPhone 5 only supports a few apps provided by Apple (e.g. email, contacts, calendars, messages and notes) and the Apple OS. It does not support other apps installed on the iPhone. In order to solve this problem, a large mode is designed to be added to this smartphone app specifically for older users. Older people are commonly defined as people aged over 65. However, Harada et al (2013) indicate that people aged between 50-64 face the same difficulties when using a smartphone as those aged over 65+. In addition, the interviewees who encountered difficulties are aged between 40-64. Older users in this study are not defined as an actual age group. They are defined as the people who encounter similar issues when using a smartphone as the elderly (65+).

Through this feature, users can switch this app between a standard and a large mode. A bigger size text, interface and keyboard are three requirements by older people because the common sizes are too small for them to read and operate via finger gestures on a limited size touch screen. The large mode feature of this smartphone app only focuses on improving the size of text and interface. Although a smartphone keyboard is also a problem for older users, developing a new keyboard is out of the scope of this study. It should be another individual topic of study. A common keyboard (iOS 7 on iPhone 5) is designed to be used in this app.

Strengers (2012) indicates font, icon and button sizes are particularly important in smartphone UI design for seniors. The large mode UI design in this smartphone app mainly focuses on increasing the size in two parts: a. Key Feature Buttons and b. Message Text. The key feature buttons (see Table 5.17 below) present the four ways to input messages provided in this app, with the message text (see Figure 5.22 below) displaying the input by users.

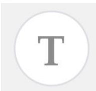
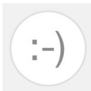
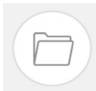
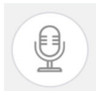
Four ways of inputting messages			
Text Typing	Emoticons	Stored Messages	Voice Recognition
			

Table 5.17. Key Feature Buttonsons

Figure 5.22 below shows an example of the increased sizes of key feature buttons and message text. The left image shows the standard mode in this smartphone app and the right side shows the larger mode. The standard mode text and interface sizes are based on the Apple iOS7 size guide (see Table 5.8, p. 146); and the large mode is discussed below.

Figure 5.22. Standard Mode vs. Large Mode

a. Key Feature Buttons: Icon size from 68x68 px to 130x130 px

The size of the four key feature buttons in the large mode is designed to be increased to nearly four times bigger than the standard size, from 68x68 px to 130x130 px (12x12 mm). In addition, the size of the spacing between the key feature buttons is designed in 36 px (3.5 mm). The design rationale is considered together with the two aspects below.

- The 130x130 px (12x12 mm) and 36 px (3.5 mm) sizes are in an accessible button/spacing size range for older users. Jin, Plocher and Kiff (2007), in an experiment with older users using a touch screen, show that sizes between 11.43 mm and 19.05 mm for a single touch button can be used to generate a better performance and accuracy by older users. The sizes between 3.17 mm and 12.7 mm can be used for spacing between buttons to generate a better performance and degree of accuracy for older users. The increasing sizes match the standard in the size guide for older users recommended by Jin, Plocher and Kiff (2007).

- Designing the four key feature buttons as big as possible in a single row (with an accessible spacing) and leaving enough space for a virtual keyboard arrangement and a display area for message text.

The bigger buttons allow older users to operate them more easily via a bigger touch sensitive area. Also, it highlights the four inputting ways provided in this smartphone app.

b. Message Text: Text size from 17 pt to 25.5 pt

The size of the message text in large mode is designed to be increased to one and half times bigger than the standard size, from 17 pt to 25.5 pt. The design rationale is considered together with the two aspects below.

- The 25.5 pt size is in an accessible text size range for older users. Jin, Plocher and Kiff (2007) indicate that older users have better reading experiences with a text size between 12-14 pt in a normal display (24-28pt in the iPhone retina display). The increasing text size matches the standard in the size guide for older users recommended by Jin, Plocher and Kiff (2007).

- Leaving enough spaces in the message text display area. The 25.5 pt text size allows at least 4 rows of messages to be displayed in the message text display area.

The bigger text can reduce the reading difficulties faced by older users when using this smartphone app.

(2) Flexible Text Size and Text-to-Voice Support for Showing Messages

Although the interviewees indicated the possibility of using a scroll bar in showing message interface, showing message interface in landscape orientation is restricted to a single page without using a scroll bar (or flick through). It is intended to keep each showing message not too long (helping the reader quickly receive information) and to keep the ‘rotating to showing messages’ action simple. The limitation of message length can also prompt people to use short messages in order to reduce the time it takes to input messages. Furthermore, a short message can be more **punchy,** quick and dynamic in expressing information.

a. Flexible Text Size Support

There are four text sizes (40 pt, 48 pt, 56 pt and 68 pt) provided in the prototype, which are all legible sizes (with a maximum 100 cm reading distance). The interviewees indicated that 56 pt text size with 75-character message length is the most suitable text size and message length for a showing message. The interviewees further indicated that users might need a smaller text size when they type a long message. A good balance between text size and message length is important when there is a limited screen size. Smaller text size offers longer message length, whilst bigger text size offers shorter message length. A flexible text size support is designed to be added to this smartphone app to strengthen the usability of showing messages. The flexible text size feature supports the four different text sizes and message lengths provided in the prototype: a. 40 pt with 140-characters, b. 48 pt with 108-characters, c. 56 pt with 75-characters and d. 68 pt with 48-characters.

The interface of the flexible text size support is shown in Figure 5.23 below. A 56 pt text size with 75-character length is used as default setting. Users can change the text size by touching the two buttons on the bottom-right of the screen when they are showing messages in landscape orientation. It provides flexible text size and message length for users who have different requirements.

Figure 5.23. Flexible Text Size Support

b. Text-to-Voice Support

In addition, the interviewees suggested that text-to-voice translation could be used when showing messages for hearing people. A text-to-voice support is another feature designed to be added to this smartphone app, serving as extra support when users are showing messages. The text-to-voice translation supports a spoken voice message that is translated from the inputting text. The interface of the text-to-voice support is shown in Figure 5.24 below, with users able to translate text to voice by touching anywhere on the screen in landscape orientation, except for the two flexible text size controller buttons. Hearing people can not only read messages via text but also hear messages via a speaker.

Figure 5.24. Text-to-Voice Translation

(2) Restriction when Inputting Messages in Portrait Orientation

A smartphone typically allows people to type in both portrait and landscape orientation. An online survey, named '*How do you type on the iPhone: Portrait or landscape?*', was conducted by Ritchie (2013) and received nearly 5000 replies, with 74.7% of respondents typing mostly in portrait orientation and only 10.9% mostly typing in landscape orientation. Moreover, 12.4% typed in both portrait and landscape orientation, depending on apps. The interviewees indicated some users might prefer to type in landscape orientation with an extra-wide keyboard. However, this smartphone app is designed to restrict the way of inputting messages in portrait orientation because there is not enough space to display messages when users attempt to input messages in landscape orientation.

Figure 5.25 below shows that predictive words and sentences can to be displayed when users type messages in portrait orientation. However, there is no space to display predictive words and sentences when the users type messages in landscape orientation.

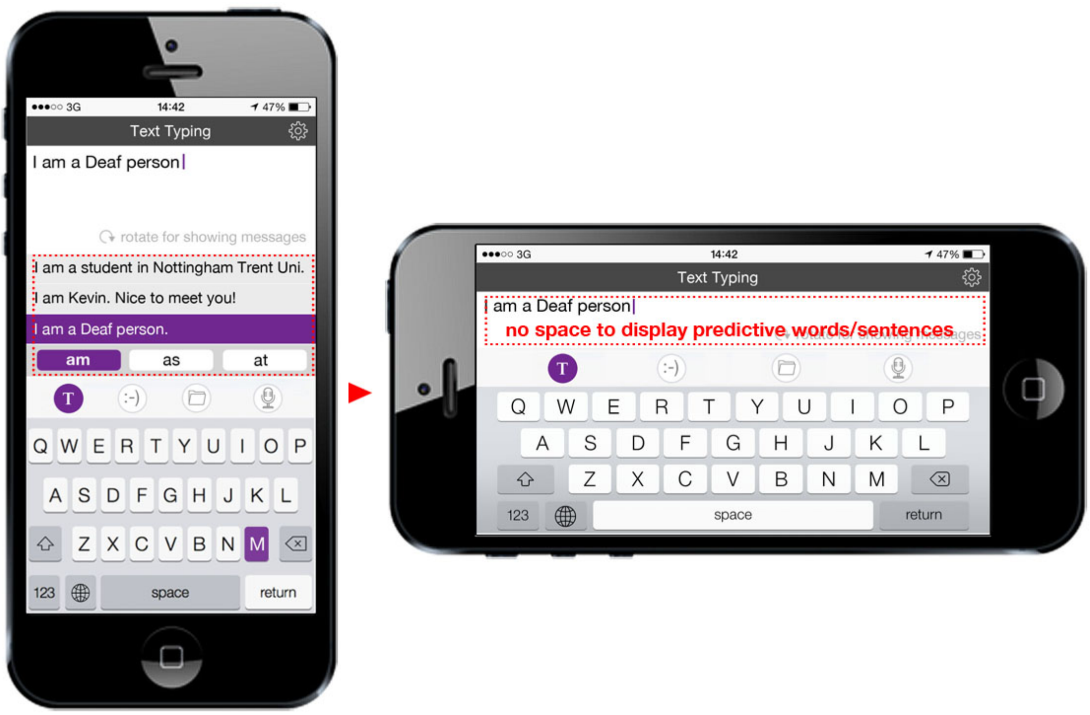


Figure 5.25. Limitation of Inputting Messages in Landscape Orientation (text typing)

Figure 5.26 below shows that when stored messages are displayed in portrait orientation around eight rows of messages can be shown. However, when stored messages are displayed in landscape orientation only three rows at a time are open to view.

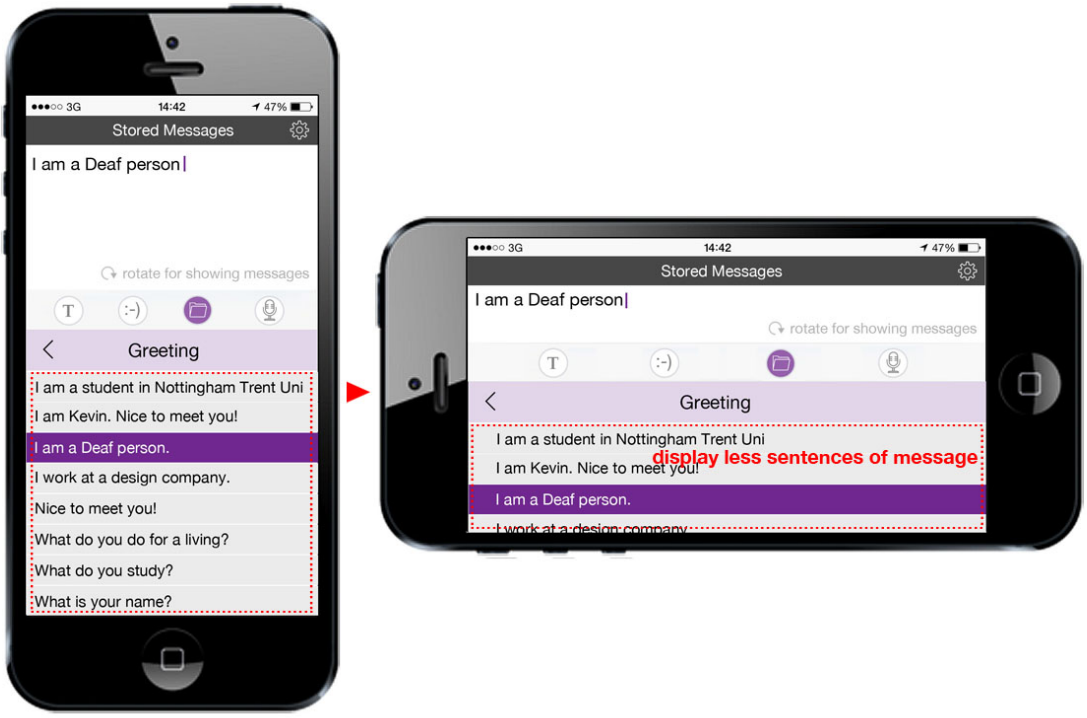


Figure 5.26. Limitation of Inputting Messages in Landscape Orientation (stored messages)

Based on these two limitations, inputting messages in landscape orientation is not allowed in this smartphone app. In addition, showing messages via rotating phones from portrait to landscape orientation is a specific action when using this app. If this app allows users to input messages in landscape orientation, an entirely new set of issues will have to be addressed.

(4) Emoticon Support

Ideogram and pictogram are two different types of symbols that represent an idea or concept more directly than a particular word or speech sound. An ideogram is a written symbol and a pictogram a graphic symbol. An emoticon can be understood as an ideogram or a pictogram (depending on the different symbol types) that specifically represent facial expressions (Kelz and Hodic 2014). Nonverbal messages in FTF communication express emotions that do not formally occur in CMC. An emoticon is a solution to help express emotions in CMC. Derks, Bos, and Von Grumbkow (2008) indicate that emoticons are mostly used to strengthen messages in CMC, with people often using emoticons in a way similar to a facial expression in FTF communication. Emoticons in CMC are able to replace nonverbal messages used in FTF communication (Walther and D'Addario 2001).

Emoticons were not designed in the prototype because the original concept of this app is to prompt users to express emotional information through physical interaction, instead of through the use of emoticons. However, the interviewees suggested that emoticons should be added as a way of inputting messages in this app. The interviewees indicated an emoticon is not just a way to express emotional information; it is an interesting way of communicating with people. It is also different to physical emotional expressions that occur in FTF communication.

An emoticon is designed to be added to this smartphone app as a way of inputting messages. Emoticons provide a quicker and easier way to input messages (especially with regard to emotional information) than text typing, as well as enriching the content of messages by using various pictures. Furthermore, Krohn (2004) indicates that emoticons are mainly used for informal communication between friends, which is related to the specific communication circumstance in this study i.e. one-to-one common (informal) conversation in FTF communication. In addition, emoticons can help D/HoH people express and detect an emotional expression because of their limited ability to express and detect verbal emotional cues.

5.6.3 Revision of Design Features

According to the above user evaluation, discussion and modification of the prototype, the revision of design features in this smartphone app encompasses three main features: (1) Four Ways of Inputting Messages, (2) Two Ways of Showing Messages with Flexible Text Size and Text-to-Voice Support and (3) A Large Mode for the Elderly.

(1) Four Ways of Inputting Messages

This feature aims to facilitate the communication process (increasing the speed of inputting messages) when using this smartphone app by providing effective ways of inputting messages for both D/HoH and hearing users.

The four ways of inputting messages are:

- Text Typing (with predictive support)
- Emoticons
- Stored Messages (with categorising support)
- Voice Recognition (with correcting support)

The methods of text typing, emoticons and stored messages are designed to be mainly used by D/HoH users because of their limited speech capabilities. The voice recognition facility is designed to be mainly used by hearing users. The voice recognition includes basic text typing and emoticons but does not include predictive and stored messages due to privacy issues.

(2) Two Ways of Showing Messages with Flexible Text Size and Text-to-Voice Support

This feature is the most significant feature designed in this smartphone app for prompting users to conduct and incorporate physical interaction with nonverbal messages in communication. It integrates CMC and FTF communication as an innovative method of dialogue used between the D/HoH and hearing people in FTF communication.

The two ways of showing messages are:

- Showing Messages via A Single Phone
- Showing Messages via Two Phones

Showing messages via a single phone is designed to be used between D/HoH and hearing people. It is the primary purpose for designing this smartphone app. A scenario showing messages via a single phone is presented in Table 5.15 (p.156). Showing messages via two phones is designed to be used between Deaf and Hard of Hearing people. It is the secondary purpose for designing this smartphone app. A scenario showing messages via two phones is shown in Table 5.16 (p.156).

In addition, the flexible text size and text-to-voice features are two further supports to increase the usability of the showing messages feature in this app.

(3) A Large Mode for the Elderly

This feature provides further support in the design of this smartphone app specifically for older users. The large mode seeks to reduce difficulties faced by older users when they are using a smartphone by providing bigger text size and interfaces.

The large mode specifically focuses on increasing the size of two elements in this smartphone app:

- Four Key Feature Buttons/Icons
- Message Text

These are three main design features of this smartphone app have been developed via a UCD process, which is based on the five design steps of the creative practice (see Figure 5.1, p.92). This smartphone app provides an innovative communication solution that can bridge the FTF communication gap between the D/HoH and hearing people. The next chapter will indicate the significant innovations of this communication solution and present the three main design features.

CHAPTER SIX

A SMARTPHONE APP: TALK2ME

Chapter 6: A Smartphone App: Talk2Me

This chapter describes the significant innovations within the smartphone app 'Talk2Me' and presents a completed prototype with detailed interfaces. Furthermore, this chapter compares the Talk2Me app with other apps that provide similar features. Finally, this chapter summarises feedback from end-users about the completed prototype.

a. Innovations of Talk2Me

   This section indicates significant innovations of the communication solution (the Talk2Me app) developed in this study.

b. A Talk2Me Prototype

   This section presents a completed prototype with detailed interfaces to explain the design features of the Talk2Me app.

c. A Comparison with Similar Apps

   This section compares Talk2Me app with other similar apps and indicates the differences between this smartphone app and others.

d. Talk2Me User Feedback

   This section evaluates the final Talk2Me prototype and summarises user feedback.

6.1 Innovations of Talk2Me

The smartphone app developed in this study is called 'Talk2Me' and reflects the users' choice of name. Chapter 2 has shown that the existing D/HoH communication solutions (sign language/voice recognitions and text-/video-based communication technologies) and the potential communication solutions (SNS and communication apps) for the D/HoH are mainly used for non-FTF communication. The Talk2Me app has significant differences from the existing and potential D/HoH communication solutions.

An innovation of the Talk2Me app is:

A D/HoH communication solution specifically developed via interaction design for FTF communication

In recent years design has come to play a significant role that inspires creative solutions that improve human health and wellbeing (Chanberlain, Wolstenholme and Dexter 2015). The Talk2Me app is a D/HoH communication solution specifically developed via interaction design, whilst most studies in the field of D/HoH communication solutions mainly focus on the development of relevant technology (see 2.2.1 Existing Communication Solutions for the D/HoH, p.18). In other words, the Talke2Me app does not contain new technology developments but new 'designs'. For example, the most significant design feature in this app (rotating to show messages) is an innovative design based on an existing technology (a smartphone accelerometer sensor). Jones and Marsden (2005) indicate that an interaction design project is specifically developed from a usability perspective rather than developing new technology. The development process of the Talk2Me app was particularly focused on the usability issue through the use of the UCD approach.

New communication opportunities offered by SNS and communication apps are mainly for non-FTF communication. Part of this research has shown that new media communication technologies (SNS and communication app) have opened new communication opportunities that are able to bridge the communication gap between the D/HoH and hearing people. However, a further communication gap in FTF communication between the D/HoH and hearing people still exists even when using SNS and communication apps. The Talk2Me communication solution provides a specific way (rotating to show messages) to communicate between two users in FTF communication. The action of 'rotating to show messages' brings significant interaction between two users such that it can encourage users to use nonverbal messages in communication. Physical interaction with nonverbal messages is a significant element in FTF communication. It is also significantly important for the D/HoH communication as the D/HoH rely on visual sense much more than hearing people during communication.

People might argue that common SMS/IM communication apps, or note apps, can also be used to show messages and is similar to the showing message feature designed in the Talk2Me app (some of the interview data has put this issue forward). However, the main difference between the showing message feature designed in the Talk2Me app and other apps is the usability. The usability of Talk2Me in FTF communication is superior to other apps e.g. showing messages via a full screen in the landscape orientation with bigger text size is a specific feature for increasing the usability in FTF communication.

6.2 A Talk2Me Prototype

The above section has indicated the significant innovations of the Talk2Me app. This section presents a completed prototype with detailed interfaces to explain the design features of the Talk2Me app.

(1) Launch Image and Home Page

The left image below is the launch image, which is the first image displayed when starting this smartphone app. The right image below is the home page, which is the first page displayed when opening this smartphone app. The home page provides brief guidance about using the most significant feature of this smartphone app (rotating to show messages). The user can start to use this smartphone app by selecting a way to input messages from the four buttons/icons at the bottom of the home page.

Launch Image	Home Page
	

Table 6.1. Launch Image & Home Page

(2) Four Ways of Inputting Messages

a. Text Typing with Predictive Support

Table 6.2 below shows the text typing interfaces in the standard (left image) and large modes (right image).

In the large mode, the message text size is increased from 17 pt to 25.5 pt and the four key feature buttons/icons increased from 68x68 px to 130x130 px.

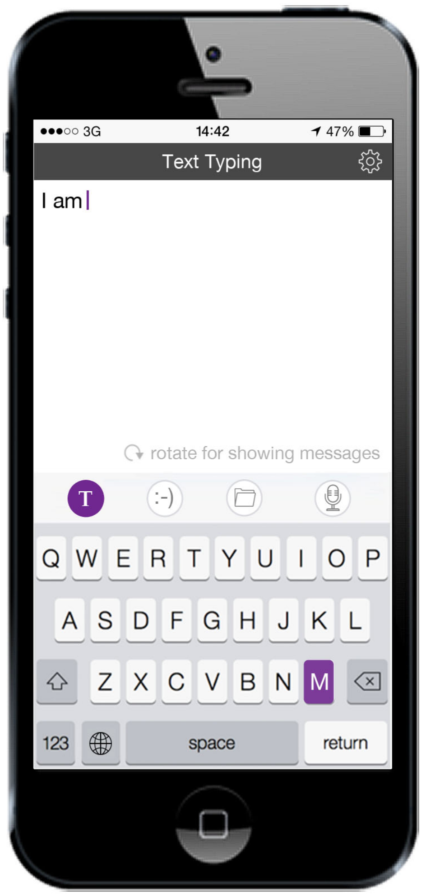
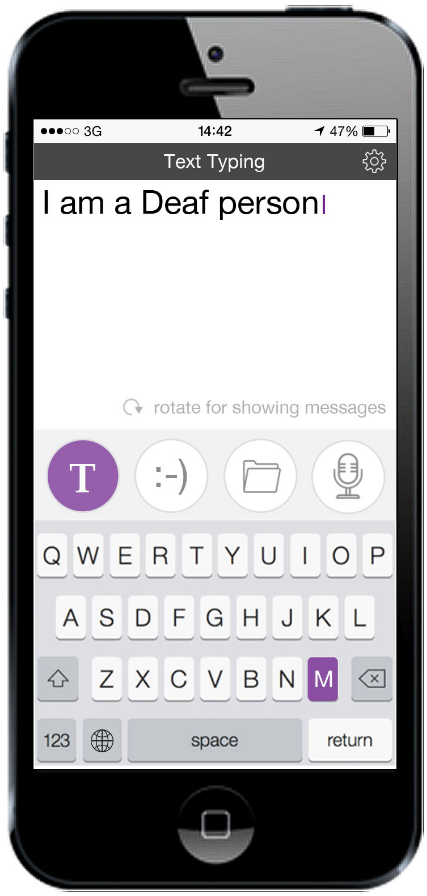
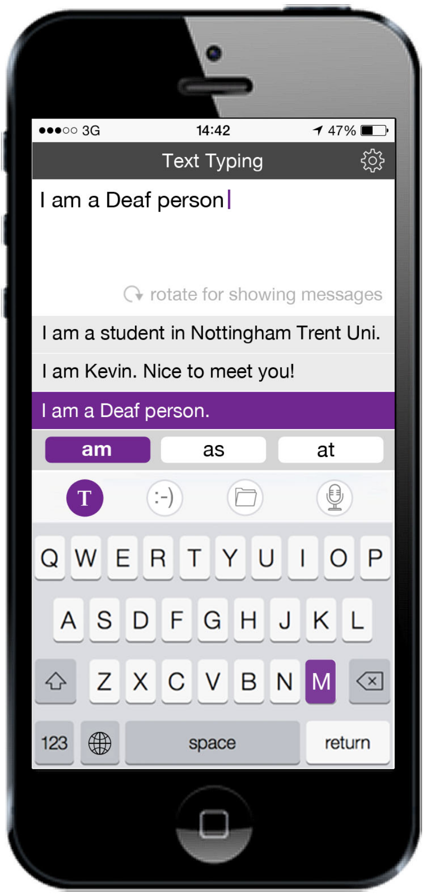
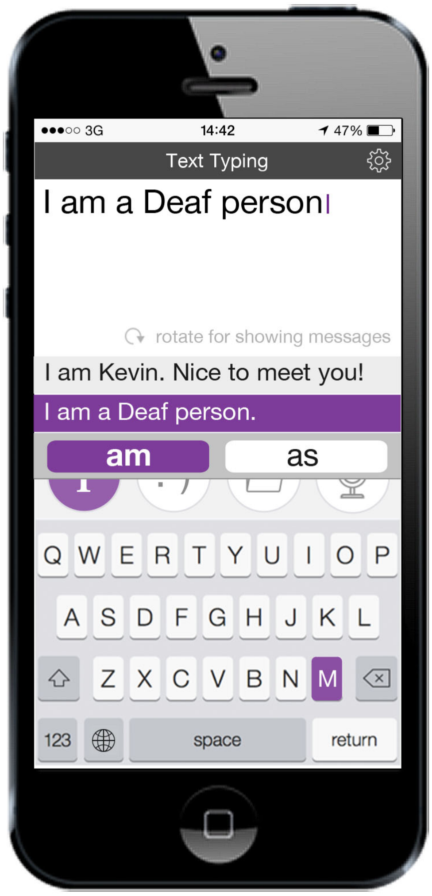
Standard Mode	Large Mode
	

Table 6.2. Text Typing with Predictive Support 1

In addition, Table 6.3 below shows the interface for text typing with the predictive words/sentences feature in the standard (left image) and large modes (right image).

In order to leave enough space to display the typing messages, there are three predictive words/sentences allowed to display in the standard mode and two in the large mode (with bigger text size). Furthermore, the predictive words/sentences in the large mode have been designed to cover part of the four key feature buttons/icons due to the limited space (at least four-row spaces to display the typing messages should be allowed).

<table>
<tr><th>Standard Mode</th><th>Large Mode</th></tr>
<tr><td>


</td><td>


</td></tr>
</table>

Table 6.3. Text Typing with Predictive Support 2

b. Emoticons

Table 6.4 below shows the emoticon interface in the standard (left image) and large modes (right image).

In large mode, the message text size is increased from 17 pt to 25.5 pt and the four key feature buttons/icons increased from 68x68 px to 130x130 px. Furthermore, the size of the emoticons is also increased to approximately one and half times bigger in the display area (upper) and four times bigger in the emoticon area (lower).

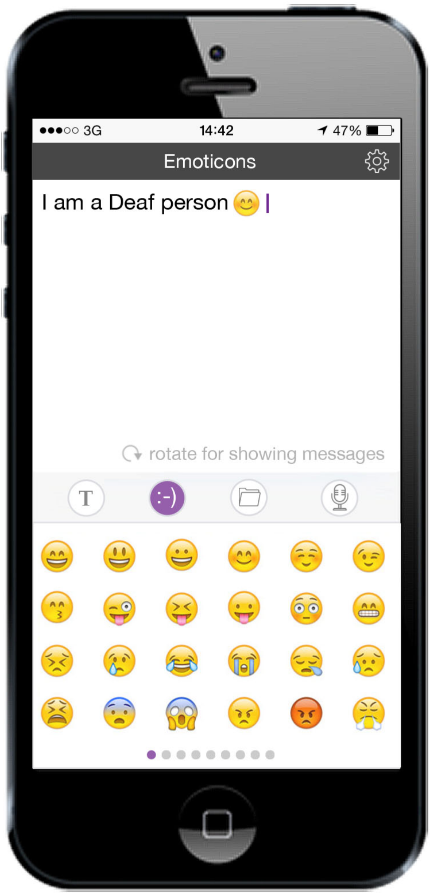
Standard Mode	**Large Mode**
	

Table 6.4. Emoticon Message Support

c. Stored Messages with Categorising Support

Table 6.5 shows the stored messages (selecting categories) in the standard (left image) and large modes (right image).

In large mode, the message text size is increased from 17 pt to 25.5 pt and the four key feature buttons/icons increased from 68x68 px to 130x130 px. The text size for the categories is also increased from 20 pt to 32 pt.

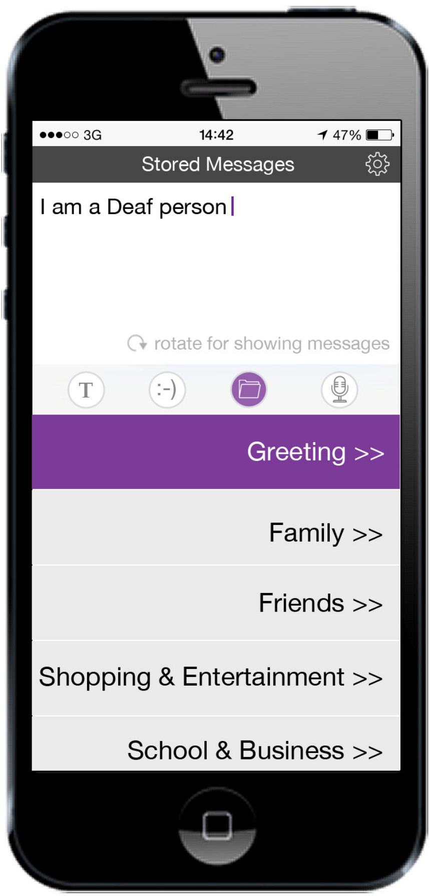
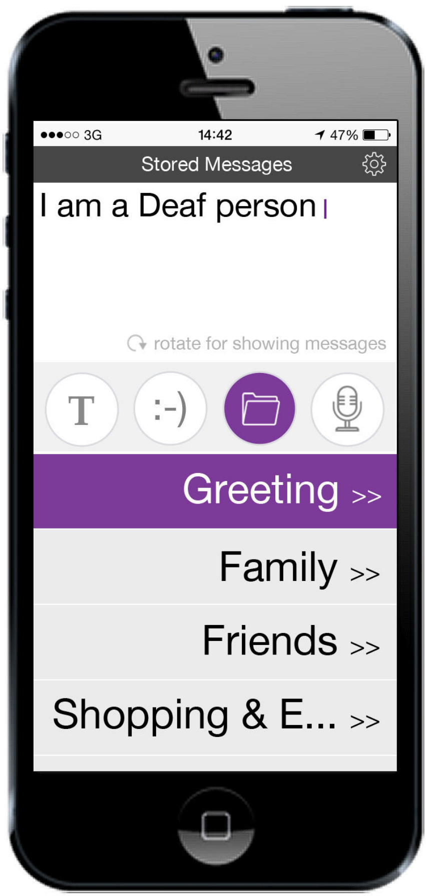
Standard Mode	Large Mode
	

Table 6.5. Stored Messages with Categorising Support 1

Table 6.6 below shows the stored messages (selecting messages) in the standard (left image) and large modes (right image).

The text size for the 'Greeting' category is increased from 18 pt to 27 pt and the stored messages text size increased from 15 pt to 22.5 pt.

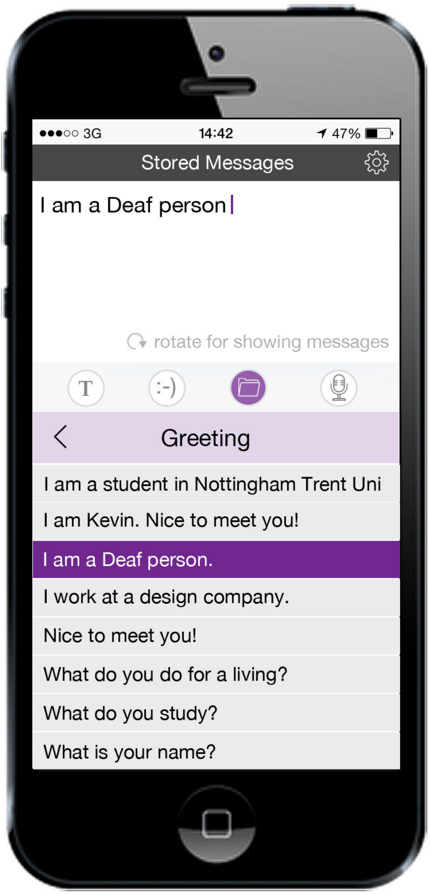
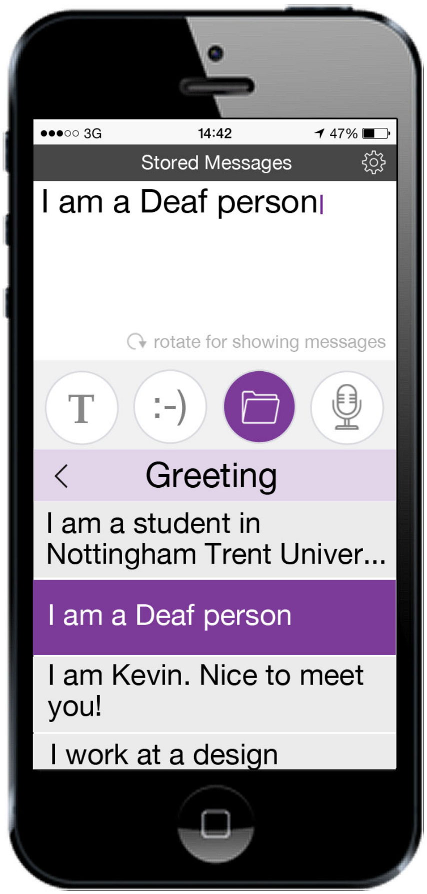
<table>
<tr><th>Standard Mode</th><th>Large Mode</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Table 6.6. Stored Messages with Categorising Support 2

d. Voice Recognition with Correcting Support

Table 6.7 below shows the voice recognition feature in the standard (left image) and large modes (right image).

In large mode, the message text size is increased from 17 pt to 25.5 pt and the four key feature buttons/icons increased from 68x68 px to 130x130 px. In addition, the size of 'Tap and Dictate' and the record button/icon is increased to one and half times bigger.

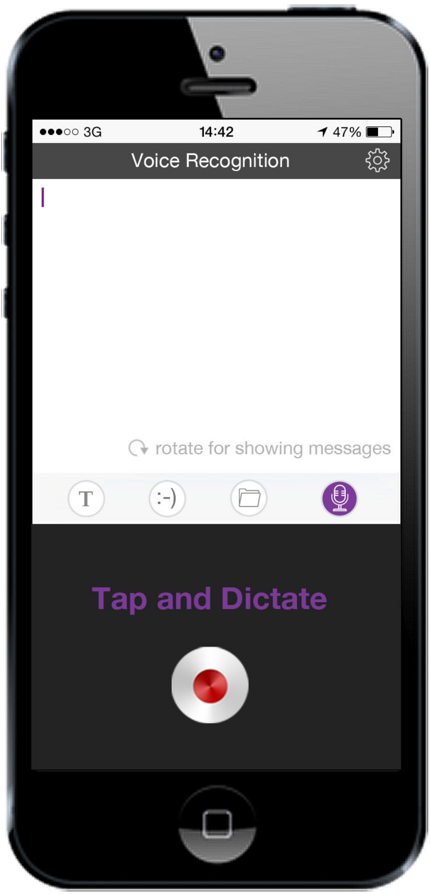
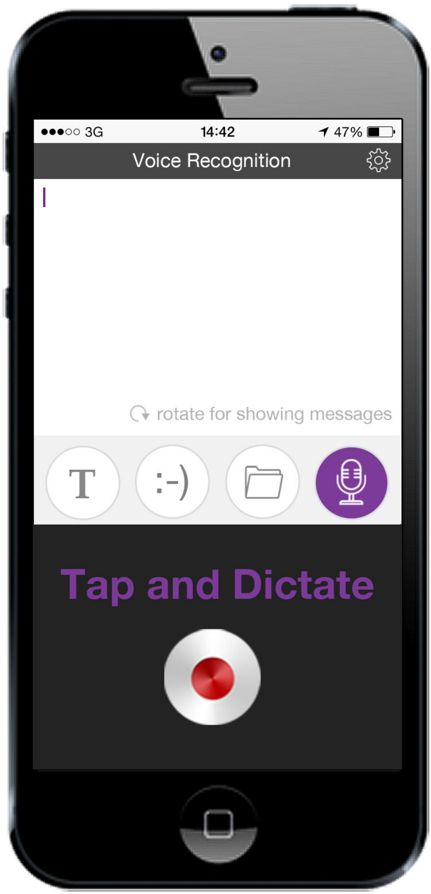
Standard Mode	Large Mode
	

Table 6.7. Voice Recognition with Correcting Support 1

Table 6.8 below shows the voice recognition (in processing) feature in the standard (left image) and large modes (right image).

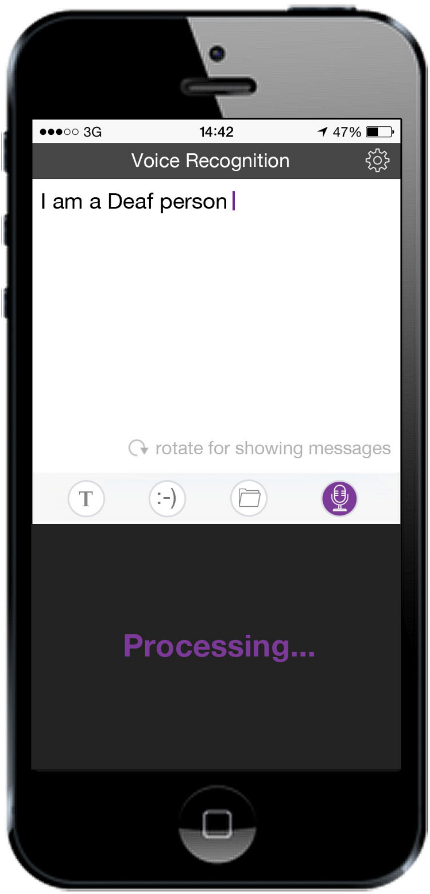
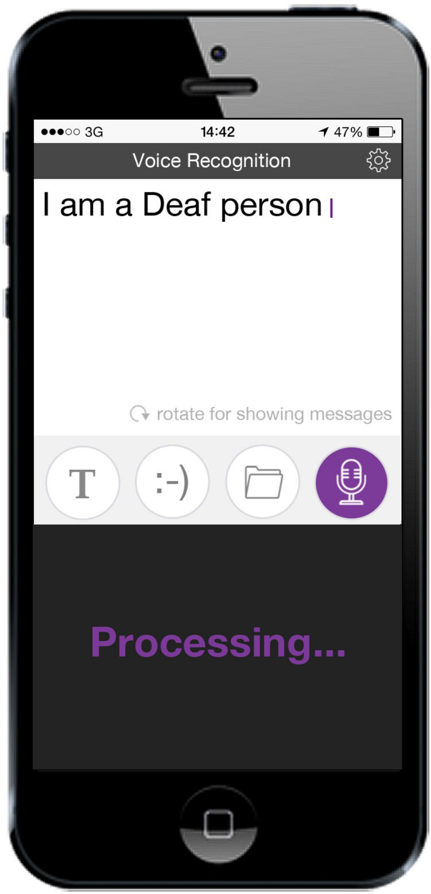
Standard Mode	Large Mode
	

Table 6.8. Voice Recognition with Correcting Support 2

Table 6.9 below shows the voice recognition (in the correcting interface) feature in the standard (left image) and large (right image) modes.

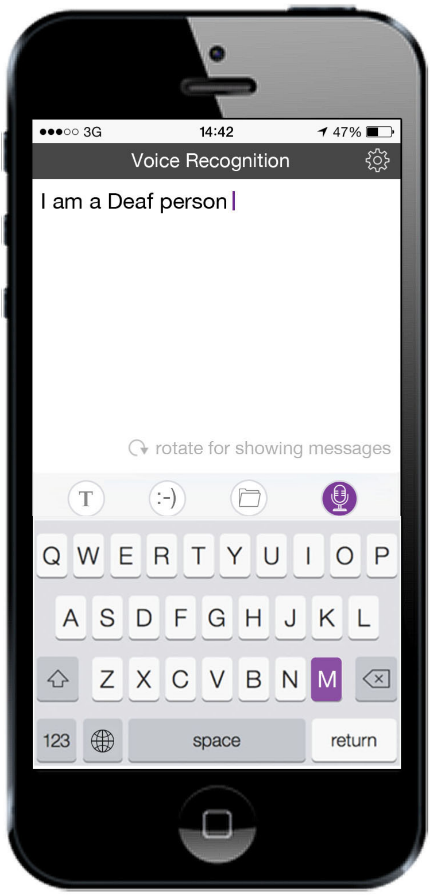
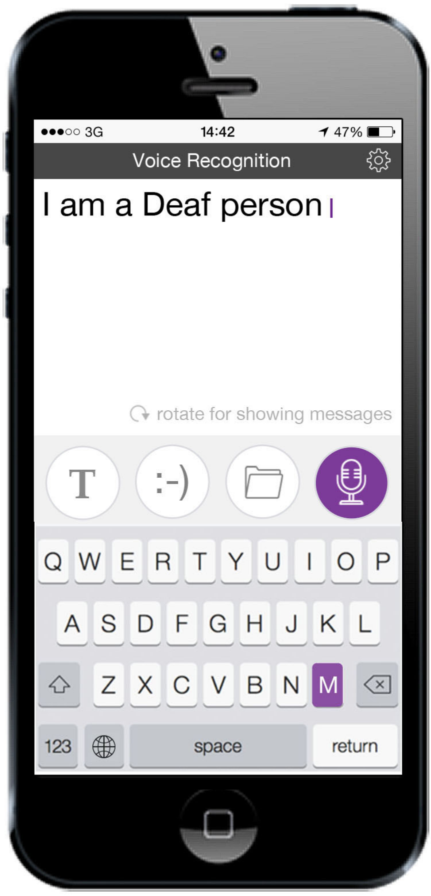
<table>
<tr><th>Standard Mode</th><th>Large Mode</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Table 6.9. Voice Recognition with Correcting Support 3

The above four ways of inputting messages in this smartphone app can be used to support each other. For example, D/HoH users can input a message, which combines text typing (with predictive support), emoticons and stored messages (with categorising support). In addition, hearing users can use voice recognition to input messages and correct mistakes that might have occurred through text typing (predictive and stored messages are not supported).

All the increased sizes in the large mode match the standard in the size guide for older users as recommended by Jin, Plocher and Kiff (2007).

(3) Viewing Messages in Portrait Orientation

The above four inputting interfaces (text typing, emoticons, stored messages and voice recognition) are hidden when the user touches the message text display area. The inputting interfaces are extended again when the user touches the inputting buttons/icons at the bottom of the page. Table 6.10 below shows when the inputting interfaces are hidden. The left image is the standard mode and the right image the large mode.

The message text size in the large mode of the viewing messages interface (right image) is increased from 25.5 pt (the large mode text size in the inputting messages interface) to 34 pt. This specific design provides extra large text size (34 pt) for older users to read more easily. The size is returned back when the inputting interfaces are extended again.

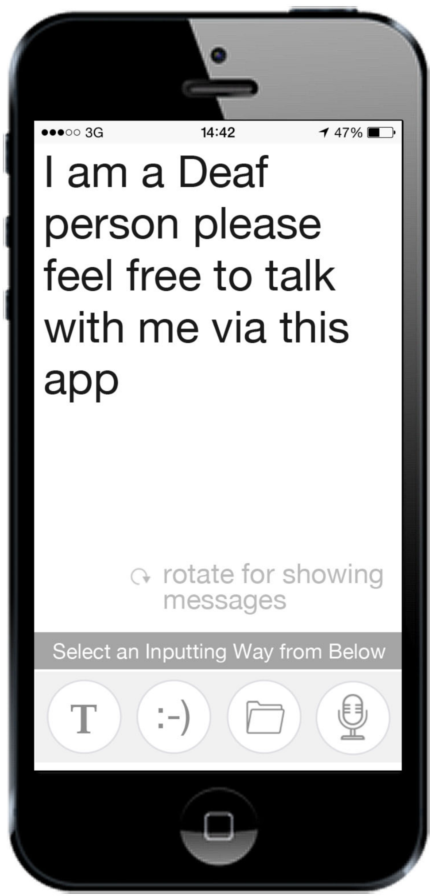
Standard Mode	Large Mode
	

Table 6.10. Viewing Messages in Portrait Orientation

(4) Showing Messages in Landscape Orientation

Showing messages in landscape orientation by rotating phones from portrait orientation is the most significant feature designed in this smartphone app. Users are restricted to input messages in portrait orientation and show messages in landscape orientation.

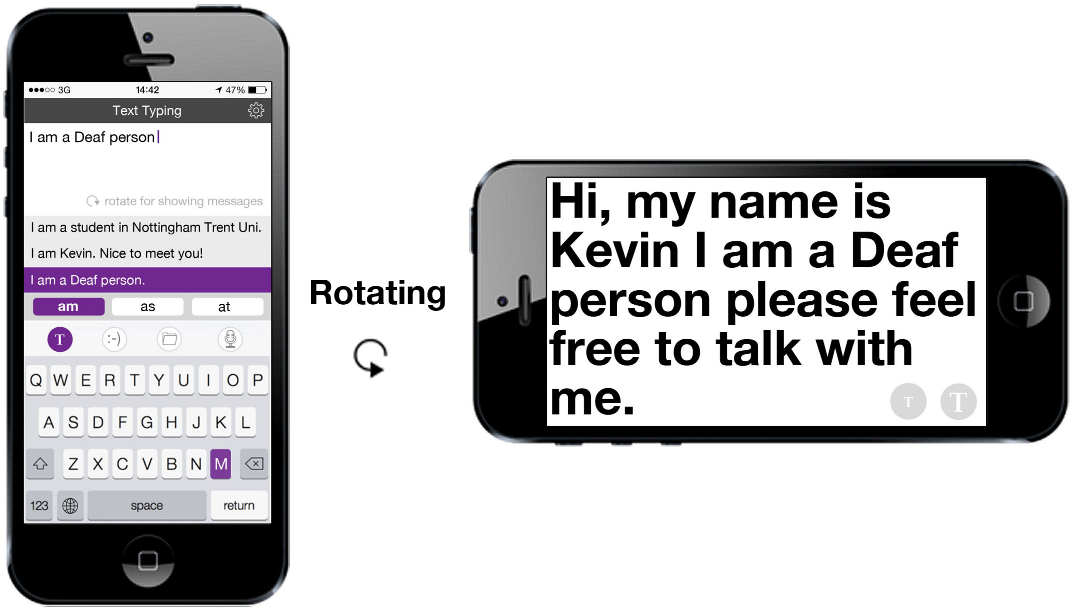


Figure 6.1. Rotating to Show Messages 2

There are two further supports provided in the showing messages interface: a. Flexible Text Size Support and b. Voice-to-Text Support.

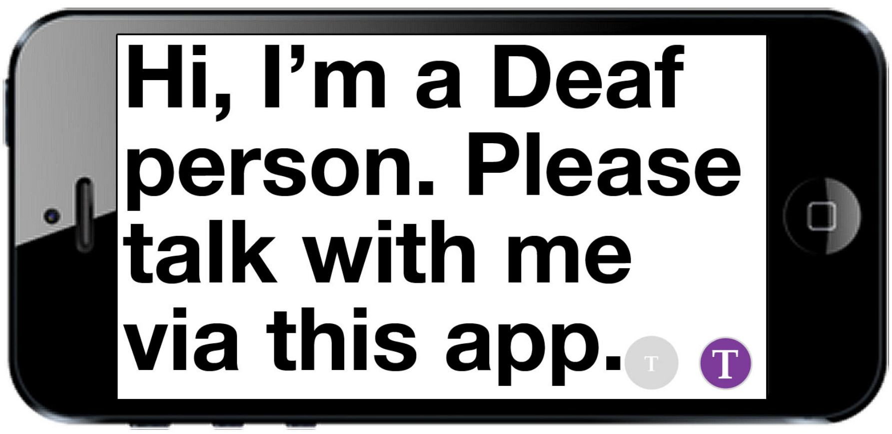
a. Flexible Text Size Support

The user can change text size via the buttons on the bottom-right of the screen when they are showing messages in landscape orientation. This feature supports four flexible text sizes with different message lengths. The four flexible text sizes and message lengths are: a. Size 68 pt in a 48-character message length, b. Size 56 pt in a 75-character message length, c. Size 48 pt in a 108-character message length and d. Size 40 pt in a 147-character length. The 56 pt size is the normal size (default size) used in this smartphone app for showing messages.

Table 6.11 below shows the showing messages interfaces in different text sizes.

Normal Size (Default size): 56 pt allows a 75-character message length

Bigger Size: 68 pt allows a 48-character message length



Smaller Size: 48 pt allows a108-character message length

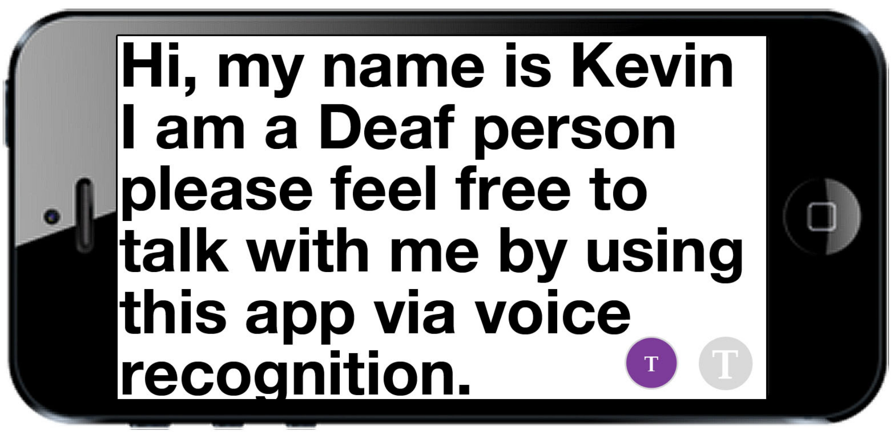


Table 6.11. Flexible Text Size Support

b. Text-to-Voice Support

The user can translate text to voice (speaker) by touching anywhere on screen, except the two flexible text size controller buttons when they are showing messages in landscape orientation.

Figure 6.2 below shows the showing messages interface when users are using the text-to-voice support feature.

Figure 6.2. Text-to-Voice Support

(5) A Scenario of using Talk2Me App

This section presents a typical scenario of using the Talk2Me app in FTF communication between a D/HoH person and a hearing person.

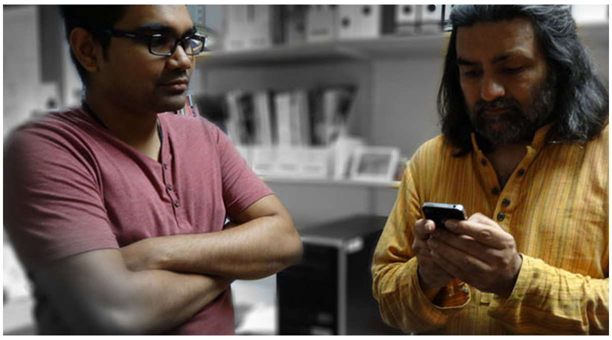
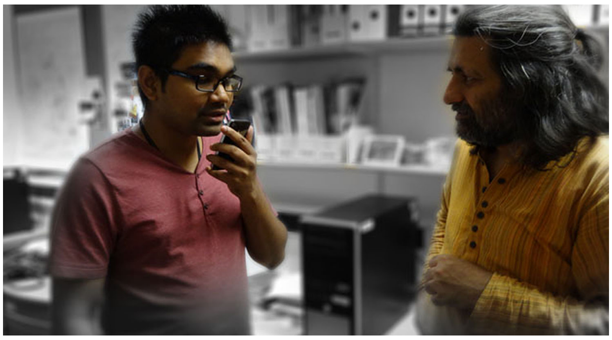
Step 1: The D/HoH person (right side) inputs a message via this smartphone app (in portrait orientation).	
Step 2: The D/HoH person (right side) shows the message to the hearing person (left side) via this smartphone app (in landscape orientation).	
Step 3: The hearing person (left side) inputs a message (voice recognition) via this smartphone app (in portrait orientation).	
Step 4: The hearing person (left side) shows the message to the D/HoH person (right side) via this smartphone app (in landscape orientation).	

Table 6.12. A Scenario of Using Talk2Me App

6.3 A Comparison with Similar Apps

This research was started on May 2011 and the initial concept of the Talk2Me app took form in the late 2012. The Talk2Me app was developed between early 2013 to July 2014 when the prototype was completed. A prototype of the Talk2Me app was developed and presented for the IxDA Interaction Awards in July 2014. It was made public in October 2014 (http://awards.ixda.org/entry/2015/talk2me/). There are other apps with similar features and/or similar names to the Talk2Me app. For example, talk2me, Talk2Me and Note Speak Listen. This section gives a comparison between these apps and the Talk2Me app and indicates the differences.

When the author decided on 'Talk2Me' as the name of the app in this study the name had not been used for other apps in the UK Apple App Store up until June 2014. However, there are two apps (Android and Windows Phone) that use the same name 'talk2me/Talk2Me.

Names	Description
talk2me	The talk2me is a Windows Phone app that provides only one simple feature: text-to-voice translation. The feature is similar to the text-to-voice translation feature (speaker) in the Talk2Me app in this study. However, the text-to-voice feature in the Talk2Me app in this study is not the main concept as it is just an extra support when showing messages. Also, text-to-voice technology has been broadly applied on smartphone apps.
Talk2Me	The Talk2Me is an Android app that is designed for people to seek, meet and chat with random people online. It provides totally different functions to the Talk2Me app in this study, except the name. This app is a social app whereby users can meet/seek new friends online.

Table 6.13. Similar Apps

Although the above two apps have same names as the Talk2Me app in this study, the purpose and concept of the two apps are totally different to the Talk2Me app designed in this study. Because of the differences, a further comparison between the two apps and the Talk2Me app is unnecessary.

However, there is an Android app 'Note Speak Listen' that provides similar features to the Talk2Me app in this study.

Names	Description
 **Note Speak Listen**	The Note Speak Listen is a communication app (Android) for D/HoH people. It allows D/HoH people to communicate with hearing people via a written note (display in a large text size) by passing the phone to each other. D/HoH users are allowed to input messages via text typing and hearing users are allowed to input messages via voice recognition with the use of this app.

Table 6.14. Note Speak Listen App

During the development process of the Talk2Me app, the Note Speak Listen app was not discovered in the UK Apple store via the key search words 'deaf' and 'hard of hearing'. There is no evidence to prove that the concept of the Note Speak Listen app was proposed earlier than the Talk2Me app. The only information available is that the last updated of the Note Speak Listen app data on Google Play (an Android App Store) was on April 11, 2014. However, this PhD research was started in 2011 and the concept of Talk2Me app appeared in 2012. Table 6.15 below shows three main features provided by the Note Speak Listen app that are very similar to the Talk2Me app designed in this study. The three features are: a. Message Display, b. Text Typing and c. Voice Recognition.

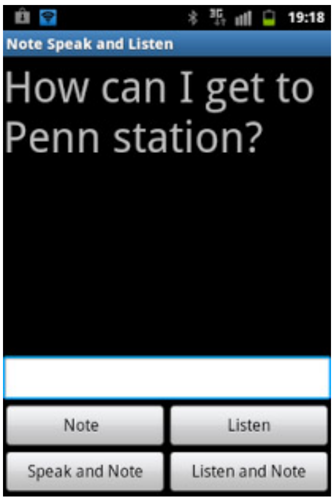
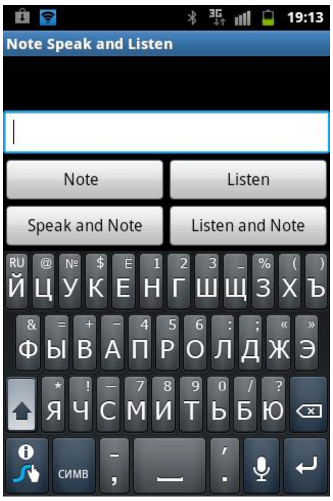
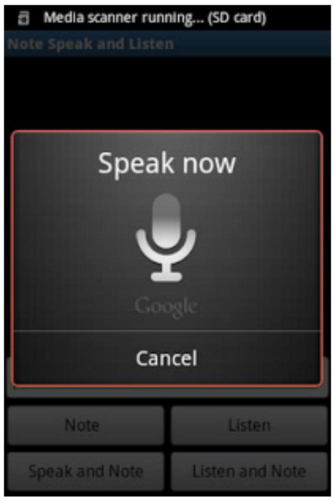
Message Display	Text Typing	Voice Recognition
		

Table 6.15. Interfaces of Note Speak Listen App

Although these three features designed in the Note Speak Listen app are similar to the Talk2Me app, the author argues that the Talk2Me app provides better usability than the Note Speak Listen app, which will be discussed relative to three significant aspects: a. Various Ways for Inputting Messages b. A Specific Action of Showing Messages and Flexible Supports and c. A Specific Mode for the Elderly.

a. Various Ways for Inputting Messages

Firstly, the Talk2Me app provides various ways of inputting messages, whilst the Note Speak Listen app only provides two ways (text typing and voice recognition). For example, the features of stored messages (with categorising support) and predictive words/sentences are two additional ways to input messages designed in the Talk2Me app. The additional inputting methods can facilitate the communication process by increasing the speed of inputting messages.

b. A Specific Action of Showing Messages and Flexible Supports

Secondly, the Talk2Me app provides a specific action ‘rotating’ for showing messages. It is the most significant design of the Talk2Me app for FTF communication. Furthermore, Talk2Me app provides a more flexible way to show messages than the Note Speak Listen app. For example, although the Note Speak Listen app also provides bigger text when showing messages, the Talk2Me app provides a flexible text size support via a full screen display. In addition, the showing message feature of the Talk2Me app supports text-to-voice translation, this is specific for hearing users. These additional supports can increase the readability and usability when users are showing messages to each other.

c. A Specific Mode for the Elderly

Thirdly, the Talk2Me app provides a specific mode for older users that contains bigger text size and interfaces. It is significant because most of D/HoH people are the elderly and they face difficulties (e.g. common text and interface sizes are too small) when they are using a smartphone. This specific mode can reduce the difficulties faced by older users. However, the Note Speak Listen app does not provide any solution for dealing with this issue.

The above three significant arguments affirm that the Talk2Me app provides better usability than the Note Speak Listen app when it is used in FTF communication between the D/HoH and hearing people. In addition, the user feedback about the Talk2Me app has substantiated the arguments. The next section will present the significant user feedback about the final prototype of the Talk2Me app. It significantly indicates three main useful features designed in the Talk2Me app: a. Various Ways for Inputting Messages b. A Specific Action of Showing Messages and Flexible Supports and c. A Specific Mode for the Elderly.

In addition, a task-oriented evaluation of the Note Speak Listen app was conducted by a communication task given to the the D/HoH and hearing people, see Appendix 14. The evaluation feedback shows that speech-to-text translation and large text display are two useful features in the Note Speak Listen app. A hearing tester said, ‘It is a good app for communicating with deaf people. The voice to text translation in this app works better than I thought’ and a D/HoH tester said, ‘I think the best part of this app is the speech to text translation function. My hearing friend only need to speak to my phone and then I can read it via text. Text being displayed in a large size is great.’ In addition, an older D/HoH tester said, ‘for me it takes time to type text as I am not used to type on my phone’. A D/HoH tester commented, ‘This app is similar to Talk2Me app, but Talk2Me app provides more useful features e.g. stored message.’ The evaluation also shows that the button of ‘note’ and ‘listen in the Note Speak Listen app is confusing.

The user feedback shows that the two useful features (a. speech-to-text translation and b. large text display) designed in the Note Speak Listen app are similar to the features designed in the Talk2Me app. However, additional support is provided by the Talk2Me app such as the above three significant aspects.

6.4 Talk2Me User Feedback

Based on the five design steps through a UCD development process, the Talk2Me app has been presented via a completed prototype with detailed interfaces, which is the final outcome of the interaction design creative practice in this study. The prototype presented and demonstrated the design features of the Talk2Me app. Furthermore, the Talk2Me app was presented via a short video to explain the novel D/HoH communication solution. The video is available at http://youtu.be/KJ1klK5aORM

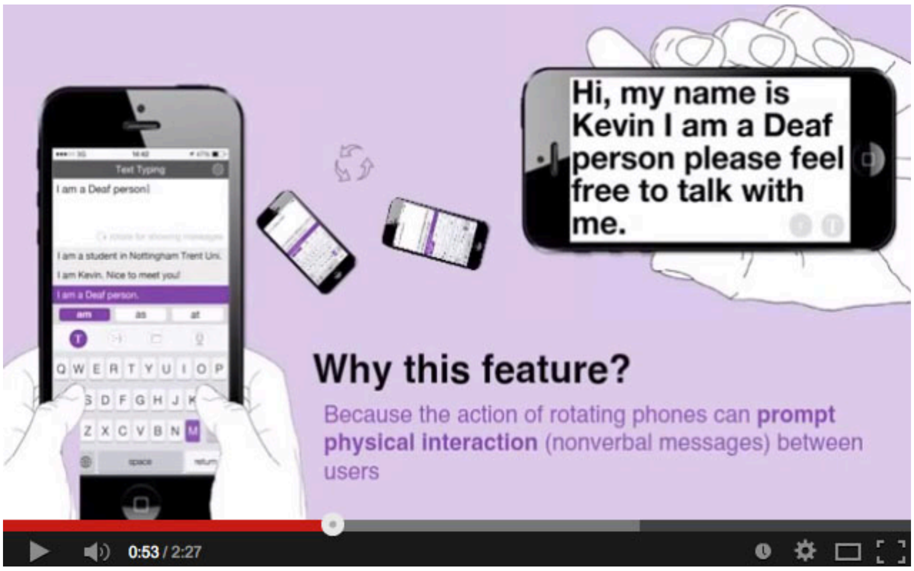


Figure 6.3. A Video Description of Talk2Me

In addition, the prototype was built in an app-simulated environment via X-code. An app-simulated environment allows the user to experience how to operate this smartphone app in a dynamic way (interaction experience). See Appendix 25.

At the end of this research, the final prototype of the Talk2Me app was evaluated via the video and the app-simulated prototype through on-line interviews and a demonstration. The feedback from the evaluations forms part of the conclusion. All the feedback can be seen in Appendix 13.

Below are some words (feedback) from the end-users commenting on the final prototype of the Talk2Me app.

'The various inputting ways on this app are good, especially the text typing with predictive words/sentences and the stored messages.'

'The Elder mode[15] *is a very useful feature. I always feel text size is too small to read on my phone and the buttons are also too small for my stupid fingers sometimes.'*

'I am really looking forward to using it. The rotating to show messages is a great idea and the messages shown using bigger text size with full screen display is very useful. Go for it! '

In addition to the above comments, there are some suggestions below from the end-users for further development of the Talk2Me app.

- Recording of the Shown Messages
  It allows users to record shown messages. Users can quickly return and use the previously shown messages they typed when they need to repeat or use the same messages.

- Supports in Different Smartphone OSs
  It allows users to install this app with different phone OS such as Google Android and Apple iOS.

- A Large UI Keyboard
  It allows older users to type text more easily via a large UI smartphone virtual keyboard.

[15] The large mode in this smartphone app was called the elder mode when interviewed.

CHAPTER SEVEN

CONCLUSION AND FURTHER WORK

Chapter 7: Conclusion and Further Work

This chapter restates the principal outlines and significant outcomes of this practice-based research project. In addition, it states the potential limitations of this research and possible future research.

There are five sections in this chapter:

a. Introduction
   This section restates the original research aims and research questions.

b. Significant Findings
   This section presents the resultant significant findings.

c. Contributions
   This section covers the most important contributions to knowledge.

d. Limitations and Recommendations
   This section highlights the limitations of this study and recommendations for future research.

e. Conclusion
   This section concludes all of the research and restates the most significant findings.

7.1 Introduction

New media communication has increased in popularity in recent years and brought new forms of communication and technologies to our daily lives, such as social media and smartphones. It has opened new communication opportunities and as a result people spend an increasing amount of time communicating. However, there is a communication gap between the D/HoH and hearing people (see 2.1.2 A Communication Gap between the D/HoH and Hearing People, p.14). The question therefore arises, are the new communication opportunities able to bridge this communication gap?

This research has investigated the influences of new media communication technologies (SNS and communication apps) as used by the D/HoH. It has also explored new communication opportunities offered by SNS and communication apps for communication between the D/HoH and hearing people. In addition, this research investigated and produced a novel communication solution for bridging the FTF communication gap between the D/HoH and hearing people. The communication solution is a smartphone app specifically developed via interaction design.

The two research questions below were answered in this research.

- Are the new media communication technologies of SNS and communication apps able to open new communication opportunities for the D/HoH to communicate and interact with the hearing community? If so, how?

- How to bridge the FTF communication gap between D/HoH and hearing people via the design of a smartphone app?

7.2 Significant Findings

By answering the two research questions, this study revealed four significant research findings.

a. New communication opportunities offered by SNS and communication apps for the communication between the D/HoH and hearing people

   This research has found from the survey that the D/HoH community believe new media communication technologies (SNS and communication apps) are able to open new communication opportunities for the D/HoH to communicate and interact with the hearing community. This finding shows that SNS and communication apps are being or could be used by a significant number of D/HoH people to communicate with hearing people.

b. Three significant features of SNS and communication apps that offer new communication opportunities

   This research indicates three features involved in SNS and communication apps that can offer new communication opportunities for the communication between the D/HoH and hearing people. The three significant features are:

   - An accessible communication channel
   - An integrated communication and social platform
   - An optimised multi-function interface

c. A FTF communication gap is proposed to exist between the D/HoH and hearing people even when using SNS and communication apps

   This research proposes that there is still a further communication gap in the FTF communication between the D/HoH and hearing people even using SNS and communication apps. This is because physical interaction with nonverbal messages is missing in the use of SNS and communication apps, but it is a significant element in FTF communication.

d. A novel communication solution for bridging the FTF communication gap between the D/HoH and hearing people has been developed

This research has developed a novel communication solution that can bridge the FTF communication gap between the D/HoH and hearing people. This communication solution is a smartphone app design. It provides an innovative method for the communication between the D/HoH and hearing people. Its specific design feature 'rotating to show messages' that allows users to conduct physical interaction with nonverbal messages when communicating FTF.

7.3 Contributions

There are three significant contributions to knowledge from this study.

- The first contribution to knowledge from this research is that it provides a new understanding of SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) as used by the D/HoH. These studies are limited in existing literature. This contribution shows that the D/HoH believe that SNS and communication apps can open new communication opportunities for the D/HoH and that SNS and communication apps can improve the communication between the D/HoH and hearing people.

- The second contribution to knowledge from this research is that it provides a further understanding of SNS and communication apps when used for the communication between the D/HoH and hearing people. This contribution indicates three significant features of SNS and communication apps (a. An accessible communication channel, b. An integrated communication and social platform and c. An optimised multi-function interface) that can open new communication opportunities for the communication between the D/HoH and hearing people.

- The third contribution to knowledge from this research is that it provides an innovative communication solution that can be used to bridge the FTF communication gap between the D/HoH and hearing people. This communication solution is a smartphone app design specifically developed from an interaction design perspective.

7.4 Limitations and Recommendations

(1) Limitations of the Talk2Me App

This research provides a novel communication solution for bridging the FTF communication gap between the D/HoH and hearing people: a smartphone app Talk2Me. However, the Talk2Me app has two limitations.

- The Talk2Me app does not include a new smartphone keyboard for older users.
- The Talk2Me app primarily supports only one communication circumstance.

(2) Recommendations for Further Work

- Re-design a smartphone virtual keyboard specifically for older users

  This study has provided a smartphone app that can bridge the FTF communication gap between the D/HoH and hearing people, it includes a large mode that is specifically designed for older users. The large mode contains a large size UI and text, but it does not include a virtual keyboard. However, text typing via the commonly sized smartphone keyboard brings difficulties for older users. As most of the D/HoH are older people, re-designing a smartphone virtual keyboard provided in the Talk2Me app would bring significant accessibility benefits but it would be a major undertaking.

- Provide further support for different communication circumstances

  This study provides a communication solution specifically focused on the communication circumstance of one-to-one conversation in FTF communication. However, the D/HoH have different requirements in different communication circumstances (e.g. group communication). A hearing aid with loop technology has been mentioned in this research and is a technology commonly used to assist the D/HoH in specific places (e.g. public locations). It would be an interesting direction for future research if the Talk2Me app could be combined with the hearing aid loop technology to support additional communication circumstances.

- More detailed surveys and use case studies of D/HoH communication

  The pilot study shows that D/HoH people believe SNS and communication apps can improve the communication between the D/HoH and hearing people. However, the samples collected from the survey are limited because of the limited collection period. More detailed surveys are recommended to be collected in future, so as to gain further understanding of SNS and communication apps as used by the D/HoH (e.g. the use of SNS and communication apps in different D/HoH age groups).

- Using different design approaches to conduct the interaction design creative practice

  This study introduces four relevant design approaches (UCD, PD, PCD and ECD). UCD was selected as the approach to conduct the development process of the Talk2Me app. However, different design approaches provide different insight during the development process. For example, PCD is interesting in that it uses the concept of a person-centred approach as a framework within which to conduct PD. It could bring significant additional insights and novel solutions to use different design approaches in future D/HoH communication research.

7.5 Conclusion

This research investigates the influences of new media communication on the D/HoH, and particularly focuses on SNS (Facebook, Twitter and Linkedin) and communication apps (WhatsApp, LINE and WeChat) as used by the D/HoH. There is a shortage of such studies in the existing literature. The result of this research shows that new media communication technologies (SNS and communication apps) have opened new communication opportunities that can bridge the communication gap between the D/HoH and hearing people. This study argues that this is because there are three significant usability features involved in SNS and communication apps: a. An accessible communication channel, b. An integrated communication and social platform and c. An optimised multi-function interface.

This research proposes there is still a communication gap in FTF communication between the D/HoH and hearing people, even with the availability of SNS and communication apps. The primary result of this research is an innovative communication solution that can be used to bridge the FTF communication gap. This communication solution was specifically developed via an interaction design practice and UCD development process: a smartphone app called Talk2Me. The Talk2Me app provides a specific way of communicating between two users, one that prompts users to conduct physical interaction with nonverbal messages. Physical interaction with nonverbal messages is a significant element in FTF communication, whilst the new communication opportunities offered by SNS and communication apps are mainly for non-FTF communication.

This study not only delivers an enhanced understanding of the issues in FTF communication between the D/HoH and hearing people, it also provides opportunities for future academic research involving improvement and enhancement of the FTF specific smartphone app.

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Appendices

Appendix 1: Questionnaire

New Media Communication for Deaf/Hard of Hearing People
My name is Chia-Ming Chang, a PhD student in the School of Art & Design at Nottingham Trent University. My current research looks at influences of new media communication on deaf/hard of hearing people. This questionnaire aims to collect relevant information to support this study. For answering this questionnaire you should be a deaf or hard of hearing person and a SNS (e.g. Facebook, Twitter and Linkedin) and communications apps on smartphones (e.g. WhatsApp, WeChat and LINE) user. For the data collection, I confirm that: • The data will be only used in this research and some relevant academic purposes (conference paper). • The data will not be used it in other purposes without your permission. • The data will not divulge to third person. • The data storage issue will comply with the procedure of Nottingham Trent University. • Participants have right to withdraw the data at any time without giving any reason. *Required Please read the explanation above and answer the questions below. * ☐ I confirm that I have read the explanation, and agree that the data I provide will only be used in this research. ☐ I confirm that I am a Deaf or Hard of Hearing person and a SNS (e.g. Facebook, Twitter and Linkedin) and communication apps (e.g. WhatsApp, WeChat and LINE) users. 1. What age group are you? * ○ Under 18 ○ 18-29 ○ 30-39 ○ 40-49 ○ 50-64 ○ 65+ 2. Gender?* ○ Male ○ Female 3. Are you a Deaf or Hard of Hearing People? * ○ Deaf ○ Hard of Hearing 4. What is the primary communication method you usually use in your daily life? * ○ Sign Language ○ Limited Speech/Lip reading (with Hearing Aid) ○ Text Messages/Written Notes (on paper, cell phone or computer) ○ Others: ________

5. What is the primary communication method you use to communicate with Deaf or Hard of Hearing people? *
   - O Sign Language
   - O Limited Speech/Lip reading (with Hearing Aid)
   - O Text Messages/Written Notes (on a paper, cell phone or computer)
   - O Others: ________

6. What is the primary communication method you use to communicate with the hearing community? *
   - O Sign Language
   - O Limited Speech/Lip reading (with Hearing Aid)
   - O Text Messages/Written Notes (on a paper, cell phone or computer)
   - O Others: ________

7. Do you agree SNS and communication apps on smartphones can improve the communication between Deaf/Hard of Hearing and the hearing community? *
   - O Yes
   - O No

Many thanks for you help!

If you have any questions or further suggestions please email me at chia-ming.chang2011@my.ntu.ac.uk.

Appendix 2: Questionnaire Data

	1. What age group are you?	2. Gender	3. Are you a Deaf or Hard of Hearing People?	4. What is the primary communication method you usually use in your life?	5. What is the primary communication method you use to communicate with Deaf or Hard of Hearing people?	6. What is the primary communication method you use to communicate with hearing community?	7. Do you agree SNS and communication apps on Smartphones can improve the communication between Deaf/Hard of Hearing and the hearing community?
1	18-29	Male	Deaf	Sign Language	Limited speech/Lip reading (with Hearing Aid)	Sign Language	Yes
2	18-29	Male	Deaf	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
3	18-29	Female	Deaf	Sign Language	Sign Language	Sign Language	Yes
4	18-29	Male	Deaf	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
5	30-39	Female	Deaf	Sign Language	Sign Language	Limited speech/Lip reading (with Hearing Aid)	Yes
6	50-64	Male	Deaf	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
7	40-49	Female	Deaf	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
8	30-39	Female	Deaf	Sign Language	Sign Language	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
9	40-49	Female	Deaf	Sign Language	Sign Language	Limited speech/Lip reading (with Hearing Aid)	Yes
10	18-29	Female	Deaf	Sign Language	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	No
11	40-49	Female	Deaf	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
1	18-29	Female	Deaf	Sign Language	Limited speech/Lip	Text Messages/Writte	Yes

2					reading (with Hearing Aid)	n Notes (on paper, cell phone or computer)	
13	30-39	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	No
14	40-49	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
15	50-64	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
16	50-64	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
17	30-39	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
18	18-29	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
19	30-39	Male	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	No
20	30-39	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
21	40-49	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
22	18-29	Male	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
23	40-49	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
24	18-29	Male	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
25	30-39	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
26	18-29	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
27	18-29	Male	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
2	30-39	Female	Hard of	Limited	Limited	Text	Yes

8			Hearing	speech/Lip reading (with Hearing Aid)	speech/Lip reading (with Hearing Aid)	Messages/Written Notes (on paper, cell phone or computer)	
29	40-49	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
30	30-39	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	No
31	18-29	Male	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
32	18-29	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
33	50-64	Male	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Limited speech/Lip reading (with Hearing Aid)	Yes
34	18-29	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Limited speech/Lip reading (with Hearing Aid)	Yes
35	30-39	Male	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
36	40-49	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
37	18-29	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Limited speech/Lip reading (with Hearing Aid)	Yes
38	30-39	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Limited speech/Lip reading (with Hearing Aid)	Yes
39	50-64	Female	Hard of Hearing	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
40	40-49	Male	Hard of Hearing	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
41	40-49	Female	Hard of Hearing	Text Messages/Written Notes (on paper, cell	Text Messages/Written Notes (on paper, cell phone	Text Messages/Written Notes (on paper, cell phone	Yes

				phone or computer)	or computer)	or computer)	
42	18-29	Female	Hard of Hearing	Sign Language	Sign Language	Sign Language	No
43	18-29	Male	Hard of Hearing	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
44	18-29	Male	Hard of Hearing	Sign Language	Sign Language	Sign Language	Yes
45	18-29	Female	Hard of Hearing	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
46	40-49	Female	Hard of Hearing	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
47	30-39	Male	Hard of Hearing	Sign Language	Sign Language	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
48	30-39	Male	Hard of Hearing	Sign Language	Sign Language	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
49	40-49	Female	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Sign Language	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
50	30-39	Male	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Sign Language	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
51	30-39	Female	Hard of Hearing	Sign Language	Sign Language	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
52	40-49	Male	Hard of Hearing	Limited speech/Lip reading (with Hearing Aid)	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Yes
53	30-39	Male	Hard of Hearing	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	Text Messages/Written Notes (on paper, cell phone or computer)	No

Appendix 3: A Document Used in The First Step Interview

Communication Issues of Deaf/Hard of Hearing People and New Media Communication

My name is Chia-Ming Chang, a PhD student in the School of Art & Design at Nottingham Trent University in the UK. My current research looks at influences of new media communication on the deaf/hard of hearing as reflected in interaction design. The purpose of this questionnaire is to explore further communication difficulties faced by the deaf/hard of hearing people in face-to-face communication and specific communication requirements needed by them. According to your answers of the questionnaire I might ask you further questions through email or in person.

For the data collection, I confirm that:

• The data will be only used in this research and some relevant academic purposes (conference paper).

• The data will not be used it in other purposes without your permission. • The data will not divulge to third person.

• The data storage issue will comply with the procedure of Nottingham Trent University.

• Participants have right to withdraw the data at any time without giving any reason.

*Required

Please read the explanation above and answer the questions below. *

☐ I confirm that I have read the explanation, and agree that the data I provide will only be used in this research.

The questions below are specifically focus on face-to-face communication.

1. What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)?

2. What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)?

3. What communication features of SNS or communication apps do you use most often when you communicate with hearing people (Deaf/Hard of Hearing people)?

4. What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created?

Many thanks for you help!

If you have any questions or further suggestions please email me at chia-ming.chang2011@my.ntu.ac.uk.

Appendix 4: Transcript of the First Step Interview

Interview Transcripts from an Expert Interviewee 1

Question: What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Every deaf or hear of hearing people use different communication ways and have different communication behavious, that brings difficulties. Some of them use sign language and some use lip reading and limited speech. Also, not all deaf and hear of hearing people can use sign language well. Even they use sign language there are different types of sign language. It is also a problem. For example, British Sign Language (BSL) and Sign Supported English (SSE) are different. Some people use SSL, which is not a language in its own right, but more a kind of English with signs. Most deaf/hard of hearing people do limited speech, but most of hearing people can't understand their voice. They also do lip reading, but it is still hard for them to understand speech through lip reading. Deaf/hard of hearing people feel hard to lipread in different accents, especially people from different nationality. lip reading is hard, even a very good lip reader only can understand 42%. Also, hearing people don't know how to communicate with deaf/hard of hearing people is another issue that hearing people always ignore or avoid to communicate with them.
Question: What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Need sign language interpreters like me I am a sign language interpreter in the university I help deaf students in classes. Sign language education is also very important not all deaf/hard of hearing people know sign language. I also use email or text to communicate with deaf/hard of hearing students. That's a good way between deaf/hard of hearing and hearing people. But in meetings or conferences sign language interpreters are still needed. Also some technologies support e.g. speech to text.
Question: What communication features of SNS or communication apps do you use the most often when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Smartphone is an important tool for deaf people. I use Text messaging, e-mail, Facebook, Twitter etc. via my phone.
Question: What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created? **Responses:** FaceTime feature, speech to text I use FaceTime a lot to it's a good way to chat with deaf students via sign language

Interview Transcripts from an Expert Interviewee 2

Question: What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Hearing people's lack awareness of how to communicate with deaf (hard of hearing) people. For example, most of deaf (hard of hearing) people can speak, a limited speech, they also can hear voice, but hearing people don't know. Most of hearing people don't understand sign language, but sign language is a normal way to communication with deaf people even some deaf or hard of hearing people can't use good sign language. There are many communicate ways can be used between deaf (hard of hearing) and hearing people. They just need choose a right way both deaf (hard of hearing) and hearing people can use it. Deaf and hard of hearing people use different way to communicate with hearing people. Some use sign language if sign language interpreters are provided. Some use limited speech lip reading and so on. It depends on their communication/hearing abilities and the people they communicate with.
Question: What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Different deaf (or hard of hearing) people need different requirements. It depends on the communication methods they used to use, also their hearing abilities, also depends on the communication places (e.g. chatting with friends, discussing in a classroom). Deaf and hard of hearing people need a full access to the communication method of their choice e.g. BSL interpreter, lip speaker, Speech To Text Reporter (STTR) etc. Plus, e-mail, SMS, Skype and face time etc. A multi-way assistant tool. Also, technology not always easy to use or accessible. Cost of provision for communication support etc. and text supports.
Question: What communication features of SNS or communication apps do you use the most often when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Text messaging, e-mail, Facebook etc, Sometime, I only read information on Facebook, I show my Facebook posts when I talk to people in person.
Question: What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created? **Responses:** FaceTime for all types of phones not just iPhone. Speech to text, speech to sign, sign to text, sign to speech. if a device can relay what people say instantly and I can say something to them through the device (it'll not that easy), then it is possible, but nothing impossible with the rapidly advancing of technology.

Interview Transcripts from an Expert Interviewee 3

Question: What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses: Most of deaf hard of hearing people can do lip read if people can speak slowly, keep talking sentences short and clear is fine. It's very hard to lip read long sentences. English grammar in BSL is different to speech. It's a main difficulty for deaf and hard of hearing. Not every deaf/hard of hearing people wear hearing aids or have cochlear implants. It's very hard to hear in a noisy place even they wear hearing aids and they can hear clear when more than one people talk at the same time.
Question: What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Assistant tools, such as pen paper, digital devices, digital devices has become important tool instead of pen and paper. An interpreter is needed when having a long conversation. Hearing people need to know BSL.
Question: What communication features of SNS or communication apps do you use the most often when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Text Messages, Facetime. But it's very hard to sign when holding a phone. I use both two hands as a method of communication and it would be difficult to hold a device and use both hands at the same time. It would be even more difficult to do that when you are walking or preoccupied such as driving. FaceTime normally use when talk with deaf who use sign language. We, both deaf and hearing people use SMS daily and everyone seems have their own mobile phone that have SMS feature, so we can be reachable by a touch of SMS anytime, anywhere. It is like a text-based voicemail where you can read messages at your convenience and you do not have to reply them immediately.
Question: What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created? **Responses:** FaceTime with improving connection quality. Speech to text support, or speech to sign. it need an internet connection and the current video technology is not reliable enough.

Interview Transcripts from a D/HoH Interviewee 1

Question: What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** If hearing community have knowledge of BSL, I can talk to them directly, otherwise BSL interpreter is needed. If an interpreter is not available, I use pen and paper to write things down; use simply gesture; or type things on technology device such as mobile phone, iPad, computer etc. yes I am profoundly Deaf and do wear a Cochlear Implant. I use both BSL (British Sign Language) and speech. Using sign language always bring difficulties when talk with a

hearing person.
Question: What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** If talking to a large group of hearing community, they tend to chat away without keep me in the loop, I'd get bored easily. If they keep me in the loop, I feel they find writing things down too cumbersome for them. Voice recognition may be a good way.
Question: What communication features of SNS or communication apps do you use the most often when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** IM, Email, FaceBook, Twitter, WhatsApp. I sometime send text messages to friends who are next to me or just in front of me. I also use my phone as a note when I don't have pen and paper. If no need internet connection so I can use it anywhere to communicate.
Question: What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created? **Responses:** Voice recognition, hearing people can keep their speech language naturally. Far better to invent something innovative and useful such as speech to text, good mobile "face time" (for all mobiles not just apple) real time communication so people can sign to each other.

Interview Transcripts from a D/HoH Interviewee 2

Question: What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Face to face communication, I use a sign language interpreter if s/he is present. In their absence, I tend to rely on paper and pen with occasional lipreading. There is no problem when we have short conversation, but it very hard to have a discussion. I have difficulties with both lipreading and using my voice.
Question: What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** An interpreter is needed, or I need to see their face and mouse, it helps me to understand their speech. People need to speech louder, speck direct to me and look at me, and not in a noisy place. I always use written note/text message when they can't understand me. I use my smartphone instead of pen and paper.
Question: What communication features of SNS or communication apps do you use the most often when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses:

Google Mail, Hotmail, Facebook and Facebook messaging

Yes absolutely as we (deaf people of young generations) are relied on digital devices to typing what we want to say instead of writing on pen and paper in the past, though some people, particular older generation, still use pen and paper nowadays. We can write down things on devices and show each other what is on our mind.

Question:

What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created?

Responses:

Sign to text support, then I can use sign language. Voice to text translation, people speak to their phone and I can immediately read what they speak in text on my phone through voice to text translation.

Interview Transcripts from a D/HoH Interviewee 3

Question:

What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses:

Hearing people don't understand sign language. I do lip read but people always talk too fast some time sentences is too long to read. Hearing people don't know how to communicate with hard of hearing people they thought we only use sign language. I feel this is the problems when I talk with hearing people they feel uncomfortable when talking with me.

Question:

What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses:

Translator is a prefect way, but s/he can't be with me all the time. A small tool. e.g. paper and pen (old way), Smartphones (new way).

SSE Interpreter for meetings. Speech to text & SSE interpreters for conferences. Text messaging Emails.

Question:

What communication features of SNS or communication apps do you use the most often when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses:

LINE, IM, Facebook chat

I can easily get out my smartphone and use it to communicate with hearing peers if needed.

Question:

What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created?

Responses:

The app would translate all desired voice recognise into text in background noise with no additional input from user. Hearing people can keep their speech language naturally without adjusting to different methods of communication such as pen and pen. People tend to say "I haven't write that much for ages" when we use pen and paper to communicate with each other. Voice recognition would keep their preferred languages.

Interview Transcripts from a Hearing Interviewee 1

Question:

What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses:

Don’t know sign language.

Because I don't sign so I only can do very limited talk with my deaf friend.

Question:

What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses:

I normally use a pen and a paper or typing on my phone when communicate with deaf people. Speech to input text may be a good way when I use my phone.

I think a phone is a necessary tool when chat with deaf I can just use text and show to them. Learning sign language seems an impossible way for me it’s not hard.

Question:

What communication features of SNS or communication apps do you use the most often when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses:

Facebook Messager, Facebook live chat, LINE

Question:

What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created?

Responses:

Speech to input message e.g. Siri or some thing like sign language translator.

Interview Transcripts from a Hearing Interviewee 2

Question:

What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses:

I think the most important part to communicate with deaf/hard of hearing people is to find a suitable way, even I don’t know sign language I still can communicate with my deaf friends with no problem through text on my phone, or pen and paper, sometime combines with hand gestures and speech.

Question:

What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)?

Responses:

In person or off person, it's a new opportunity on new media communication. SNS or

communication apps a new way to support face-to-face communication, such as pen and paper but provide something more. E.g sign language translation, speech to text, speech to sign.
Question: What communication features of SNS or communication apps do you use the most often when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Facebook Message, LINE, WhatsAPP. I use text message to talk with my deaf friend.
Question: What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created? **Responses:** Speech to text etc. Direct communication, voice recognition

Interview Transcripts from a Hearing Interviewee 3

Question: What communication difficulties do you have when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** People don't know sign language is the main communication difficulty. However, I use other ways to communicate with deaf people for example I use speech and body language. My deaf friend still can understand it but just for simple conversation. A complicated communication will be a problem.
Question: What communication requirements do you need when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** I usually talk with my deaf friend via text on my phone, I use facebook and Line. Voice to text translation could be extra support because typing is time cost. A sign language interpreter may need, but I never communicate with my deaf friends through it.
Question: What communication features of SNS or communication apps do you use the most often when you communicate with hearing people (Deaf/Hard of Hearing people)? **Responses:** Text messages, Facebook Messager, LINE
Question: What communication features of SNS or communication apps do you think will be useful for Deaf/Hard of Hearing people if it can be created? **Responses:** Sign language translation, hearing people no need to know sign language. Voice-to-text translation.

Appendix 5: Initial Codes of the First Step Interview

Interview Data	Codes
Every deaf or hear of hearing people use different communication ways and have different communication behavious, that brings difficulties. Some of them use sign language and some use lip reading and limited speech. Also, not all deaf and hear of hearing people can use sign language well. Even they use sign language there are different types of sign language. It is also a problem. For example, British Sign Language (BSL) and Sign Supported English (SSE) are different. Some people use SSL, which is not a language in its own right, but more a kind of English with signs. Most deaf/hard of hearing people do limited speech, but most of hearing people can't understand their voice. They also do lip reading, but it is still hard for them to understand speech through lip reading. Deaf/hard of hearing people feel hard to lipread in different accents, especially people from different nationality. lip reading is hard, even a very good lip reader only can understand 42%. Also, hearing people don't know how to communicate with deaf/hard of hearing people is another issue that hearing people always ignore or avoid to communicate with them. -- Hearing people's lack awareness of how to communicate with deaf (hard of hearing) people. For example, most of deaf (hard of hearing) people can speak, a limited speech, they also can hear voice, but hearing people don't know. Most of hearing people don't understand sign language, but sign language is a normal way to communication with deaf people even some deaf or hard of hearing people can't use good sign language. There are many communicate ways can be used between deaf (hard of hearing) and hearing people. They just need choose a right way both deaf (hard of hearing) and hearing people can use it. Deaf and hard of hearing people use different way to communicate with hearing people. Some use sign language if sign language interpreters are provided. Some use limited speech lip reading and so on. It depends on their communication/hearing abilities and the people they communicate with. -- Most of deaf hard of hearing people can do lip read if people can speak slowly, keep talking sentences short and clear is fine. It's very hard to lip read long sentences. English grammar in BSL is different to speech. It's a main difficulty for deaf and hard of hearing. Not every deaf/hard of hearing people wear hearing aids or have cochlear implants. It's very hard to hear in a noisy place even they wear hearing aids and they can hear clear when more than one people talk at the same time.	• Different communication methods/behaviours used by the D/HoH • Different types of sign language • Not all D/HoH can use sign language • Difficulties in lip reading • Hearing people's lack awareness of how to communicate with with the D/HoH • Hearing people don't understand sign language • Many communication methods can be used between D/HoH and hearing people • Choose e a right/suitable way between D/HoH and hearing people • Depends on communication/hearing abilities • Lip reading is an accessible way if people speak slowly and shortly • Long-sentence communication brings difficulties • Hearing aids/cochlear implants (not very popular) • Written note (pen/paper, typing via mobile phone) • Simple gestures • No problems in a short conversation
--	

If hearing community have knowledge of BSL, I can talk to them directly, otherwise BSL interpreter is needed. If an interpreter is not available, I use pen and paper to write things down; use simply gesture; or type things on technology device such as mobile phone, iPad, computer etc. yes I am profoundly Deaf and do wear a Cochlear Implant. I use both BSL (British Sign Language) and speech. Using sign language always bring difficulties when talk with a hearing person. -- Face to face communication, I use a sign language interpreter if s/he is present. In their absence, I tend to rely on paper and pen with occasional lipreading. There is no problem when we have short conversation, but it very hard to have a discussion. I have difficulties with both lipreading and using my voice. -- Hearing people don't understand sign language. I do lip read but people always talk too fast some time sentences is too long to read. Hearing people don't know how to communicate with hard of hearing people they thought we only use sign language. I feel this is the problems when I talk with hearing people they feel uncomfortable when talking with me. -- Don't know sign language. Because I don't sign so I only can do very limited talk with my deaf friend. -- I think the most important part to communicate with deaf/hard of hearing people is to find a suitable way, even I don't know sign language I still can communicate with my deaf friends with no problem through text on my phone, or pen and paper, sometime combines with hand gestures and speech. -- People don't know sign language is the main communication difficulty. However, I use other ways to communicate with deaf people for example I use speech and body language. My deaf friend still can understand it but just for simple conversation. A complicated communication will be a problem.	
Need sign language interpreters like me I am a sign language interpreter in the university I help deaf students in classes. Sign language education is also very important not all deaf/hard of hearing people know sign language. I also use email or text to communicate with deaf/hard of hearing students. That's a good way between deaf/hard of hearing and hearing people. But in meetings or conferences sign language interpreters are still needed. Also some technologies support e.g. speech to text. -- Different deaf (or hard of hearing) people need different requirements. It depends on the communication methods they used to use, also their hearing abilities, also depends on the communication places (e.g. chatting with friends, discussing in a classroom). Deaf and hard of hearing people need a full access to the communication method of their choice e.g. BSL interpreter, lip speaker, Speech To	• Sign language education • Sign language interpreters • Text support (e.g. email & SMS) • Different requirements needed (in different communication places & hearing abilities) • A fully accessible communication method • A multi-way assistant tool (e.g. pen & paper &

Text Reporter (STTR) etc. Plus, e-mail, SMS, Skype and face time etc. A multi-way assistant tool. Also, technology not always easy to use or accessible. Cost of provision for communication support etc. and text supports. --- Assistant tools, such as pen paper, digital devices, digital devices has become important tool instead of pen and paper. An interpreter is needed when having a long conversation. Hearing people need to know BSL. --- If talking to a large group of hearing community, they tend to chat away without keep me in the loop, I'd get bored easily. If they keep me in the loop, I feel they find writing things down too cumbersome for them. Voice recognition may be a good way. --- An interpreter is needed, or I need to see their face and mouse, it helps me to understand their speech. People need to speech louder, speck direct to me and look at me, and not in a noisy place. I always use written note/text message when they can't understand me. I use my smartphone instead of pen and paper. --- Translator is a prefect way, but s/he can't be with me all the time. A small tool. e.g. paper and pen (old way), Smartphones (new way). SSE Interpreter for meetings. Speech to text & SSE interpreters for conferences. Text messaging Emails. --- I normally use a pen and a paper or typing on my phone when communicate with deaf people. Speech to input text may be a good way when I use my phone. I think a phone is a necessary tool when chat with deaf I can just use text and show to them. Learning sign language seems an impossible way for me it's not hard. --- In person or off person, it's a new opportunity on new media communication. SNS or communication apps a new way to support face-to-face communication, such as pen and paper but provide something more. E.g sign language translation, speech to text, speech to sign. --- I usually talk with my deaf friend via text on my phone, I use facebook and Line. Voice to text translation could be extra support because typing is time cost. A sign language interpreter may need, but I never communicate with my deaf friends through it.	digital devices) • Written note is too cumbersome • Voice recognition • Text via smartphones
Smartphone is an important tool for deaf people. I use Text messaging, e-mail, Facebook, Twitter etc. via my phone. --- Text messaging, e-mail, Facebook etc, Sometime, I only read information on Facebook, I show my Facebook posts when I talk to people in person. --- Text Messages, Facetime. But it's very hard to sign when holding a phone. I use both two hands as a method of communication and it would be difficult to hold a device	• Text messages (e.g. Facebook, Whatsapp &LINE) • Use as written note (pen & paper) • FTF communication Materials

and use both hands at the same time. It would be even more difficult to do that when you are walking or preoccupied such as driving. FaceTime normally use when talk with deaf who use sign language. We, both deaf and hearing people use SMS daily and everyone seems have their own mobile phone that have SMS feature, so we can be reachable by a touch of SMS anytime, anywhere. It is like a text-based voicemail where you can read messages at your convenience and you do not have to reply them immediately. -- IM, Email, FaceBook, Twitter, WhatsApp. I sometime send text messages to friends who are next to me or just in front of me. I also use my phone as a note when I don't have pen and paper. If no need internet connection so I can use it anywhere to communicate. -- Google Mail, Hotmail, Facebook and Facebook messaging Yes absolutely as we (deaf people of young generations) are relied on digital devices to typing what we want to say instead of writing on pen and paper in the past, though some people, particular older generation, still use pen and paper nowadays. We can write down things on devices and show each other what is on our mind. -- LINE, IM, Facebook chat I can easily get out my smartphone and use it to communicate with hearing peers if needed. -- Facebook Messager, Facebook live chat, LINE -- Facebook Message, LINE, WhatsAPP. I use text message to talk with my deaf friend. -- Text messages, Facebook Messager, LINE	
FaceTime feature, speech to text I use FaceTime a lot to it's a good way to chat with deaf students via sign language -- FaceTime for all types of phones not just iPhone. Speech to text, speech to sign, sign to text, sign to speech. if a device can relay what people say instantly and I can say something to them through the device (it'll not that easy), then it is possible, but nothing impossible with the rapidly advancing of technology. -- FaceTime with improving connection quality. Speech to text support, or speech to sign. it need an internet connection and the current video technology is not reliable enough. -- Voice recognition, hearing people can keep their speech language naturally. Far better to invent something innovative and useful such as speech to text, good mobile "face time" (for all mobiles not just apple) real time communication so people can sign to each other. -- Sign to text support, then I can use sign language. Voice to text translation, people speak to their phone and I can	• Voice recognition (speech to input message) • FaceTime • Sign language recognition

immediately read what they speak in text on my phone through voice to text translation. --- The app would translate all desired voice recognise into text in background noise with no additional input from user. Hearing people can keep their speech language naturally without adjusting to different methods of communication such as pen and pen. People tend to say "I haven't write that much for ages" when we use pen and paper to communicate with each other. Voice recognition would keep their preferred languages. --- Speech to input message e.g. Siri or some thing like sign language translator. --- Speech to text etc. Direct communication, voice recognition --- Sign language translation, hearing people no need to know sign language. Voice-to-text translation.	

Appendix 6: A Document Used in The Second Step Interview

A Smartphone App: Alternatives of Potential Features

My name is Chia-Ming Chang, a PhD student in the School of Art & Design at Nottingham Trent University in the UK. My current research looks at influences of new media communication on the deaf/hard of hearing as reflected in interaction design. The purpose of this questionnaire is to test the design concepts (alternative potential features of a smartphone app). This questionnaire is used as part of interview. According to your answers of the questionnaire I might ask you further questions through email or in person.

For the data collection, I confirm that:

• The data will be only used in this research and some relevant academic purposes (conference paper).

• The data will not be used it in other purposes without your permission. • The data will not divulge to third person.

• The data storage issue will comply with the procedure of Nottingham Trent University.

• Participants have right to withdraw the data at any time without giving any reason.

*Required

Please read the explanation above and answer the questions below. *

☐ I confirm that I have read the explanation, and agree that the data I provide will only be used in this research.

This smartphone app is designed as a communication solution that can be used to bridge the face-to-face communication gap between deaf/hard of hearing and hearing people. The prototype below presents the design features of this smartphone app.

Please read the below Part 1. Explaination of this smartphone app and answer the Part 2. Questions.

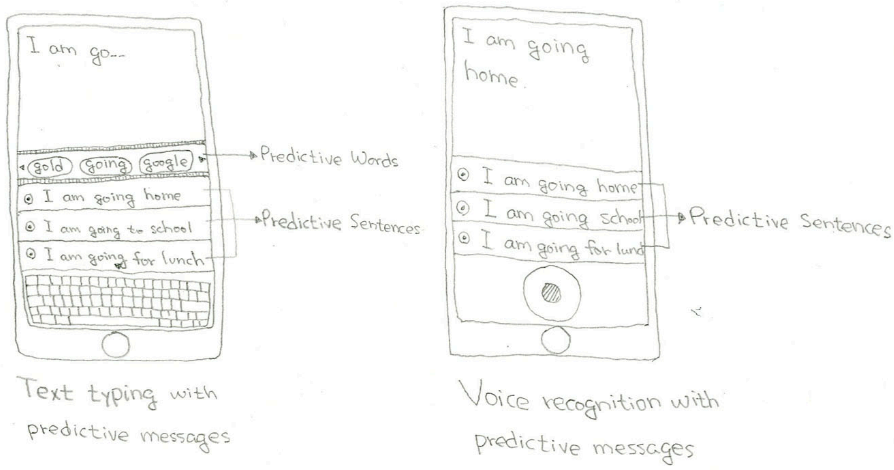
Part 1. Explanation of this Smartphone App

The alternative potential features of this smartphone app will be discussed in the two parts below: (1) Ways of Inputting Messages and (2) Way of Transmitting Messages and Conducting Physical Interaction.

(1) Ways of Inputting Messages

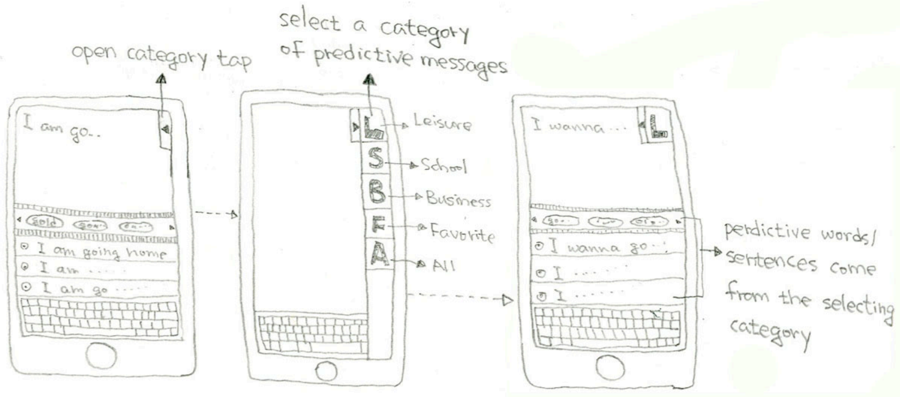
d. Text Typing and Voice Recognition with Prediction Support

Text typing and voice recognition are chosen as the two ways of inputting messages in this smartphone app. Predictive message is a specific feature designed in this smartphone app to support text typing and voice recognition. The predictive message feature helps users input messages easily and quickly by giving predictive words and sentences during text typing. See the Figure below.



e. Categorisation Support

Categorisation support is another feature designed in this smartphone app to facilitate the communication process. The categorisation support feature allows the user to organise the predictive message database into different categories (e.g. Leisure, School, Business, Favourite and All). See the Figure below.

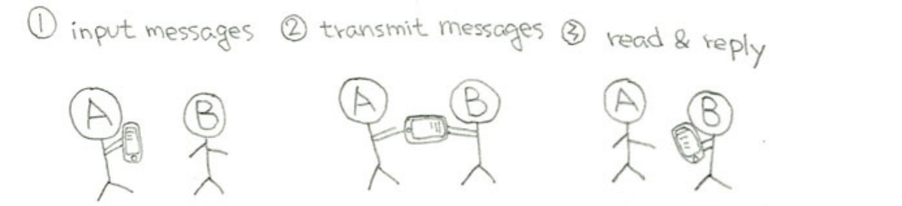


(2) Way of Transmitting Messages and Conducting Physical Interaction

a. Communication via a Single Phone without Connection Technology

Communication via a single phone without using connection technology is a feature designed in this smartphone app that aims to prompt users to conduct physical interaction with nonverbal messages during communication when using this smartphone app. Showing messages via a single phone without using connection technology (through the phone screen display) is more direct and intuitive than transmitting messages via two phones through connection technologies (e.g. GSM, 3G/4G and Wifi).

Scenario
Person A: D/HoH People Person B: Hearing People

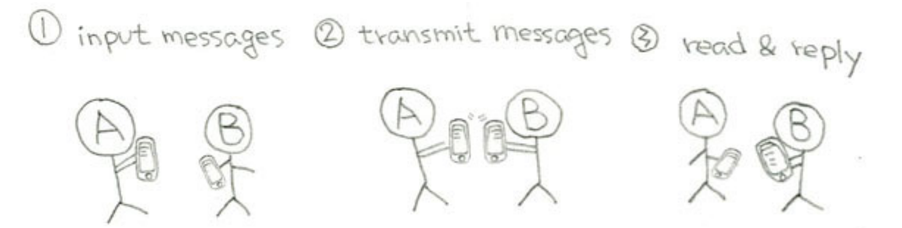


Step 1: Person A inputs messages via this app on his/her smartphone.
Step 2: Person A shows messages to Person B via his/her smartphone.
Step 3: Person B reads and replies to messages via Person A's smartphone.

b. Text Communication via Two Phones with NFC Connection Technology

Communication via two phones with NFC connection technology is another feature designed in this smartphone app that aims to prompt users to physically interact with nonverbal messages. NFC connection technology is used to support message transmitting by two phones touching or by bringing two phones into close proximity.

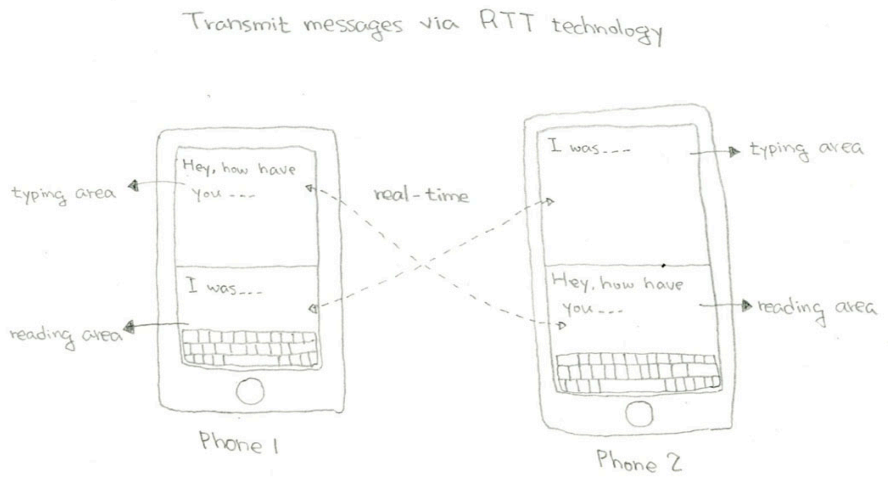
Scenario
Person A: D/HoH People Person B: Hearing People



Step 1: Person A inputs messages via this app on his/her smartphone.
Step 2: Person A transfer messages from his/her smartphone to Person B's Smartphone via NFC (two phones touching or in close proximity).
Step 3: Person B reads and replies to messages via his/her own smartphone.

c. Communication via Two Phones with Real-time Text Transmission Support

The real-time text transmission support aims to reduce the time gap between face-to-face communication (real-time) and CMC (non-real time). Real-time text transmission is a way that allows text to be instantly transmitted as it is being typed. The recipient can immediately read the message whilst it is being typed by the other person, without having to wait. See the Figure below.



Part 2. Questions

Question 1. What do you think about the alternative potential features of this smartphone app?

Ways of Inputting Messages:

- Text Typing and Voice Recognition with Prediction Support (Is it helpful? Why? Other suggestions?)
  Please answer here…

- Categorisation Support (Is it helpful? Why? Other suggestions?)
  Please answer here…

Way of Transmitting Messages and Conducting Physical Interaction:

- Communication via a Single Phone without Connection Technology (Is it helpful? Why? Other suggestions?)
  Please answer here…

- Text Communication via Two Phones with NFC Connection Technology (Is it helpful? Why? Other suggestions?)
  Please answer here…

- Communication via Two Phones with Real-time Text Transmission Support (Is it helpful? Why? Other suggestions?)
  Please answer here…

Question 2. Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication?

Question 3. Other suggestions for this app?

Many thanks for your help.

Please feel free to email me at chia-ming.chang2011@my.ntu.ac.uk if you have any further questions.

Appendix 7: Transcript of the Second Step Interview

Interview Transcripts from an Expert Interviewee 1

Question: What do you think about the alternative potential features of this smartphone app? **Responses:** Text typing with predictive support is a good way that can help me to input messages quicker. Voice recognition also a good way for hearing people to use speech. I am not sure about the categorisation support feature. I feel it is complicated. I think the best part of this app is, this app is designed for face-to-face communication. Showing messages via a single phone or NFC is novel and easy. But, what is the difference between this app or I just use a note app to show message? Is there any different design in this app? I agree that using NFC technology to send messages can bring physical interaction between peoples. But I feel it's needless in face-to-face communication. Real-time text transmission may be a way to sort out the time gap between face-to-face communication and CMC but I don't think it's a useful feature for face-to-face communication. In a face-to-face communication, people should look at each other, not look at their screens. Real-time text feature might force people looking at their phone screens all the time.
Question: Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication? **Responses:** Yes!!!!! It helps a lot. Sometime gestures can help communication smoothly, especially when people from different countries or cultures. So do hearing and deaf/hearing people. And another way is writing.
Question: Other further suggestions for this app? **Responses:** Does this app support one-to-many communication? Can I use it in a group talking? If I am in a group communication for example do I need to show messages to each people one by one or do I have to touch all people's phone when I use NEF to transmit messages? it's inconvenient! any other ways? For this app, one-to-one communication looks OK…but in a group you might need to think about it. Different types of communication need different supports for example one-to-one communication and one-to-many communication are different. Communication in different places also needs different supports. For example, the voice recognition will be a problem in a noisy place. I suggest that this app could combine with hearing aids, also with loop technology. Loop technology is a service for deaf/hard of hearing people who wear hearing aids. It's broadly used in public spaces such as in a train station. Deaf/hard of hearing people can receive broadcast information directly through their hearing aids. Maybe this app can connect with hearing aids and loop technology. It also could support group communication e.g. a hearing person talk to their phone via voice recognition and then all deaf people can hear through their hearing aids. Or solve the problem when communicate in a noisy place.

Interview Transcripts from an Expert Interviewee 2

Question:

What do you think about the alternative potential features of this smartphone app?

Responses:

I think the text typing and voice recognition features are useful especially the predictive words and sentences. However, I don't think categorizing predictive messages in different categories is necessary. Written notes (pen & paper) is a common way used between deaf or hard of hearing and hearing people when sign language is not available. Showing messages via a phone is like written notes, but provide an easier way without using a pen and a paper.

NFC transmission can be a way that kind of to make physical interaction. I am considering why not just showing your phone screen to the people you talk with. You don't need to transmit messages to another phone you can just show it to him/her.

I don't feel it is a useful feature, especially in face-to-face communication. I understand your idea but in face-to-face communication I think real-time text transmission …do we really need it? When you talk with a people who stand right in front of you, imagine it…I don't think real-time text transmission is needed in this situation.

Question:

Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication?

Responses:

Yes, eyes are mainly as a means for deaf/hard of hearing to receive information they rely on it a lot. Simple gestures are also used as signals in communication for deaf people.

Question:

Other further suggestions for this app?

Responses:

See what I said above.

I suggest that you could provide more details in the sketch prototypes.

Interview Transcripts from an Expert Interviewee 3

Question:

What do you think about the alternative potential features of this smartphone app?

Responses:

Yes, I do agree text typing and voice recognition are two useful ways to input messages in this app. I think the predictive text suggestion is a very good feature. It helps people type faster and hearing people can use speech.

Showing messages via a phone without connection (3G/Wifi) seems an easy and quick way. It's useful sometimes, however, people already do something similar via their phones, they use 'note' apps to show messages. I don't think it's a totally new design. You might need to design something more. You should think about it.

I do agree the idea of conducting physical interaction is very important for deaf communication, deaf people rely on facial expressions a lot in communication.

NFC could be a new way to send messages between two phones. But does all phones

support NFC? Can people also use 3G or Wifi in this app?
Question: Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication? **Responses:** Yes. As I mentioned above facial expressions is very important for deaf communication. Wordless information such as body gestures are always used by deaf. It's communication cues between deaf and hearing people.
Question: Other further suggestions for this app? **Responses:** This smartphone app seems only support one-to-one communication. If I use SMS I can send a message to more than one people in the same time. Maybe you could consider it and add SMS function in this app that allows users sending messages via 3G and Wifi.

Interview Transcripts from a D/HoH Interviewee 1

Question: What do you think about the alternative potential features of this smartphone app? **Responses:** Text typing predictive support is good. They are helpful and save time for typing. The best thing is that this function can memorize the user's frequent messages. Also, I think emoji is a way use to send emotional or particular information, instead of typing. it also can save time. Good!!! It is helpful for sure. Users can manage and categorise messages to make typing easily and save time. I mean if you can edit database of predictive messages that would be good, but people don't need to select a category when they type it automatically, make it simple… It is truly helpful to communicate with hearing people. And also easily to show the screen to them to let hearing people know what deaf/hard hearing people's feeling and thinking without misunderstanding. In addition, it saves time for each group. For me, I am not a fan for this function. It is no need to do this, typing is easier, because two smart phones have to be close in 20 cm, I would like to send messages directly or see the screen is quicker. This function looks like not necessary. Real-time text typing is good because I can see each's messages at the same time. But I prefer to up side down the reading and texting areas. I think it is a feature trying to increase speed of communication when people are communicating online. I don't think it is a useful feature for face-to-face communication.
Question: Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication? **Responses:** Yes. It's necessary in face-to-face communication when talk with people who don's sign. I always use limited speech with hand gestures in the same time.

Question:

Other further suggestions for this app?

Responses:

I think the colour and images on this app are also important. Because this is for the deaf/hard hearing people to use. The graphic design can catch their eyes directly and help them to use easier.

Does this app support hearing aid?

Interview Transcripts from a D/HoH Interviewee 2

Question:

What do you think about the alternative potential features of this smartphone app?

Responses:

Some people said voice recognition is not as accurate as they'd like so the message come up incorrectly. It does not help when you're in noise places as this would prone to inaccurate voice recognition. As far as I aware of, the voice recognition requires an active internet connection and not many have the luxury to use when in remote places.

It can eliminate unnecessary words that might not relevant to your conversation if you are in certain places. However deaf people are usually talk about anything. To keep things simpler, why not use GPS and calendar (appointment), for instance, if you created an appointment on your calendar and the phone would know you're somewhere for your appointment. If you have not created an appointment and the phone can look up where you are – say you're around a school building thus predication would cover conversation regarding school and so on.

I use this facility all the time with a generic app that is not designed for this situation. Sometime other people that I share my phone with to convey conversation, they tends not able to use my phone well as their phones are different to mine so their response slower than they would've used their phone. We end up use our own phone to convey our conversation. People always prefer use their own phone. I use iPhone and sometime I even don't know how to use a simple function in a Android phone….also the personal predictive words and sentences are not available on other person's phone. I also don't want other people see my person predictive messages.

Not every modern phone is equipped with NFC but most likely have Bluetooth technology implanted instead. If phones have NFC, it would most likely simplify the process of connection between two phones than over Bluetooth (I'm not sure how these two technologies work within your prototype app). However, use two phones transmitting messages via NFC could be a way to solve the problem that people can use their own phones.

Yes, I agree it is a kind of physical interaction.

It can be helpful – save your time but sometime you type away and then realise you do not want to show this particular message to someone (slip up) and this could produce an awkward situation if you do not want to talk the slip up further. If one types faster than another, this could make their conversation confused due to delay. For instance Person A types something and then Person B replies while Person A types something new message while Person B still replying to the original message – conversation would be less flow and out of synchronised.

Question:

Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication?

Responses: Yes they are part of my language I use them all the time, even people don't know sign language they can understand a bit through my gestures or guess what I said through my gestures. For your prototype app, you type something a long message and you don't know why other person laughs or which part of the message they found funny. You can feel something from people's face or eyes.
Question: Other further suggestions for this app? **Responses:** Some of deaf people's first language is sign language so it would be a good idea if they could convey their language into text using sign language recognition, similar to voice recognition. However this is not as practical as voice recognition as you need two hands to sign and you can't sign while you holding a phone unless the other person holding the phone for you while you signing.

Interview Transcripts from a D/HoH Interviewee 3

Question: What do you think about the alternative potential features of this smartphone app? **Responses:** It's useful when I can't use sign language. I think the predictive words and sentences support is great. Also, if I can create and edit the database of predictive messages that would be better. I can use the messages I create and save in database. Vocie recognition is a good feature for hearing people. Also, it's useful that people can edit predictive message database. The idea is good, physical interaction and nonverbal messages is quite important for us, especially to see hearing people's face and their mouth (lip reading sometimes) when I talk with them. I can guess what they said from their face ^^ Showing messages on a phone to hearing people is common way I use, most of deaf/hard of hearing people use it already. As you said it's kind of physical interaction when showing messages. That's very important for me when I talk with hearing people. I expect maybe this app could provide something more such as the predictive words and sentences is a good feature. I think the 'Real-time Text Transmission Support' feature is not useful when people communicate in face to face.
Question: Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication? **Responses:** Yes. body language is an important part for me. Hearing people don't sign but they still use some body language.
Question: Other further suggestions for this app? **Responses:** When hearing people speak via voice recognition can it connect to hearing aids? If it can

connect with my hearing aids I think it is good then I can hear what they are saying if it is not clear I also can read text translated from voice recognition.

Interview Transcripts from a Hearing Interviewee 1

Question: What do you think about the alternative potential features of this smartphone app? **Responses:** The ways of inputting messages on this app is OK. The prediction support is good and very useful. The categorisation support features on this smartphone app is a new design I haven't seen any similar feature before. The original idea is good. But, I feel it's not very convenient to choose a category of predictive message database everytime when I input messages, especially shifting from one category to another during typing. I like the idea of showing messages via a single phone. It's an interesting way through the NFC transmission, I am looking for this feature two phone touch can bring physical interaction between two users. I think it would be fun, like you touch somebody. I think showing messages via a phone is better than the real-time text transmission feature.
Question: Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication? **Responses:** Yes, I can understand them (deaf & hard of hearing people) more through their face when we talk.
Question: Other further suggestions for this app? **Responses:** I know some deaf people wear hearing assistance maybe this app could link with hearing assistance.

Interview Transcripts from a Hearing Interviewee 2

Question: What do you think about the alternative potential features of this smartphone app? **Responses:** It's useful. But, what is the main difference between this app and other apps? Some apps also support predictive words when I am typing. Also the voice recognition is not a new function. Is there any new way for inputting messages? Showing messages via my smartphone to deaf people is a way I usually use. It's a basic way we use between me and my deaf friends. But, again, what is the difference between the feature in this app and others. For example, I can just type SMS messages and show to my friends instead of send it. I think maybe you can design more readable interface e.g. bigger text size.

I think transmit messages through NFC is a good way to having a physical connection with other people. I feel it is similar to showing messages if the people just next you or in front of you. You don't need to transmit messages through NFC you can just show the messages. I think it is not necessary too similar to showing messages. It's not a useful feature. I knew this kind of technology and tried it before. It's awful!!! Sometime you just see people are typing, revising, deleting, re-typing…. It's confusing, you don't even know what actual information they want to talk.
Question: Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication? **Responses:** Yes, It's a very important part when I communicate with deaf people. I can know do they understand me or not. They also can know if I don't understand them through my face.
Question: Other further suggestions for this app? **Responses:** Does this app support 'sticker' (emotion icons)? I use sticker messages a lot on LINE and Facebook. Some stickers also contain words e.g. 'Yes', 'No', 'Oh My God!'. It's a very interesting way to express information through images especially for short reply and expressing emotion information.

Interview Transcripts from a Hearing Interviewee 3

Question: What do you think about the alternative potential features of this smartphone app? **Responses:** I think voice recognition is a useful way when I need to communicate with deaf/hard of hearing people. Deaf people can use text typing. I can use speech instead of type it's a quicker way to input message. But, the only concern I have is the accuracy of voice recognition. Voice recognition on my iPhone works quite good for a single word or a simple or short sentence but it becomes terrible sometimes when I try to speak a long sentence. Showing messages to communicate is useful. It's a very easy way no need 3G and Wifi. Why not use two phone? I prefer use my own phone to type. When two people are close I think NCF is unnecessary. They can just show messages to each other. Showing messages via two phones is better than via one phone. No need NFC no need 3G, Wifi. Yes, these two ways can encourage people to conduct physical interaction and nonverbal messages. I think in face-to-face communication 'showing' messages is a best way, 'transmitting' message is unnecessary, even via NFC, 3G, wifi… It may be useful. But I don't prefer people instantly see what I am typing. I prefer send (or show) a completed sentence. You mentioned about physical interaction in face-to-face communication. I think people will concentrate on the screen all the time without doing any physical interaction when they use real-time text feature.
Question: Are you aware of various communication channels (e.g. eye contact, gestures) in face-to-face communication? And how do they affect your communication?

Responses: Yes, it's useful. It helps me to communicate with deaf/hard of hearing people. They can't hear me but they can read me through my face and some gestures.
Question: Other further suggestions for this app? **Responses:** I didn't see emoticon support in this app, but I think it's could be part of text typing. The concept of this app looks good in general I'm looking forward to seeing more details.

Appendix 8: Initial Codes of the Second Step Interview

Interview Data	Codes
Text typing with predictive support is a good way that can help me to input messages quicker. Voice recognition also a good way for hearing people to use speech. I am not sure about the categorisation support feature. I feel it is complicated. I think the best part of this app is, this app is designed for face-to-face communication. Showing messages via a single phone or NFC is novel and easy. But, what is the difference between this app or I just use a note app to show message? Is there any different design in this app? I agree that using NFC technology to send messages can bring physical interaction between peoples. But I feel it's needless in face-to-face communication. Real-time text transmission may be a way to sort out the time gap between face-to-face communication and CMC but I don't think it's a useful feature for face-to-face communication. In a face-to-face communication, people should look at each other, not look at their screens. Real-time text feature might force people looking at their phone screens all the time. -- I think the text typing and voice recognition features are useful especially the predictive words and sentences. However, I don't think categorizing predictive messages in different categories is necessary. Written notes (pen & paper) is a common way used between deaf or hard of hearing and hearing people when sign language is not available. Showing messages via a phone is like written notes, but provide an easier way without using a pen and a paper. NFC transmission can be a way that kind of to make physical interaction. I am considering why not just showing your phone screen to the people you talk with. You don't need to transmit messages to another phone you can just show it to him/her. I don't feel it is a useful feature, especially in face-to-face communication. I understand your idea but in face-to-face communication I think real-time text transmission …do we really need it? When you talk with a people who stand right in front of you, imagine it…I don't think real-time text transmission is needed in this situation. -- Yes, I do agree text typing and voice recognition are two useful ways to input messages in this app. I think the predictive text suggestion is a very good feature. It helps people type faster and hearing people can use speech. Showing messages via a phone without connection (3G/Wifi) seems an easy and quick way. It's useful sometimes, however, people already do something similar	• Predictive words/sentences in text typing (positive feedback) • Voice recognition (positive feedback) • Categorisation support (negative feedback) • Showing messages via a single phone (positive feedback) • NFC (positive feedback) • Two phones touching beings physical interaction • NFC (negative feedback) • NFC transmission is similar to showing messages • Difference between this app and others • Conducting physical interaction with nonverbal messages positive feedback) • Real-time text transmission (negative feedback) • Showing message instead of transmitting • Emoticons • Accuracy of voice recognition • Use other person's phone (different interface) • Use two phones • Editing database of predictive messages • More readable interface

via their phones, they use 'note' apps to show messages. I don't think it's a totally new design. You might need to design something more. You should think about it. I do agree the idea of conducting physical interaction is very important for deaf communication, deaf people rely on facial expressions a lot in communication. NFC could be a new way to send messages between two phones. But does all phones support NFC? Can people also use 3G or Wifi in this app? -- Text typing predictive support is good. They are helpful and save time for typing. The best thing is that this function can memorize the user's frequent messages. Also, I think emoji is a way use to send emotional or particular information, instead of typing. it also can save time. Good!!! It is helpful for sure. Users can manage and categorise messages to make typing easily and save time. I mean if you can edit database of predictive messages that would be good, but people don't need to select a category when they type it automatically, make it simple… It is truly helpful to communicate with hearing people. And also easily to show the screen to them to let hearing people know what deaf/hard hearing people's feeling and thinking without misunderstanding. In addition, it saves time for each group. For me, I am not a fan for this function. It is no need to do this, typing is easier, because two smart phones have to be close in 20 cm, I would like to send messages directly or see the screen is quicker. This function looks like not necessary. Real-time text typing is good because I can see each's messages at the same time. But I prefer to up side down the reading and texting areas. I think it is a feature trying to increase speed of communication when people are communicating online. I don't think it is a useful feature for face-to-face communication. -- Some people said voice recognition is not as accurate as they'd like so the message come up incorrectly. It does not help when you're in noise places as this would prone to inaccurate voice recognition. As far as I aware of, the voice recognition requires an active internet connection and not many have the luxury to use when in remote places. It can eliminate unnecessary words that might not relevant to your conversation if you are in certain places. However deaf people are usually talk about anything. To keep things simpler, why not use GPS and calendar (appointment), for instance, if you created an appointment on your calendar and the phone would know you're somewhere for your appointment. If you have not created an appointment and the phone can look up where you are – say you're around a school building thus predication would cover conversation	

regarding school and so on. I use this facility all the time with a generic app that is not designed for this situation. Sometime other people that I share my phone with to convey conversation, they tends not able to use my phone well as their phones are different to mine so their response slower than they would've used their phone. We end up use our own phone to convey our conversation. People always prefer use their own phone. I use iPhone and sometime I even don't know how to use a simple function in a Android phone….also the personal predictive words and sentences are not available on other person's phone. I also don't want other people see my person predictive messages. Not every modern phone is equipped with NFC but most likely have Bluetooth technology implanted instead. If phones have NFC, it would most likely simplify the process of connection between two phones than over Bluetooth (I'm not sure how these two technologies work within your prototype app). However, use two phones transmitting messages via NFC could be a way to solve the problem that people can use their own phones. Yes, I agree it is a kind of physical interaction. It can be helpful – save your time but sometime you type away and then realise you do not want to show this particular message to someone (slip up) and this could produce an awkward situation if you do not want to talk the slip up further. If one types faster than another, this could make their conversation confused due to delay. For instance Person A types something and then Person B replies while Person A types something new message while Person B still replying to the original message – conversation would be less flow and out of synchronised. --- It's useful when I can't use sign language. I think the predictive words and sentences support is great. Also, if I can create and edit the database of predictive messages that would be better. I can use the messages I create and save in database. Vocie recognition is a good feature for hearing people. Also, it's useful that people can edit predictive message database. The idea is good, physical interaction and nonverbal messages is quite important for us, especially to see hearing people's face and their mouth (lip reading sometimes) when I talk with them. I can guess what they said from their face ^^ Showing messages on a phone to hearing people is common way I use, most of deaf/hard of hearing people use it already. As you said it's kind of physical interaction when showing messages. That's very important for me when I talk with hearing people. I expect maybe this app could provide something more such as the predictive words and sentences is a good feature. I think the 'Real-time Text Transmission Support' feature is not useful when people communicate in face to face.	

-- The ways of inputting messages on this app is OK. The prediction support is good and very useful. The categorisation support features on this smartphone app is a new design I haven't seen any similar feature before. The original idea is good. But, I feel it's not very convenient to choose a category of predictive message database everytime when I input messages, especially shifting from one category to another during typing. I like the idea of showing messages via a single phone. It's an interesting way through the NFC transmission, I am looking for this feature two phone touch can bring physical interaction between two users. I think it would be fun, like you touch somebody. I think showing messages via a phone is better than the real-time text transmission feature. -- It's useful. But, what is the main difference between this app and other apps? Some apps also support predictive words when I am typing. Also the voice recognition is not a new function. Is there any new way for inputting messages? Showing messages via my smartphone to deaf people is a way I usually use. It's a basic way we use between me and my deaf friends. But, again, what is the difference between the feature in this app and others. For example, I can just type SMS messages and show to my friends instead of send it. I think maybe you can design more readable interface e.g. bigger text size. I think transmit messages through NFC is a good way to having a physical connection with other people. I feel it is similar to showing messages if the people just next you or in front of you. You don't need to transmit messages through NFC you can just show the messages. I think it is not necessary too similar to showing messages. It's not a useful feature. I knew this kind of technology and tried it before. It's awful!!! Sometime you just see people are typing, revising, deleting, re-typing…. It's confusing, you don't even know what actual information they want to talk. -- I think voice recognition is a useful way when I need to communicate with deaf/hard of hearing people. Deaf people can use text typing. I can use speech instead of type it's a quicker way to input message. But, the only concern I have is the accuracy of voice recognition. Voice recognition on my iPhone works quite good for a single word or a simple or short sentence but it becomes terrible sometimes when I try to speak a long sentence. Showing messages to communicate is useful. It's a very easy way no need 3G and Wifi. Why not use two phone? I prefer use my own phone to type. When two people are close I think NCF is unnecessary. They can just show messages to each other. Showing messages via two phones is better than via one phone. No	

need NFC no need 3G, Wifi. Yes, these two ways can encourage people to conduct physical interaction and nonverbal messages. I think in face-to-face communication 'showing' messages is a best way, 'transmitting' message is unnecessary, even via NFC, 3G, wifi… It may be useful. But I don't prefer people instantly see what I am typing. I prefer send (or show) a completed sentence. You mentioned about physical interaction in face-to-face communication. I think people will concentrate on the screen all the time without doing any physical interaction when they use real-time text feature.	
Yes!!!!! It helps a lot. Sometime gestures can help communication smoothly, especially when people from different countries or cultures. So do hearing and deaf/hearing people. And another way is writing. -- Yes, eyes are mainly as a means for deaf/hard of hearing to receive information they rely on it a lot. Simple gestures are also used as signals in communication for deaf people. -- Yes. As I mentioned above facial expressions is very important for deaf communication. Wordless information such as body gestures are always used by deaf. It's communication cues between deaf and hearing people. -- Yes. It's necessary in face-to-face communication when talk with people who don's sign. I always use limited speech with hand gestures in the same time. -- Yes they are part of my language I use them all the time, even people don't know sign language they can understand a bit through my gestures or guess what I said through my gestures. For your prototype app, you type something a long message and you don't know why other person laughs or which part of the message they found funny. You can feel something from people's face or eyes. -- Yes. body language is an important part for me. Hearing people don't sign but they still use some body language. -- Yes, I can understand them (deaf & hard of hearing people) more through their face when we talk. -- Yes, It's a very important part when I communicate with deaf people. I can know do they understand me or not. They also can know if I don't understand them through my face. -- Yes, it's useful. It helps me to communicate with deaf/hard of hearing people. They can't hear me but they can read me through my face and some gestures.	• Gestures help communication • D/HoH people rely on it a lot (nonverbal information) • Eye contact / facial expressions / body language are important • Simple gestures are used as signals • Wordless information • Communication cues
Does this app support one-to-many communication? Can I use it in a group talking? If I am in a group communication for example do I need to show messages to each people one by one or do I have to touch all people's phone when I use NEF to transmit messages? it's inconvenient! any other ways? For this app, one-to-one communication looks	• Different communication circumstances need different supports • One-to-one communication

OK…but in a group you might need to think about it. Different types of communication need different supports for example one-to-one communication and one-to-many communication are different. Communication in different places also needs different supports. For example, the voice recognition will be a problem in a noisy place. I suggest that this app could combine with hearing aids, also with loop technology. Loop technology is a service for deaf/hard of hearing people who wear hearing aids. It's broadly used in public spaces such as in a train station. Deaf/hard of hearing people can receive broadcast information directly through their hearing aids. Maybe this app can connect with hearing aids and loop technology. It also could support group communication e.g. a hearing person talk to their phone via voice recognition and then all deaf people can hear through their hearing aids. Or solve the problem when communicate in a noisy place. -- See what I said above. I suggest that you could provide more details in the sketch prototypes. -- This smartphone app seems only support one-to-one communication. If I use SMS I can send a message to more than one people in the same time. Maybe you could consider it and add SMS function in this app that allows users sending messages via 3G and Wifi. -- I think the colour and images on this app are also important. Because this is for the deaf/hard hearing people to use. The graphic design can catch their eyes directly and help them to use easier. Does this app support hearing aid? -- Some of deaf people's first language is sign language so it would be a good idea if they could convey their language into text using sign language recognition, similar to voice recognition. However this is not as practical as voice recognition as you need two hands to sign and you can't sign while you holding a phone unless the other person holding the phone for you while you signing. -- When hearing people speak via voice recognition can it connect to hearing aids? If it can connect with my hearing aids I think it is good then I can hear what they are saying if it is not clear I also can read text translated from voice recognition. -- I know some deaf people wear hearing assistance maybe this app could link with hearing assistance. -- Does this app support 'sticker' (emotion icons)? I use sticker messages a lot on LINE and Facebook. Some stickers also contain words e.g. 'Yes', 'No', 'Oh My God!'. It's a very interesting way to express information through images especially for short reply and expressing emotion information. -- I didn't see emoticon support in this app, but I think it's could be part of text typing. The concept of this app looks good in general I'm looking forward to seeing more details.	• Group communication • Hearing aids and loop technology • Voice recognition with hearing aids • Design issues (colour/image) • Sign language recognition • Emoticon is needed

Appendix 9: A Document Used in The Third Step Interview

Prototype of A Smartphone App

My name is Chia-Ming Chang, a PhD student in the School of Art & Design at Nottingham Trent University in the UK. My current research looks at influences of new media communication on the deaf/hard of hearing (D/HoH) as reflected in interaction design. The purpose of this questionnaire is to evaluate a prototype of a smartphone app. This questionnaire is used as part of interview. According to your answers of the questionnaire I might ask you further questions through email or in person.

For the data collection, I confirm that:

• The data will be only used in this research and some relevant academic purposes (conference paper).

• The data will not be used it in other purposes without your permission. • The data will not divulge to third person.

• The data storage issue will comply with the procedure of Nottingham Trent University.

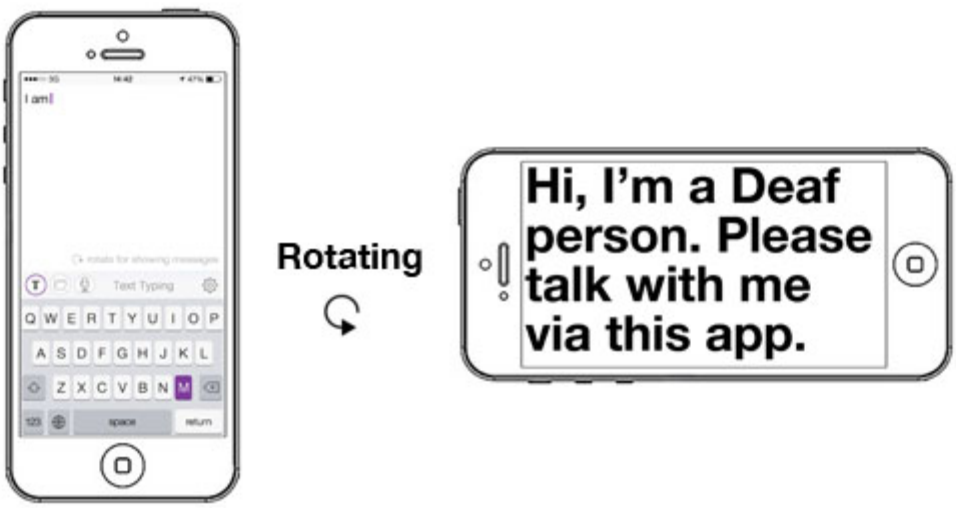
• Participants have right to withdraw the data at any time without giving any reason.

*Required

Please read the explanation above and answer the questions below. *

☐ I confirm that I have read the explanation, and agree that the data I provide will only be used in this research.

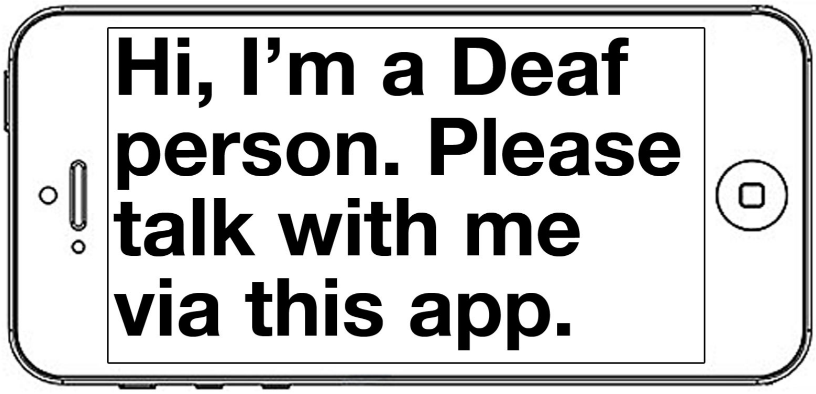
This smartphone app is designed as a communication solution that can be used to bridge the face-to-face communication gap between D/HoH and hearing people. The prototype below presents the design features of this smartphone app.



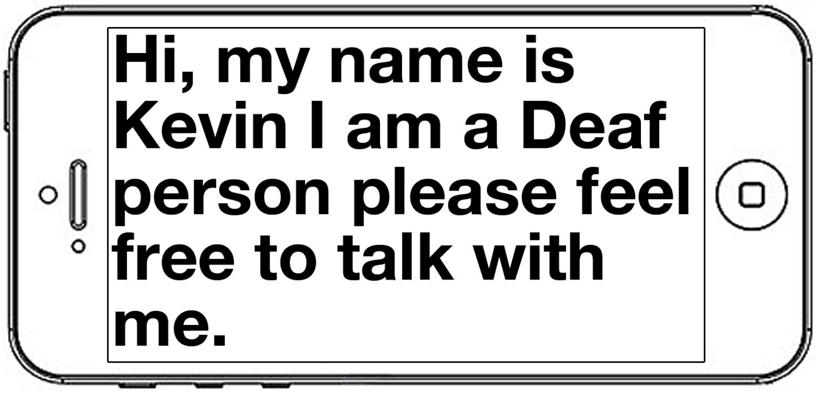
This app provides a specific way (see above image) to communicate between two users in face-to-face without needing connection technologies (e.g. 3G or Wifi). I call it 'Rotating to Show Messages'. The action of 'rotating' brings a significant interaction between users that aims to conduct physical interaction with nonverbal messages into communication. It is because physical interaction with nonverbal messages is one of the most significant parts of face-to-face communication. It's also very important for D/HoH people as they rely on visual sense much more than hearing people during communication. When using this app, users need to input messages in portrait orientation and show messages in landscape orientation. When the user rotates their phone into landscape orientation the message will automatically be shown in bigger text size with full screen.

There are four readable text sizes (with a maximum 100 cm reading distance) designed in this app for the feature of showing messages: 68 pt, 56 pt, 48 pt and 40 pt. The maximum length for a (showing) message depends on text size, with the message restricted to a single page.

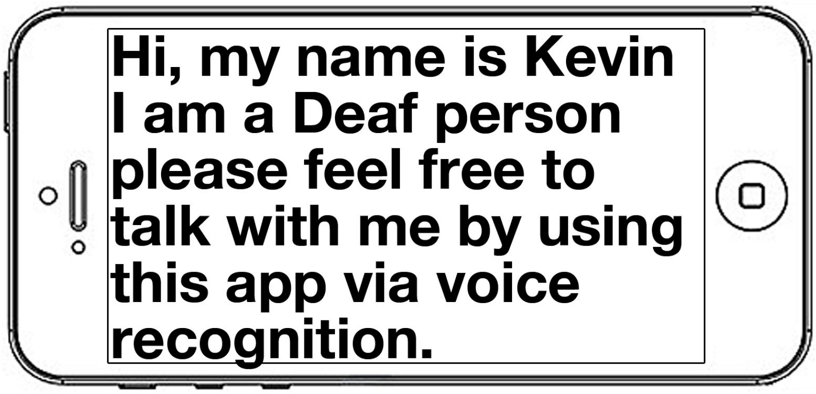
For a text size of 68 pt that allows 48-character messages in 4 rows:



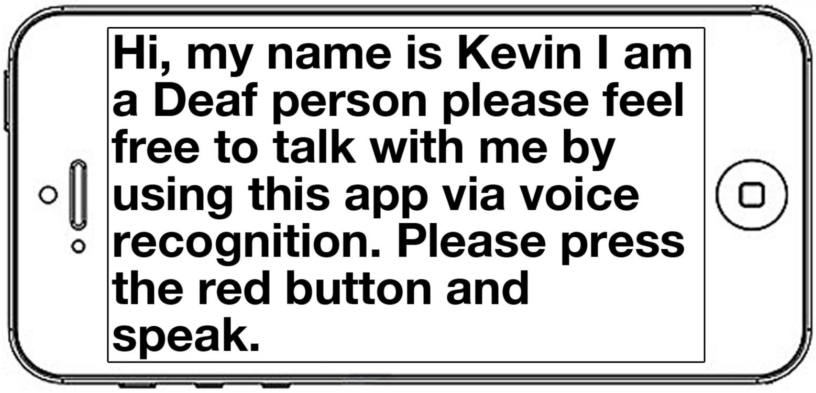
For a text size of 56 pt that allows 75-character messages in 5 rows:



For a text size of 48 pt that allows 108-character messages in 6 rows:



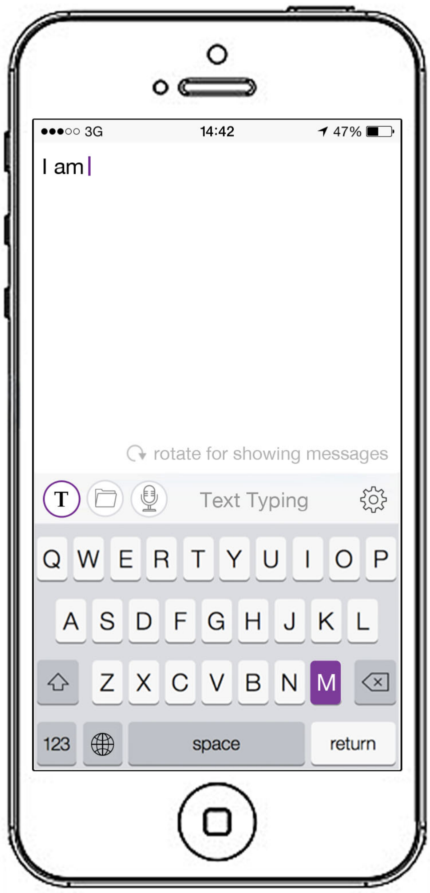
For a text size of 40 pt that allows 147-character messages in 7 rows:



In addition, this smartphone app provides three ways for users to input messages: (1) Text Typing with Predictive Support, (2) Stored Messages with Categorising Support and (3) Voice Recognition with Correcting Support.

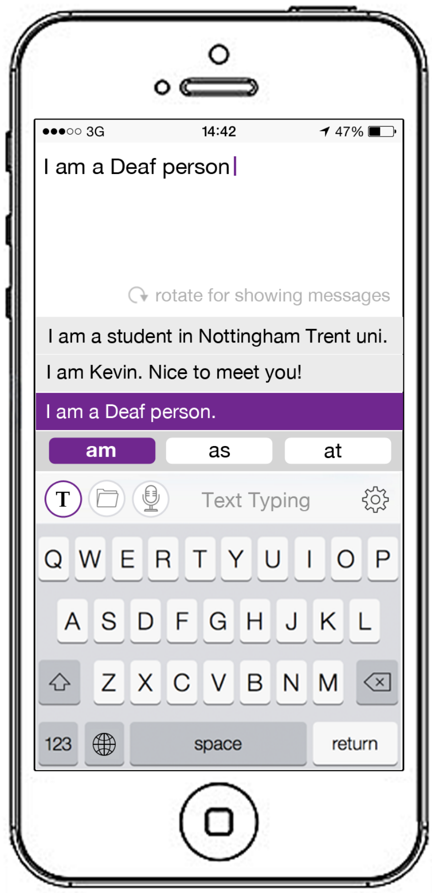
(1) Text Typing with Predictive Supports

Text typing is the primary way of inputting messages in this app specifically designed for D/HoH users. The text typing feature in this app is similar to most of text typing feature in other apps, but it includes a predictive support (suggestive words and sentences). Although some other apps have provided suggestive words, the suggestive sentences support is a further feature for increasing the speed of text typing.



Homepage Interface

Type messages via the keyboard (dark background space).

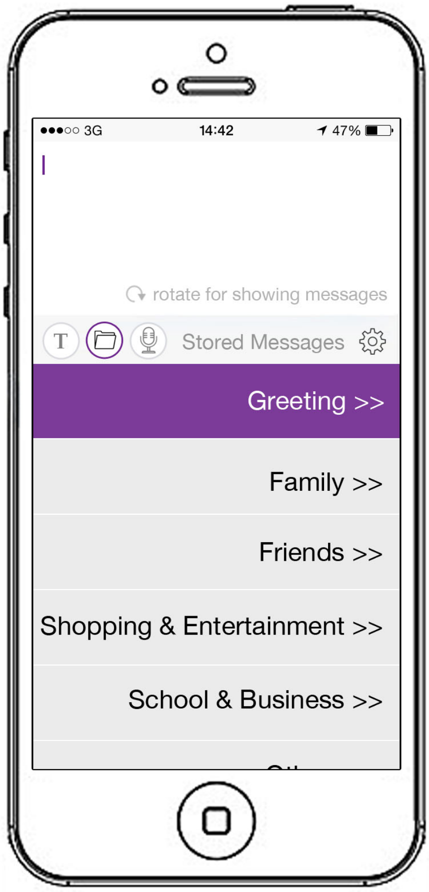


Detailed Interface

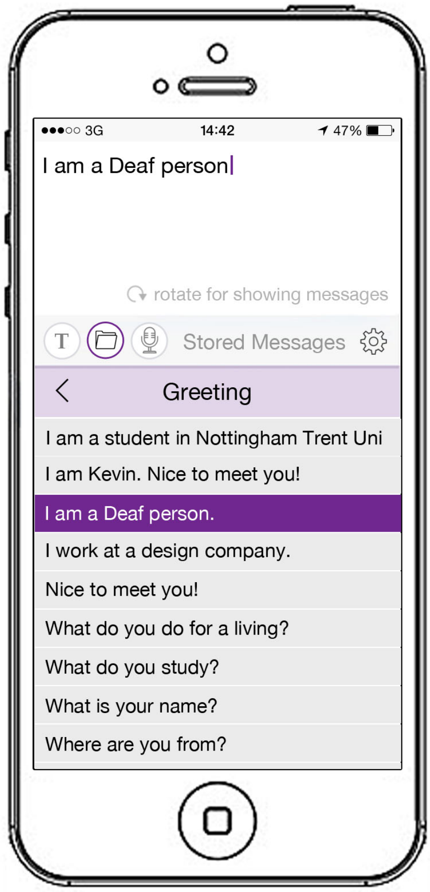
Select a predictive a word and sentence (dark background space).

(2) Stored Messages with Categorising Supports

Stored messages with categorising support is another way of inputting messages in this app specifically designed for D/HoH users. This feature also aims to increase the speed of inputting messages by using existing messages that users create and save in advance. Users can organize their stored messages into different categories via the categorising support that helps users to select a particular message more quickly.



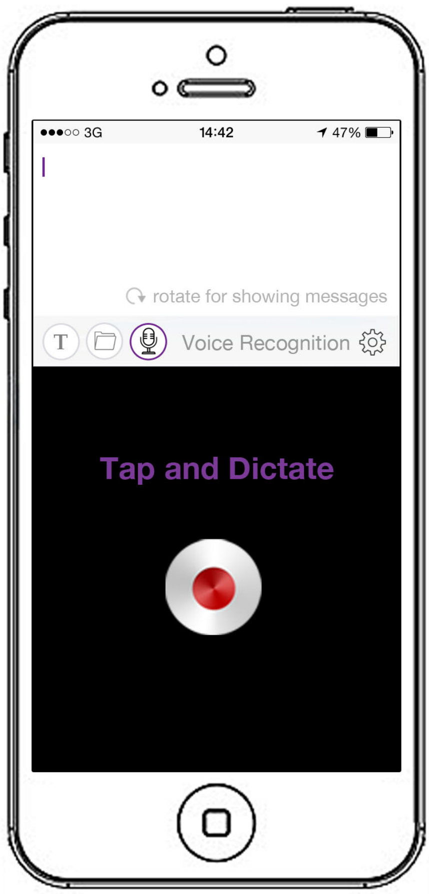
Homepage Interface
Select a stored message category (dark background space).



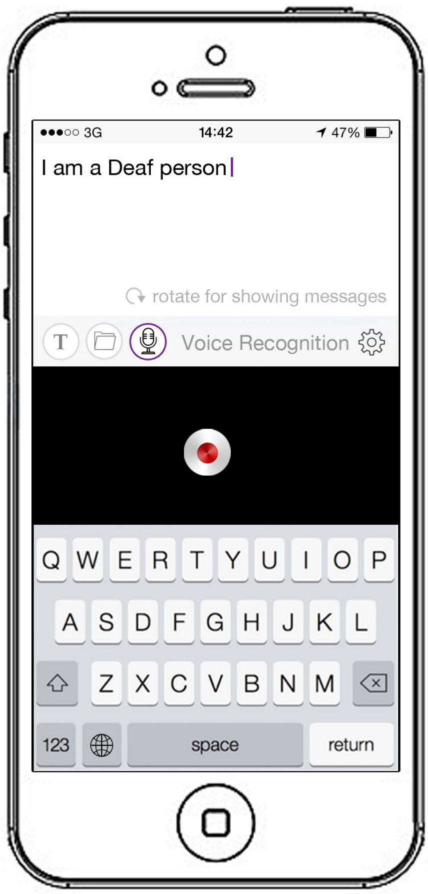
Detailed Interface
Select a stored sentence from the selected category (dark background space).

(3) Voice Recognition with Correcting Supports

Voice recognition with correcting support is the way of inputting messages in this app specifically designed for hearing users. This feature aims to allow hearing users keeping their primary communication method speech. The voice recognition feature in this app includes a correcting support (with a basic text-typing interface) that allows hearing people to modify incorrect results from voice recognition, as well as allowing hearing users to input messages via text typing. The basic text-typing interface in the voice recognition does no include the support of predictive words and sentences to avoid the privacy issue associated with personal predictive messages when using other people's phones.



Homepage Interface
Tap the record icon and dictate the message.

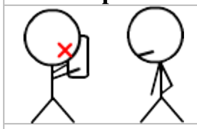
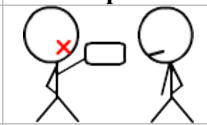
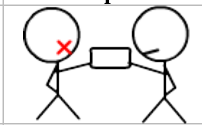
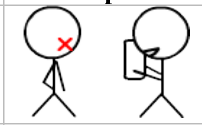
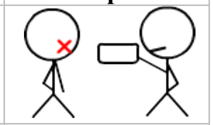


Detailed Interface
Voice recognition results. Correct it via the keyboard if needed.

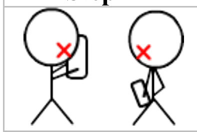
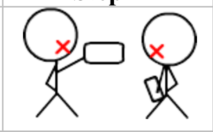
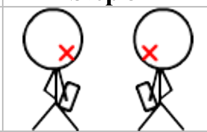
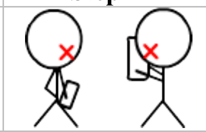
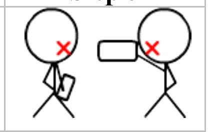
There are two scenorios of using thia app.

* This app is expected to be installed on D/HoH people's phones only because most of hearing people may not install this app on their phones (hearing people do not expect needing to communicate with the D/HoH).

Scenorio 1: Showing messages via a single phone, which is specifically used between a D/HoH and a hearing person.

Step 1	**Step 2**	**Step 3**	**Step 4**	**Step 5**
				
A D/HoH person inputs messages via text typing or stored messages.	The D/HoH person shows messages to a hearing person.	The hearing person reads messages and takes the phone.	The hearing person inputs messages via voice recognition.	The hearing person shows messages back to the D/HoH person.

Scenorio 2: Showing messages via two phones, which is specifically used between a deaf and a hard of hearing person.

Step 1	**Step 2**	**Step 3**	**Step 4**	**Step 5**
				
A deaf person inputs messages via text typing or stored messages.	The deaf person shows messages to a hard of hearing person.	Both the deaf and hard of hearing people use their own phones.	The hard of hearing person also inputs messages via text typing or stored messages.	The hard of hearing person shows messages back to the deaf person.

You also can see the prototype of this smartphone app in a web-based simulated environment via the link http://adonischang.com/web-based/index.html

Questions:

1. What is your feedback about this smartphone app?
   (e.g. the ways of showing messages and inputting messages)

2. What do you think about emoticon if it could be added as a way of inputting messages in this app? (The original concept of not using emoticon is this app is specific for FTF communication that aims to prompt users to express emotional information through physical interaction with nonverbal messages, instead of via the use of emoticon.)

3. Could you choose three names that you prefer to represent this app from the 10 names below?

Name	Concept
1. RoTalk	'RoTalk' is composed of two words 'Rotate' and 'Talk'. This specific term aims to present the significant feature of this app—talking with people by showing messages through rotating phones. This feature brings nonverbal messages into communication as part of face-to-face communication between Deaf/Hard of Hearing and hearing people.
2. Talk2Me	The name Talk2Me aims to express information to hearing people that they can talk to me (Deaf/Hard of Hearing people) by using this ap.
3. Show4Talk	The name Show4Talk aims to express the specific feature of this app: showing messages for talking.
4. Show&Talk	Same as Above.
5. Show2Talk	Same as Above.
6. 2Chat	The name 2Chat can be explained as 'second chat', 'two chat' and 'to chat', as this app is a 'second' communication way for Deaf/Hard of Hearing people, this app is mainly used for 'two' people communication and this app supports Deaf/Hard of Hearing people 'to' chat with hearing people.
7. EyesChat	EyesChat is a metaphor of this app, as eye contact is an important part of nonverbal message in face-to-face communication and this app is designed for face-to-face communication between Deaf/Hard of Hearing and hearing people.
8. F2FTalk	F2F is an abbreviation of face-to-face, as this app is specifically designed for face-to-face communication between Deaf/Hard of Hearing and hearing people.
9. FaceChat	Same as above.
10. EZChat	EZChat pronounces easy chat, as this app aims to provide an easy way to communication between Deaf/Hard of Hearing and hearing people.

Many thanks for your help.

Please feel free to email me at chia-ming.chang2011@my.ntu.ac.uk if you have any further questions.

Appendix 10: Transcript of the Third Step Interview

Interview Transcripts from an Expert Interviewee 1

Question: What is your feedback about this smartphone app? **Responses:** It's a convenient way to chat with people for those who cannot hear. However, for the interface, if the typing area could be bigger, it will be good. The UI design could be modified a little to let users type clearly, such as the showing message UI. A large text size message shown in landscape orientation is quite clear. You must be aware that most of deaf /hard of hearing are the elderly. Your UI design may need to consider about them. I think the three ways of inputting messages are quite OK, the stored messages may be a good way for a long message instead of typing. If the UI could be improved this app would be much better.
Question: What do you think about emoticon if it could be added as a way of inputting messages in this app? **Responses:** For me, I do use emoticon, but I think it is not an important way as you said this app aims to physically express emotional information.
Question: Could you choose three names that you prefer to represent this app from the 10 names below? **Responses:** RoTalk Talk2Me F2FTalk

Interview Transcripts from an Expert Interviewee 2

Question: What is your feedback about this smartphone app? **Responses:** Rotating to show messages is a great idea. I think it is a very useful design that people just need to show messages via rotating their phones. It's easy and simple. Can I type in a landscape orientation when use this app? An extra-wide keyboard is supported in landscape orientation on my iphone. I prefer to type via an extra-wide keyboard because common size keyboard on my iphone is a bit small. Some older deaf may also prefer to use an extra-wide keyboard. Predictive words can be time-saver so one can taps one of predictive words without typing a word in full. If one selected incorrect predictive word, they could tap the word and a pop-up of predictive words available to rectify the selection. Also, the stored message and voice recognition are quick ways to input messages. However, I feel the text size in the stored messages is too small to read. The three buttons (middle of the interface) are too small too.

Question: What do you think about emoticon if it could be added as a way of inputting messages in this app? **Responses:** You could add emoticon as part of text typing. It is a common way all people use it, not just for deaf people.
Question: Could you choose three names that you prefer to represent this app from the 10 names below? **Responses:** Show2Talk Talk2Me EZChat

Interview Transcripts from an Expert Interviewee 3

Question: What is your feedback about this smartphone app? **Responses:** Showing messages via a large size is a good design especially for older deaf. Many people lose their hearing as they age. many deaf are older people. Large text displays on a full screen in landscape orientation is a good feature. I think the 48-character long message might be too short. If the message is longer the limitation what happens? Can I user a scroll bar? I think 75-character long message in 56pt is the best setting from the prototypes, I feel 40pt text size may be to small. It would be good if users can decide font size they prefer. I feel the font size of stored message is too tiny I think it would bring problems to older deaf people. Also, the interfaces of "predictive words/sentences" and "stored messages" are too small, older deaf people might feel very hard to use it. If people can save the most frequently used messages in the stored message, it would be very useful. Does it link to predictive sentences? It might be good if the predictive sentences link to the database of stored messages.
Question: What do you think about emoticon if it could be added as a way of inputting messages in this app? **Responses:** I don't use it very often. But I think you could add it as part of text typing. Many message apps support it.
Question: Could you choose three names that you prefer to represent this app from the 10 names below? **Responses:** RoTalk EyesChat 2Chat

Interview Transcripts from a D/HoH Interviewee 1

Question: What is your feedback about this smartphone app? **Responses:** I think showing message is a good and creative idea for the people who are deaf or hard of hearing. But the interface design of this app looks not that special and unique. What is the pop out design for this? I am looking forwards to seeing the difference from the other apps because this app is for deaf users and their visual affections might be stronger than normal people. Showing message via a big text size to people is fine. I am also thinking if the showing messages could be spoken out loud via speaker it would be good for a hearing person. Hearing people can listen it rather than read it. Stored message is a good function. I am sure I will rely upon it a lot. It can save a lot of time. Voice recognition is not without flawless as people come from diversity background, therefore they have their own dialect/accent. If it was used in a quiet environment, it could provide more accuracy over noisy background. Some people can type without proofreading it so I can image people who use voice recognition might not proofread what they've dictated into voice recognition system, which could cause confusion for hard of hearing/Deaf person to read unintended words.
Question: What do you think about emoticon if it could be added as a way of inputting messages in this app? **Responses:** You should add emoticon into this app. I use it a lot via other apps e.g. whatsapp. It's a fun way to communicate!
Question: Could you choose three names that you prefer to represent this app from the 10 names below? **Responses:** Show2Talk Talk2Me F2FTalk

Interview Transcripts from a D/HoH Interviewee 2

Question: What is your feedback about this smartphone app? **Responses:** I'm not sure rotation is essential, but it does improve visibility automatically so – great idea! I do like the idea of large font size when shows messages. It's similar to written note, but it's more convenient. Can users decide the text size themselves? If I need type a long sentence I might choose a smaller size because the restriction of message length. Excellent. I think the combination of the three ways of inputting message gives people a choice, but not too many choices or too confusing. Speaking might be preferred by people

with little experience if keyboard-style input.
Question: What do you think about emoticon if it could be added as a way of inputting messages in this app? **Responses:** Might be useful in a future version, but emoticons mean different things to different people. Go for it – release the app as it is. Its apparent simplicity is its USP (unique selling point).
Question: Could you choose three names that you prefer to represent this app from the 10 names below? **Responses:** RoTalk. This is a great name, distinctive, explanatory, short, snappy and easy to remember. Show2Talk. Says what it does. Reasonably short, not so easy to say. More difficult for hard-of-hearing people to hear because of the ‘Sh’ at the start. Show&Talk. Not so snappy but similar to my comments about Show2Talk. I don’t like any of the others as they are not specific enough to explain the App, and that is essential for advertising.

Interview Transcripts from a D/HoH Interviewee 3

Question: What is your feedback about this smartphone app? **Responses:** I like the concept of rotating the phone screen when one has done typing to show bigger texts. However if he typed a long text, rotated text can be cramped into a small size of the phone screen, makes text smaller therefore difficult to read for some people. I have seen this feature before - Google Translation uses this similar feature. To avoid cramming a long text into a small screen, scrollable screen could overcome the issue of smaller texts. For the categorising supports, it might work with a small list of phrases so they do not have to go through the list to pick the right one. If one has a long list to go through, it might not as quick as typing words manually instead. If the feature could have an access to calendar or location, it might improve the accuracy. It has been known the activity of location service can have negative impact on the battery life. To avoid the impact of battery life, the most recently or most popular can appear top of the list so it can be selected quicker and easier.
Question: What do you think about emoticon if it could be added as a way of inputting messages in this app? **Responses:** Emoticons can be useful as it provides quicker and easier than type a full word. However a picture can tells a thousand of words, which people could interpret it differently to intended conveyed meaning.
Question: Could you choose three names that you prefer to represent this app from the 10 names below? **Responses:**

RoTalk
Talk2Me
Show2Talk

Interview Transcripts from a Hearing Interviewee 1

Question:
What is your feedback about this smartphone app?

Responses:
It's a good idea, typed messages are automatically increase into a large text size and shown on a full screen is a very useful feature. I always type text on my phone and show it to my deaf friend, but common text size is too small. I can change text size via setting page, but it gets more complicated when we talk.

Voice recognition is a useful way for hearing people to input messages. I have been using a similar function (iPhone Siri) instead of typing. Also, I think the stored message will be a useful way for deaf people.

Question:
What do you think about emoticon if it could be added as a way of inputting messages in this app?

Responses:
I understand your reasons that emoticon is not involved in this app. But, emoticon is still different to emotional expressions in face-to-face communication. For me emoticon is not just for expressing emotions it is a very interesting way to chat with friends.

Question:
Could you choose three names that you prefer to represent this app from the 10 names below?

Responses:
Talk2Me
EyesChat
RoTalk

Interview Transcripts from a Hearing Interviewee 2

Question:
What is your feedback about this smartphone app?

Responses:
It is an easy way for deaf people to communicate but no WOW.
Because if I was a deaf person, I can still type on notes for communication, I don't need too many databases to chat with people every time, maybe just for strangers or people we meet at the first time. I would like to see more visual designs on the app

It's a convenient way to chat with deaf people. But still, would like to see the special and unique visual design. However, how many saving messages could be recorded? Or can the users organise saving messages by themselves? It will be good if the app can have this function.

Question:
What do you think about emoticon if it could be added as a way of inputting messages in

this app? **Responses:** Add it! It's not just for emotional expressions sometime an emoji means a lot rather than words. It's powerful than a text message. I always use it.
Question: Could you choose three names that you prefer to represent this app from the 10 names below? **Responses:** RoTalk Talk2Me EZChat

Interview Transcripts from a Hearing Interviewee 3

Question: What is your feedback about this smartphone app? **Responses:** It's good overall. Rotating to showing message obviously is a new way to communicate between hearing and deaf people in face-to-face. I can use speech recognition to input messages what I wanna say and deaf people can use text typing and stored messages. The stored message feature would be very useful for deaf people. They don't waste time to type they can just select existing messages. I think the best part of this app is the showing messages in landscape orientation via a large font size. It is big enough to read. Does it support text-to-speech? It could an extra function that supports voice messages for hearing people. When shows messages in landscape orientation the message also cab be pronounced.
Question: What do you think about emoticon if it could be added as a way of inputting messages in this app? **Responses:** For me, I prefer to have it. There are so many emoticons supporting different topics that we can download online. For instance, emoticons for holidays (xmas, new year) and idol emoticons. It makes chat more interesting.
Question: Could you choose three names that you prefer to represent this app from the 10 names below? **Responses:** Talk2Me Show2Talk Show&Talk

Appendix 11: Initial Codes of the Third Step Interview

Interview Data	Codes
It's a convenient way to chat with people for those who cannot hear. However, for the interface, if the typing area could be bigger, it will be good. The UI design could be modified a little to let users type clearly, such as the showing message UI. A large text size message shown in landscape orientation is quite clear. You must be aware that most of deaf /hard of hearing are the elderly. Your UI design may need to consider about them. I think the three ways of inputting messages are quite OK, the stored messages may be a good way for a long message instead of typing. If the UI could be improved this app would be much better. --- Rotating to show messages is a great idea. I think it is a very useful design that people just need to show messages via rotating their phones. It's easy and simple. Can I type in a landscape orientation when use this app? An extra-wide keyboard is supported in landscape orientation on my iphone. I prefer to type via an extra-wide keyboard because common size keyboard on my iphone is a bit small. Some older deaf may also prefer to use an extra-wide keyboard. Predictive words can be time-saver so one can taps one of predictive words without typing a word in full. If one selected incorrect predictive word, they could tap the word and a pop-up of predictive words available to rectify the selection. Also, the stored message and voice recognition are quick ways to input messages. However, I feel the text size in the stored messages is too small to read. The three buttons (middle of the interface) are too small too. --- Showing messages via a large size is a good design especially for older deaf. *Many* people lose their hearing as they age. many deaf are older people. Large text displays on a full screen in landscape orientation is a good feature. I think the 48-character long message might be too short. If the message is longer the limitation what happens? Can I user a scroll bar? I think 75-character long message in 56pt is the best setting from the prototypes, I feel 40pt text size may be to small. It would be good if users can decide font size they prefer. I feel the font size of stored message is too tiny I think it would bring problems to older deaf people. Also, the interfaces of "predictive words/sentences" and "stored messages" are too small, older deaf people might feel very hard to use it. If people can save the most frequently used messages in the stored message, it would be very useful. Does it link to predictive sentences? It might be good if the predictive sentences link to the database of stored messages. --- I think showing message is a good and creative idea for the	• UI design issues • Older D/HoH users • Stored messages (positive feedback) • Orientation of showing messages • Text and interface sizes are too small • Large text size messages (positive feedback) • Rotating to show messages (positive feedback) • Database of the stored messages • Further development (e.g. UI and text-to-speech) • Showing message interface (text size) • Text size and message length • Flexible text size • Voice recognition (positive feedback) • Connection of predictive words/sentences & stored messages •

people who are deaf or hard of hearing. But the interface design of this app looks not that special and unique. What is the pop out design for this? I am looking forwards to seeing the difference from the other apps because this app is for deaf users and their visual affections might be stronger than normal people.

Showing message via a big text size to people is fine. I am also thinking if the showing messages could be spoken out loud via speaker it would be good for a hearing person. Hearing people can listen it rather than read it.

Stored message is a good function. I am sure I will rely upon it a lot. It can save a lot of time. Voice recognition is not without flawless as people come from diversity background, therefore they have their own dialect/accent. If it was used in a quiet environment, it could provide more accuracy over noisy background. Some people can type without proofreading it so I can image people who use voice recognition might not proofread what they've dictated into voice recognition system, which could cause confusion for hard of hearing/Deaf person to read unintended words.

I'm not sure rotation is essential, but it does improve visibility automatically so – great idea!

I do like the idea of large font size when shows messages. It's similar to written note, but it's more convenient.

Can users decide the text size themselves? If I need type a long sentence I might choose a smaller size because the restriction of message length.

Excellent. I think the combination of the three ways of inputting message gives people a choice, but not too many choices or too confusing. Speaking might be preferred by people with little experience if keyboard-style input.

I like the concept of rotating the phone screen when one has done typing to show bigger texts. However if he typed a long text, rotated text can be cramped into a small size of the phone screen, makes text smaller therefore difficult to read for some people. I have seen this feature before - Google Translation uses this similar feature. To avoid cramming a long text into a small screen, scrollable screen could overcome the issue of smaller texts.

For the categorising supports, it might work with a small list of phrases so they do not have to go through the list to pick the right one. If one has a long list to go through, it might not as quick as typing words manually instead. If the feature could have an access to calendar or location, it might improve the accuracy. It has been known the activity of location service can have negative impact on the battery life. To avoid the impact of battery life, the most recently or most popular can appear top of the list so it can be selected quicker and easier.

It's a good idea, typed messages are automatically increase into a large text size and shown on a full screen is a very

useful feature. I always type text on my phone and show it to my deaf friend, but common text size is too small. I can change text size via setting page, but it gets more complicated when we talk. Voice recognition is a useful way for hearing people to input messages. I have been using a similar function (iPhone Siri) instead of typing. Also, I think the stored message will be a useful way for deaf people. --- It is an easy way for deaf people to communicate but no WOW. Because if I was a deaf person, I can still type on notes for communication, I don't need too many databases to chat with people every time, maybe just for strangers or people we meet at the first time. I would like to see more visual designs on the app It's a convenient way to chat with deaf people. But still, would like to see the special and unique visual design. However, how many saving messages could be recorded? Or can the users organise saving messages by themselves? It will be good if the app can have this function. --- It's good overall. Rotating to showing message obviously is a new way to communicate between hearing and deaf people in face-to-face. I can use speech recognition to input messages what I wanna say and deaf people can use text typing and stored messages. The stored message feature would be very useful for deaf people. They don't waste time to type they can just select existing messages. I think the best part of this app is the showing messages in landscape orientation via a large font size. It is big enough to read. Does it support text-to-speech? It could an extra function that supports voice messages for hearing people. When shows messages in landscape orientation the message also cab be pronounced.	
For me, I do use emoticon, but I think it is not an important way as you said this app aims to physically express emotional information. --- You could add emoticon as part of text typing. It is a common way all people use it, not just for deaf people. --- I don't use it very often. But I think you could add it as part of text typing. Many message apps support it. --- You should add emoticon into this app. I use it a lot via other apps e.g. whatsapp. It's a fun way to communicate! --- Might be useful in a future version, but emoticons mean different things to different people. Go for it – release the app as it is. Its apparent simplicity is its USP (unique selling point). --- Emoticons can be useful as it provides quicker and easier than type a full word. However a picture can tells a	• Suggests to add it • Emoticon is different to emotional expressions in person • Not just for emotional expressions • Supports different topics (positive feedback) • More powerful than text messages (positive feedback) • An interesting way (positive feedback) • It's not an important way

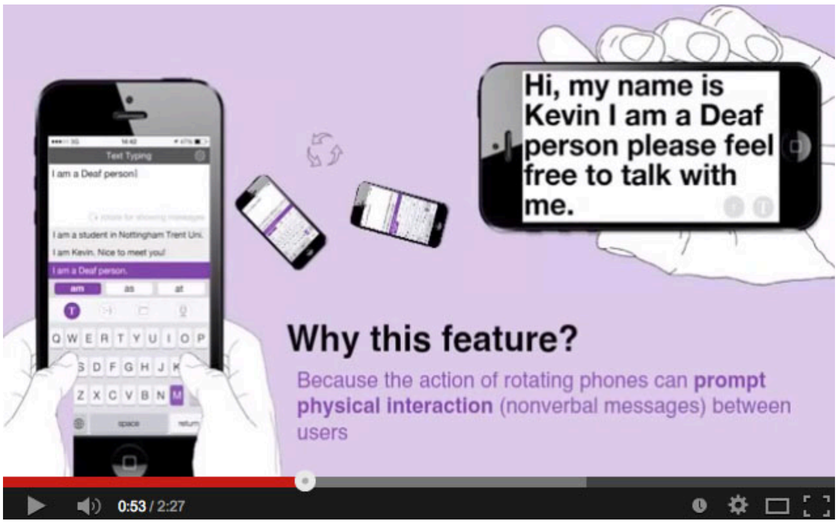
thousand of words, which people could interpret it differently to intended conveyed meaning. -- I understand your reasons that emoticon is not involved in this app. But, emoticon is still different to emotional expressions in face-to-face communication. For me emoticon is not just for expressing emotions it is a very interesting way to chat with friends. -- Add it! It's not just for emotional expressions sometime an emoji means a lot rather than words. It's powerful than a text message. I always use it. -- For me, I prefer to have it. There are so many emoticons supporting different topics that we can download online. For instance, emoticons for holidays (xmas, new year) and idol emoticons. It makes chat more interesting.	in this app (negative feedback)
RoTalk Talk2Me F2FTalk -- Show2Talk Talk2Me EZChat -- RoTalk EyesChat 2Chat -- Show2Talk Talk2Me F2FTalk -- RoTalk. This is a great name, distinctive, explanatory, short, snappy and easy to remember. Show2Talk. Says what it does. Reasonably short, not so easy to say. More difficult for hard-of-hearing people to hear because of the 'Sh' at the start. Show&Talk. Not so snappy but similar to my comments about Show2Talk. I don't like any of the others as they are not specific enough to explain the App, and that is essential for advertising. -- RoTalk Talk2Me Show2Talk -- Talk2Me EyesChat RoTalk -- RoTalk Talk2Me EZChat -- Talk2Me Show2Talk Show&Talk	• Talk2Me • RoTallk • Show2Talk

Appendix 12: A Document Used in The Final Evaluation

Talk2Me: a novel communication app for deaf/hard of hearing people in face-to-face communication

My name is Chia-Ming Chang, a PhD candidate in the School of Art & Design at Nottingham Trent University in the UK. My research has investigated a novel communication solution, which is a smartphone app design that can be used to bridge the face-to-face communication gap between deaf/hard of hearing and hearing people.

Here is a video description about this smartphone app 'Talk2Me'. Please watch it via http://youtu.be/KJ1klK5aORM and give any feedback you might have about this app.



For the data collection, I confirm that:

• The data will be only used in this research and some relevant academic purposes (conference paper).

• The data will not be used it in other purposes without your permission. • The data will not divulge to third person.

• The data storage issue will comply with the procedure of Nottingham Trent University.

• Participants have right to withdraw the data at any time without giving any reason.

*Required

Please read the explanation above and answer the questions below. *

☐ I confirm that I have read the explanation, and agree that the data I provide will only be used in this research.

Many thanks for you help!

If you have any questions or further suggestions please email me at chia-ming.chang2011@my.ntu.ac.uk.

Appendix 13: Feedback of Talk2Me

Feedback 1: I have been looking at some of your work ready for Wednesday. Chia, it's a good app. The various inputting ways on this app are good, especially the text typing with predictive words/sentences and the stored messages. Also, the large interface is useful. Is the app available in online app store now? I will forward your email to my friends and obtain more feedback and I will show your idea to the deaf job club I attend on Wednesdays.
Feedback 2: Hi there. Great App. I like the idea showing message via rotating a phone.
Feedback 3: It's a good app. The large mode in this app is prefect for me, but the typing interface (keyboard) in the large mode looks same as normal size. Perhaps, you could try to enlarge it.
Feedback 4: Good research! The Elder mode is a very useful feature. I always feel text size is too small to read on my phone and the buttons are also too small for my stupid fingers sometimes. My father has hearing problems all the time when talk I think this app would be a good solution. I am also thinking if people speak different language, can the voice recognition translate language like Google translate? Is this available to download?
Feedback 5: Yes, physical interaction (nonverbal messages) is very important for us when we communicate with hearing people. It's a good design. Can I download it form Apple store?
Feedback 6: I think this app is absolutely good for deaf or hard of hearing people. For me, I like the stored message that saves time. Does it support Android phone? I don't use iphone. I am looking forward to using it.
Feedback 7: I am really looking forward to using it. The rotating to show messages is a great idea and the messages shown using bigger text size with full screen display is very useful. Go for it!
Feedback 8: It's a useful app for deaf people. The way of showing message looks very interesting. The stored message is a useful feature for deaf people and voice recognition is a nice feature for hearing people.
Feedback 9: I like the way of using this app 'rotating and showing'. It's cool. Also the ways of inputting message are supportive.
Feedback 10: Very nice study! Showing message in landscape is good I can read it easily. Can I record the messages? I mean when rotates phone back in a portrait direction does the previous message be recorded for next time use when I need the same message? or do I need to type again?

I think the stored message feature in this app will be very useful. When will you launch this talk2me app? I am looking to using it.
Feedback 11: It looks good. I like the design of showing message via a large text size. It's a normal way I always use to talk with my deaf friends. I type on my phone and show to them but the text is too small to read. Large text size is obviously useful design in this app, also the stored message is good design. Have you published this app? Can I find it in app store?
Feedback 12: It's a great communication solution for non-sign hearing people to communicate with deaf or hard of hearing people.

Appendix 14: A Task-oriented Evaluation of Note Speak Listen App

A Conversation Task
D/HoH Person: Hello, how are you? **Hearing Person:** I am fine. Thank you. How was your weekend? **D/HoH Person:** It's great! I went hiking with my family. I am going to hiking again with Chia-Ming. Do you want to come with us? **Hear Person:** I want to go. I have to check my schedule first. I will let you know later. **D/HoH Person:** Ok, let me know if you can join.

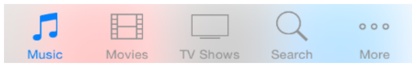
Feedback 1: **[Feedback from a D/HoH User, Male, Age 37]** After using this app to chat with a hearing friend, I think the best part of this app is the speech to text translation function. My hearing friend only need to speak to my phone and then I can read it via text. Text being displayed in a large size is great. Typing text for me is just a common way I usually use when I chat with my hearing friends. This app is similar to Talk2Me app, but Talk2Me app provides more useful features e.g. stored message. **[Feedback from a Hearing User, Female, Age 29]** It's good that I can use voice to enter text. I am used to use similar tool such as the Google Translate when talk with my deaf friends. It seems that this app uses Google's voice recognition technology. However, text size is small on Google Translate the big text on this app is more readable.
Feedback 2: **[Feedback from a D/HoH User, Male, Age 33]** Typing text on my phone is the method I always use to communicate with my hearing friends. It seems not a new way when using this app. But displaying text in large font is a useful design in this app. I can easily complete the communication task via this app without any problem. But, the "note" and "listen" buttons are confusing. **[Feedback from a Hearing User, Male, 30]** It is a good app for communicating with deaf people. The voice to text translation in this app works better than I thought.
Feedback 3: **[Feedback from a D/HoH User, Male, Age 58]** This app is a good communication solution between my son and myself. My son doesn't know much about sign language. We completed the simple communication task through this app. But, for me it takes time to type text as I am not used to type on my phone. I prefer to writing in down on a paper it easier for me. I think large text display is very clear. **[Feedback from a Hearing User, Male, Age 22]** I am not deaf, but my father is deaf person. My sign language is poor. This app provides an easy way for me to communicate with my father. I got no problem with this app in the use of speech to text translation. However, I feel it is difficult for my father when he is typing text via this app. He is not familiar with typing on a smartphone.

Appendix 15: GUI elements iOS7 on iPhone 5

The Apple interface guidelines divide interface elements into four categories: a. Bars, b. Content Views, c. Controls and d. Temporary Views.

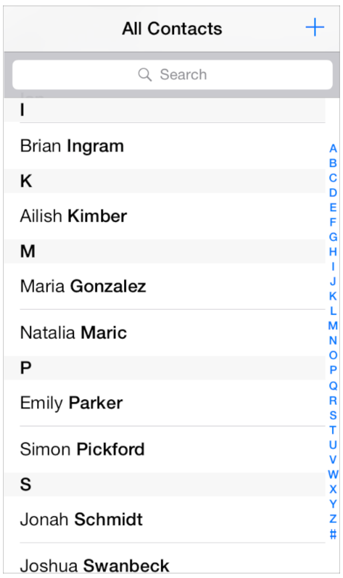
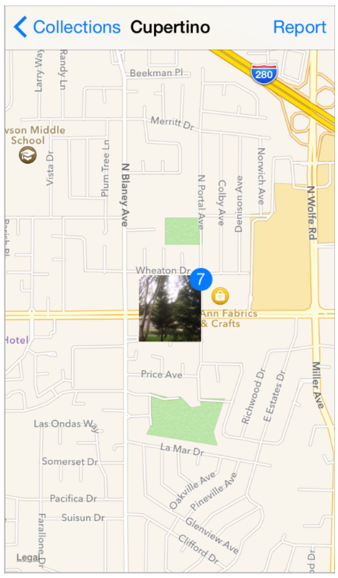
a. Bars

Bars are typically located at the top or bottom of a window, containing contextual information that tell users where they are and the controls provided to navigate or initiate actions.

The Status Bar The status bar displays important information about the device and the current environment. 	**Navigation Bar** A **navigation bar** enables navigation through an information hierarchy and, optionally, the management of screen content. 
Toolbar A toolbar contains controls that perform actions related to objects on the screen or view. 	**Tab Bar** A tab bar gives people the ability to switch between different subtasks, views or modes in an app. 

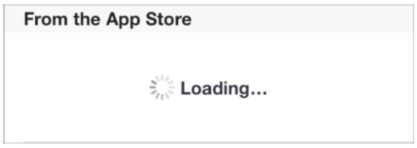
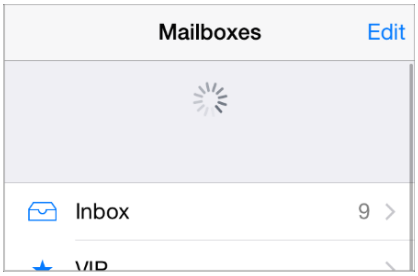
b. Content Views

The content views area typically occupies most of the space in the middle of a window, containing app-specific content and enabling behaviours such as scrolling, insertion, deletion and rearrangement of items.

Table View A table view presents data in a scrolling single-column list of multiple rows. 	**Map View** A map view presents geographical data and supports most of the functionality provided by the built-in Maps app. 

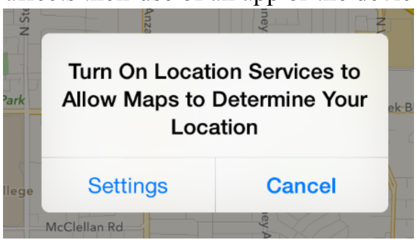
c. Controls

Controls perform actions or display information.

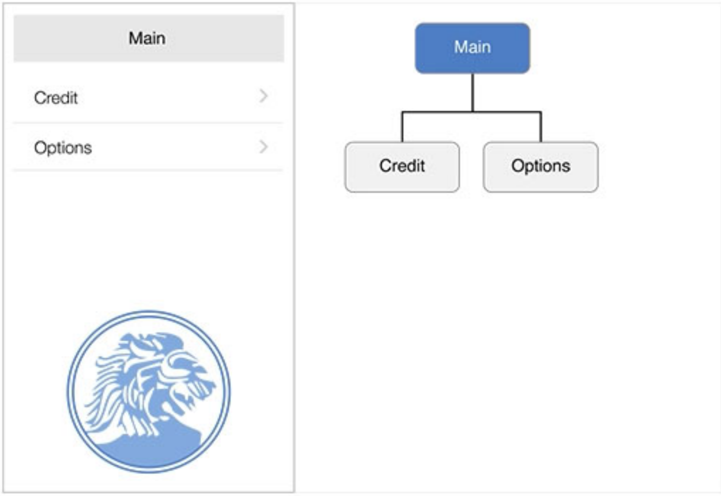
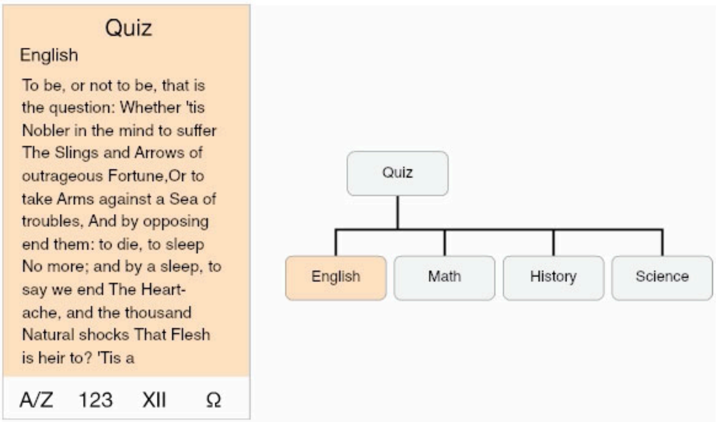
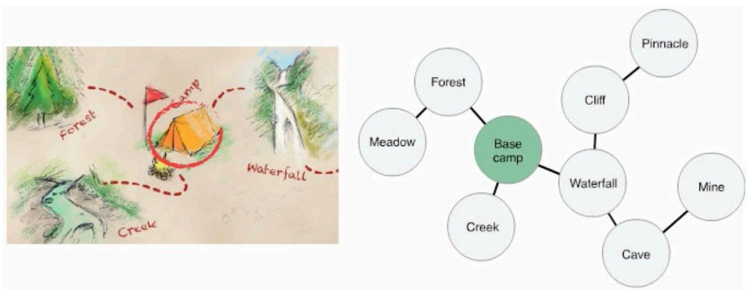
<table>
<tr>
<td>Activity Indicator
An activity indicator that shows that a task or process is progressing.
</td>
<td>Refresh Control
A refresh control performs a user-initiated content refresh—typically in a table.
</td>
</tr>
<tr>
<td>Page Control
A page control indicates the number of open views and which one is currently visible.
</td>
<td>Segmented Control
A segmented control is a linear set of segments, each of which functions as a button that can display a different view.
</td>
</tr>
</table>

d. Temporary Views

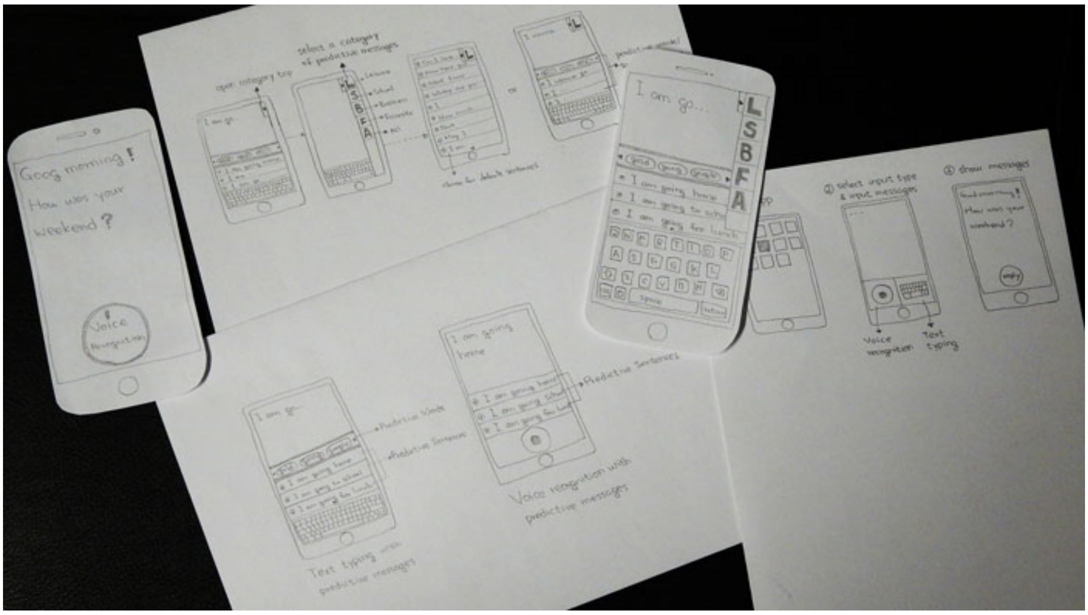
Temporary views appear briefly to give users important information or additional choices and functionality.

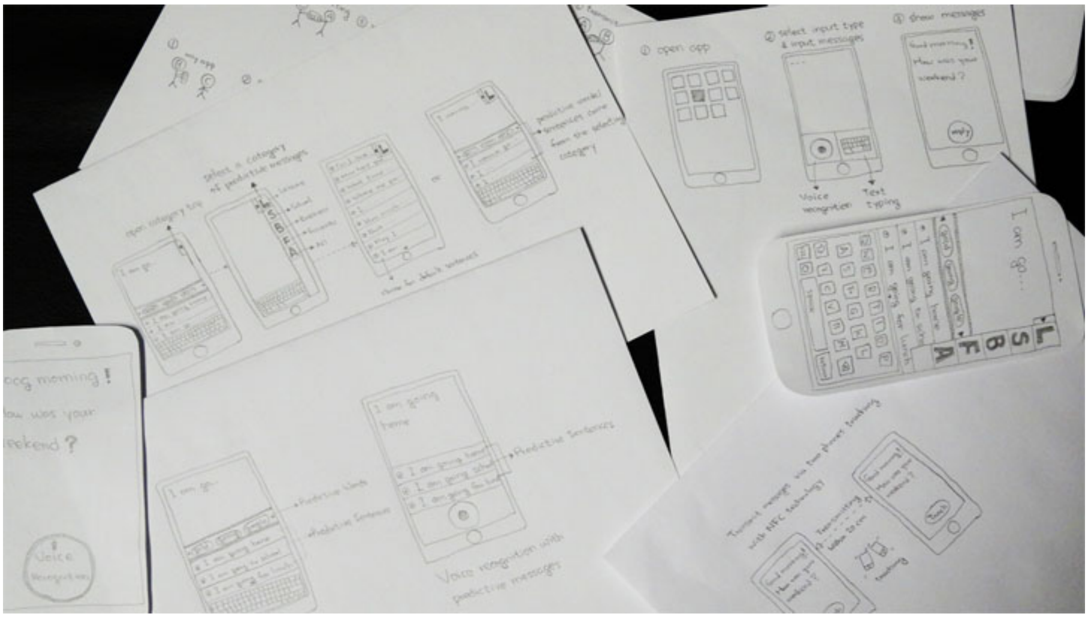
<table>
<tr>
<td>Alert
An alert gives people important information that affects their use of an app or the device.
</td>
<td>Action Sheet
An action sheet displays a set of choices related to a task the user initiates.
</td>
</tr>
</table>

In addition, iOS7 provides three styles of navigation for structuring app content. Different navigation styles provide different ways for users to read content (e.g. text-based and visual-based) on a limited screen. The three navigation styles are Hierarchical, Flat and Content-driven (or experience-driven).

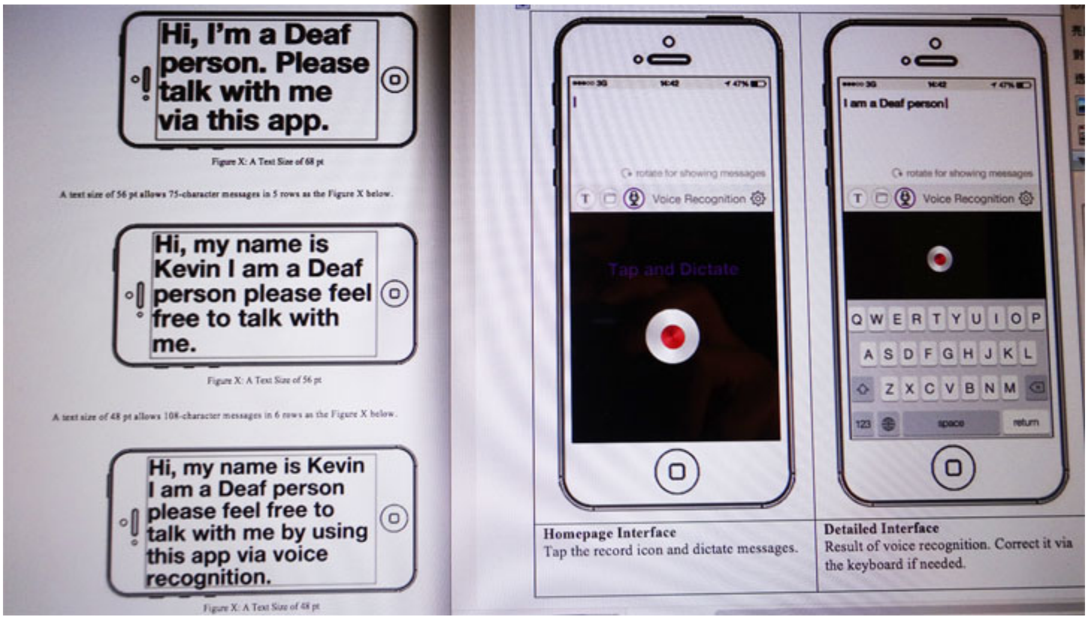
	**Hierarchical** In a hierarchical app, users navigate by making one choice per screen until they reach their destination. To navigate to another destination, users must retrace some of their steps—or start over from the beginning—and make different choices.
	**Flat** In an app with a flat information structure, users can navigate directly from one primary category to another because all primary categories are accessible from the main screen.
	**Content-driven or experience-driven** In an app that uses a content-driven or experience-driven information structure, navigation is also defined by the content or experience.

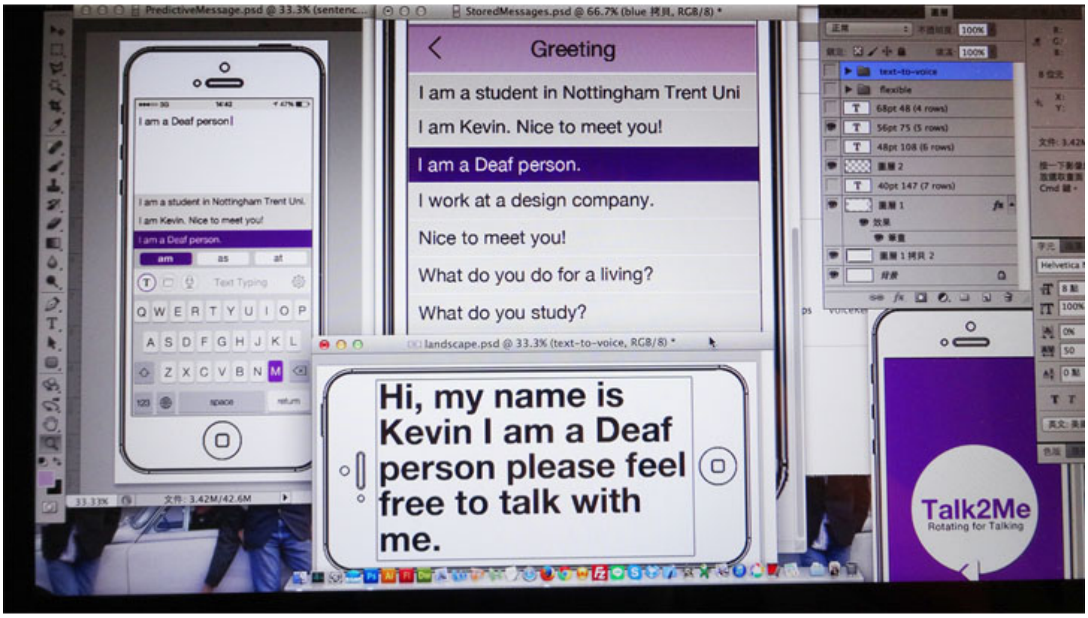
Appendix 16: A Sample of Paper-based Sketch Prototype



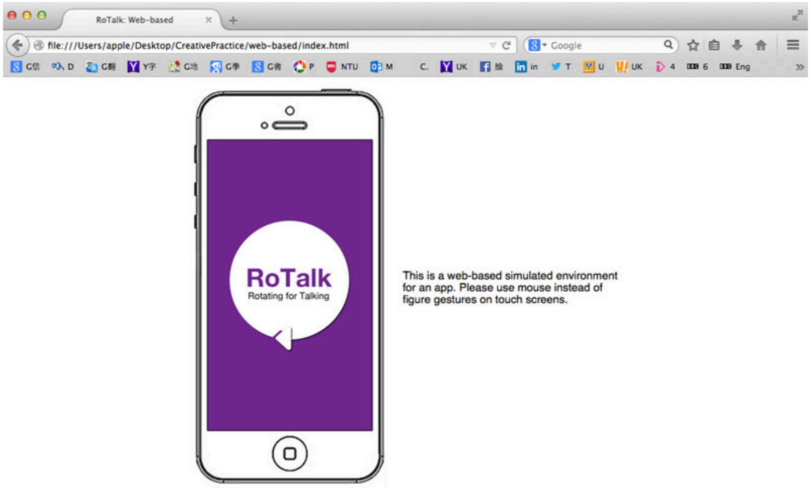


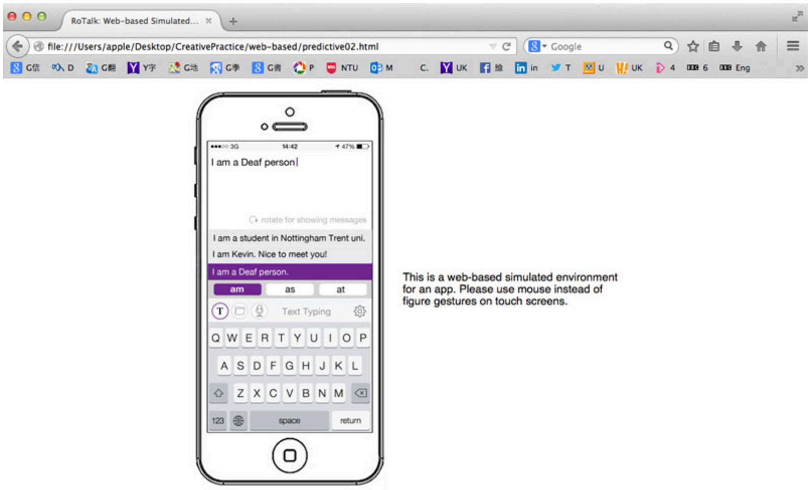
Appendix 17: A Sample of Digital Graph Prototype

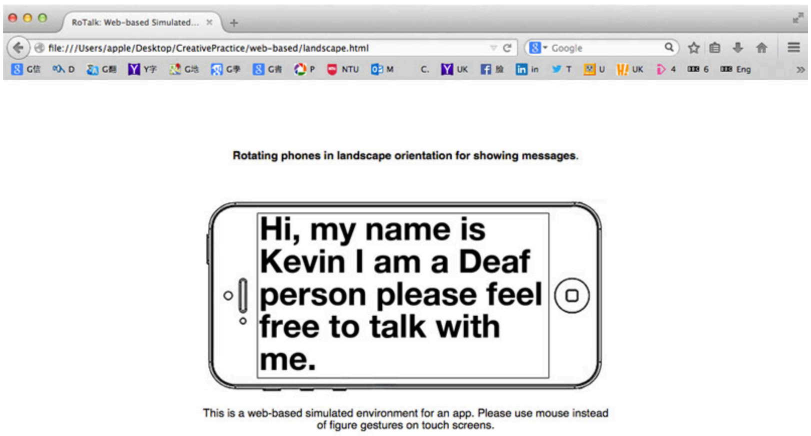




Appendix 18: Prototype in a Web-based Environment

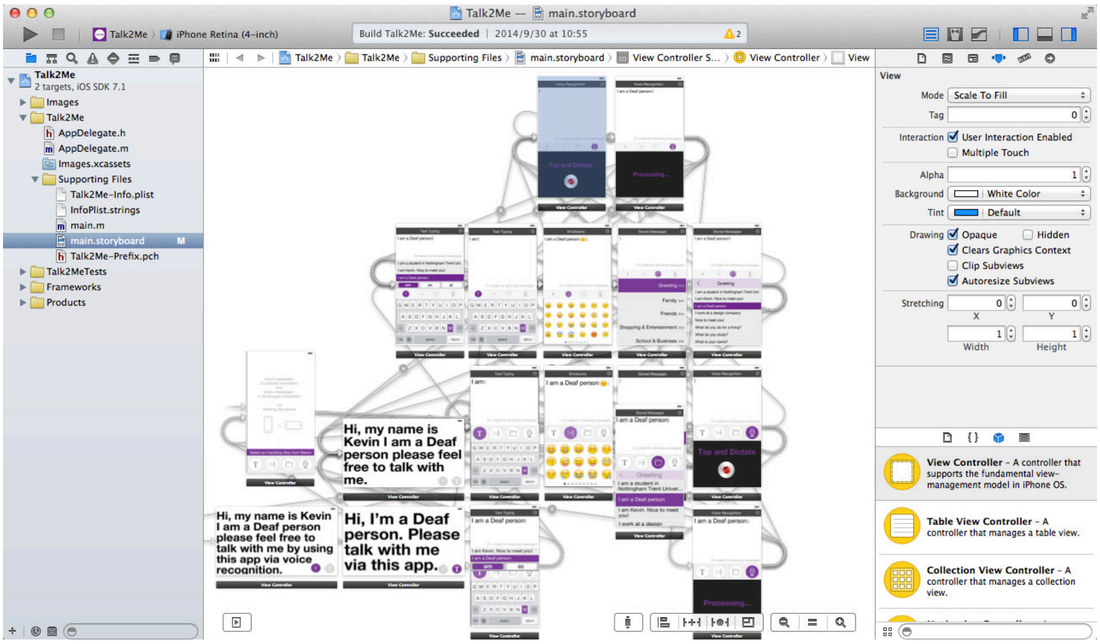


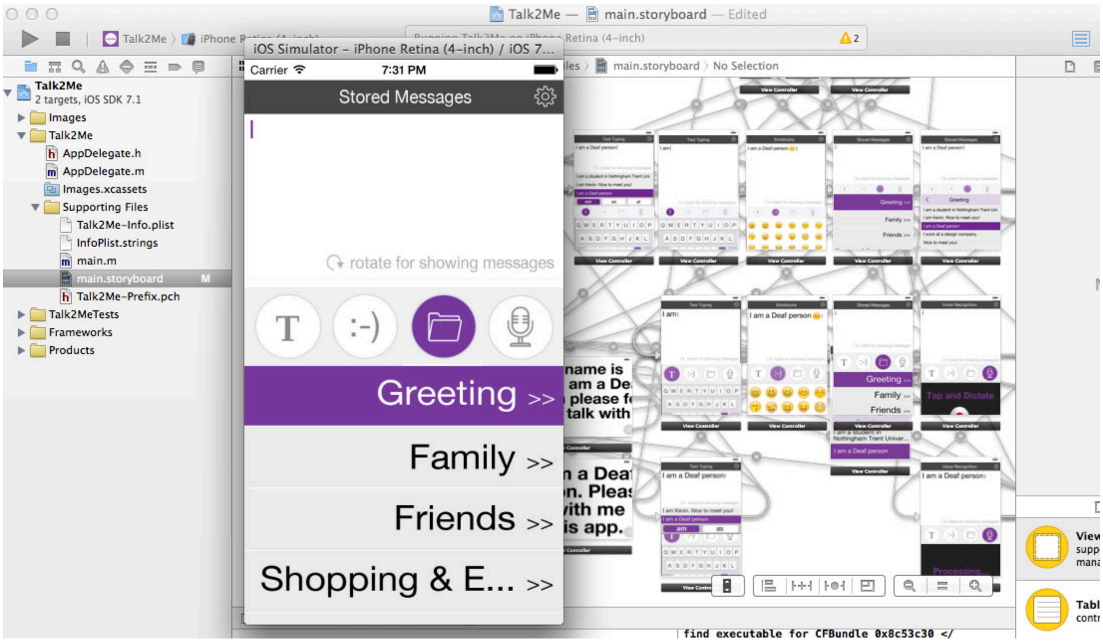




The web-based prototype is available online via the link http://adonischang.com/web-based/index.html

Appendix 19: Prototype in an App-simulated Environment (X-code)





Appendix 20: Ethics Clearance Checklist

JOINT INTER COLLEGE ETHICS COMMITTEE
ETHICAL CLEARANCE CHECKLIST
College of Art & Design and Built Environment; College of Arts and Science; and the Centre for Academic Development and Quality (CADQ)

(TO BE COMPLETED FOR ***ALL*** INVESTIGATIONS INVOLVING PARTICIPANTS)

All staff and students wishing to conduct an investigation involving participants in order to collect new data in either their research projects or teaching activities are required to complete this checklist before commencement. It may be necessary after completion of this form to submit a full application to the Joint Inter College Ethics Committee (JICEC). Where necessary, official approval from the JICEC should be obtained ***before*** the research is commenced. This should take no longer than one month.

IF YOUR RESEARCH IS BEING CONDUCTED OFF CAMPUS AND ETHICAL APPROVAL FOR YOUR STUDY HAS BEEN GRANTED BY AN EXTERNAL ETHICS COMMITTEE, YOU MAY NOT NEED TO SEEK FULL APPROVAL FROM THE JICEC. HOWEVER, YOU WILL BE EXPECTED TO PROVIDE EVIDENCE OF APPROVAL FROM THE EXTERNAL ETHICS COMMITTEE AND THE TERMS ON WHICH THIS APPROVAL HAS BEEN GRANTED.

IF YOUR RESEARCH IS TRANSFERRING INTO NOTTINGHAM TRENT UNIVERSITY AND APPROVAL WAS OBTAINED FROM YOUR ORIGINATING INSTITUTION, THERE IS A REQUIREMENT ON THE UNIVERSITY TO ENSURE THAT APPROPRIATE APPROVALS ARE IN PLACE.
If you believe either of these statements applies to your research, please contact the Professional Support Research Team adbresearch1@ntu.ac.uk with evidence of former approval and the terms on which this approval has been granted.

IT IS THE RESPONSIBILITY OF INDIVIDUAL INVESTIGATORS AND/OR SUPERVISORS TO ENSURE THAT THERE IS APPROPRIATE INSURANCE COVER FOR THEIR INVESTIGATION.
If you are at all unsure about whether or not your study is covered, please contact the Finance & Planning Manager in your Finance team to check.

Name of Applicant: Chia-Ming Chang (N0360259)

School: Art & Design

Title of Investigation: Questionnaire and Interview

Staff ☐ **Student** ■ (*if student, please complete)

Degree Title and Level*: PhD Level 1

Name of Programme Supervisor*: Simon Perkins

Section A: Investigators

Do investigators have previous experience of, and/or adequate training in, the methods employed?	Yes■	No**□
Will junior researchers/students be under the direct supervision of an experienced member of staff?	Yes■	No**□
Will junior researchers/students be expected to undertake physically invasive procedures (not covered by a generic protocol) during the course of the research?	Yes**□	No■
Are researchers in a position of direct authority with regard to participants (e.g. academic staff using student participants, sports coaches using his/her athletes in training)?	Yes**□	No■

** If you select ANY answers marked **, please submit your completed Ethical Clearance Checklist accompanied by a statement covering how you intend to manage the issues (indicated by selecting a ** answer) to the JICEC.

Section B: Participants

Vulnerable Groups

Does your research involve vulnerable participants? If not, go to Section C

If your research does involve vulnerable participants, will participants be knowingly recruited from one or more of the following vulnerable groups?

Children under 18 years of age (please refer to published guidelines)	Yes*□	No■
People over 65 years of age	Yes*□	No■
Pregnant women	Yes*□	No■
People with mental illness	Yes*□	No■
Prisoners/Detained persons	Yes*□	No■
Other vulnerable group (please specify): **Deaf/Hard of Hearing People**	Yes*■	No□

* Please submit a full application to the JICEC.

Chaperoning Participants
If appropriate, e.g. studies which involve vulnerable participants, taking physical measures or intrusion of participants' privacy:

Will participants be chaperoned by more than one investigator at all times?	Yes□	No*□	N/A■

Will at least one investigator of the same sex as the participant(s) be present throughout the investigation?	Yes□	No*□	N/A■
Will participants be visited at home?	Yes*□	No■	N/A□

* Please submit a full application to the JICEC.
If you have selected N/A please provide a statement in the space below explaining why the chaperoning arrangements are not applicable to your research proposal: Click here to enter text.

Advice to Participants following the investigation

Investigators have a duty of care to participants. When planning research, investigators should consider what, if any, arrangements are needed to inform participants (or those legally responsible for the participants) of any health related (or other) problems previously unrecognised in the participant. This is particularly important if it is believed that by not doing so the participants well-being is endangered. Investigators should consider whether or not it is appropriate to recommend that participants (or those legally responsible for the participants) seek qualified professional advice, but should not offer this advice personally. Investigators should familiarise themselves with the guidelines of professional bodies associated with their research.

Section C: Methodology/Procedures

To the best of your knowledge, please indicate whether the proposed study:

Involves taking bodily samples	Yes †□	No■
Involves procedures which are likely to cause physical, psychological, social or emotional distress to participants	Yes †□	No■
Is designed to be challenging physically or psychologically in any way (includes any study involving physical exercise)	Yes †□	No■
Exposes participants to risks or distress greater than those encountered in their normal lifestyle	Yes*□	No■
Involves use of hazardous materials	Yes*□	No■

* Please submit a full application to the JICEC
† If the procedure is covered by an existing generic protocol, please insert reference number here Click here to enter text. If the procedure is not covered by an existing generic protocol, please submit a full application to the JICEC.

Section D: Observation/Recording

Does the study involve observation and/or recording of participants? If yes please complete the rest of section D, otherwise proceed to section E	Yes■	No□
Will those being observed and/or recorded be informed that the observation and/or recording will take place?	Yes■	No*□

* Please submit a full application to the JICEC

Section E: Consent and Deception

Will participants give informed consent❖ freely? If yes please complete the ***Informed Consent*** section below. *If no, please submit a full application to the JICEC.	Yes■	No*□

❖Note: where it is impractical to gain individual consent from every participant, it is acceptable to allow individual participants to "opt out" rather than "opt in".

Informed Consent

Will participants be fully informed of the objectives of the investigation and all details disclosed (preferably at the start of the study but where this would interfere with the study, at the end)?	Yes■	No*□
Will participants be fully informed of the use of the data collected (including, where applicable, any intellectual property arising from the research)?	Yes■	No*□

For children under the age of 18 or participants who have impairment of understanding or communication:

- will consent be obtained (either in writing or by some other means)?	Yes■	No*□
- will consent be obtained from parents or other suitable person?	Yes■	No*□
- will they be informed that they have the right to withdraw regardless of parental/ guardian consent?	Yes■	No*□
For investigations conducted in schools, will approval be gained in advance from the Head-teacher and/or the Director of Education of the appropriate Local Education Authority?	Yes■	No*□
For detained persons, members of the armed forces, employees, students and other persons judged to be under duress, will care be taken over gaining freely informed consent?	Yes■	No*□

* Please submit a full application to the JICEC

Does the study involve deception of participants (ie withholding of information or the misleading of participants) which could potentially harm or	Yes□	No■

exploit participants? If yes please complete the ***Deception*** section below.		

Deception

Is deception an unavoidable part of the study?	Yes□	No*□
Will participants be de-briefed and the true object of the research revealed at the earliest stage upon completion of the study?	Yes□	No*□
Has consideration been given on the way that participants will react to the withholding of information or deliberate deception?	Yes□	No*□

* Please submit a full application to the JICEC

Section F: Withdrawal

Will participants be informed of their right to withdraw from the investigation at any time and to require their own data to be destroyed?	Yes■	No*□

* Please submit a full application to the JICEC

Section G: Storage of Data and Confidentiality

Please see University guidance on https://www.ntu.ac.uk/intranet/policies/legal_services/data_protection/16231gp.html. You will need your user name and password to gain access to this page on the Staff Intranet.

Will all information on participants be treated as confidential and not identifiable unless agreed otherwise in advance, and subject to the requirements of law?	Yes■	No*□
Will storage of data comply with the Data Protection Act 1998?	Yes■	No*□
Will any video/audio recording of participants be kept in a secure place and not released for use by third parties?	Yes■	No*□
Will video/audio recordings be destroyed within six years of the completion of the investigation?	Yes■	No*□

* Please submit a full application to the JICEC

Section H: Incentives

Have incentives (other than those contractually agreed, salaries or basic expenses) been offered to the investigator to conduct the investigation?	Yes**□	No■
Will incentives (other than basic expenses) be offered to potential participants as an inducement to participate in the investigation?	Yes**□	No■

** If you select ANY answers marked **, please submit your completed Ethical Clearance Checklist accompanied by a statement covering how you intend to manage the issues (indicated by selecting a ** answer) to the JICEC.

Compliance with Ethical Principles

If you have completed the checklist to the best of your knowledge without selecting an answer marked with *, ** or † your investigation is deemed to conform with the ethical checkpoints and you do not need to seek formal approval from the JICEC.

Please sign the declaration below, and lodge the completed checklist with Melanie Bentham-Hill in the Professional Support Research Team, Maudslay 312, City Campus, or via email adbresearchteam1@ntu.ac.uk.

Declaration
I have read the Ethics & Governance Statement http://www.ntu.ac.uk/research/ethics_governance/index.html. I confirm that the above named investigation complies with published codes of conduct, ethical principles and guidelines of professional bodies associated with my research discipline.

Signature of Applicant *(Research Student or Principal Investigator)*	Chia-Ming Chang
Signature of Supervisor/Line Manager *(Director of Studies/ATL)*	Simon Perkins
Date	10/05/2012

Appendix 21: Ethics Approval Letter

NOTTINGHAM
TRENT UNIVERSITY

Chia-Ming Chang
F81, Victoria Hall
Curzon Street
Nottingham
NG3 1DJ

Melanie Bentham-Hill
Research Office Team Leader/JICEC Committee Officer
Nottingham Trent University
Art & Design and Built Environment/Arts and Science
Burton Street
Nottingham NG1 4BU
Tel: +44 (0)115 848 2177
Fax: +44 (0)115 848 2096
Email: melanie.bentham-hill@ntu.ac.uk

23 May 2012

Dear Chia-Ming Chang

I am writing to confirm that your ethical clearance checklist for the project "Silent Song' The influence of deaf or hard of hearing people reflected in new media communication' was seen by Professor Michael White, chair for the Joint Inter-College Ethics Committee (JICEC) in Art & Design and Built Environment/Arts and Science on 17 May 2012, and was signed off clear on that same day.

If you have any further queries regarding the JICEC, it's methods and procedures, then please do not hesitate to contact me.

Yours sincerely

M Bentham-Hill

Melanie Bentham-Hill
Research Office Team Leader

Nottingham Trent University
Burton Street, Nottingham NG1 4BU
Tel. +44 (0)115 941 8418 www.ntu.ac.uk

Appendix 22: Publications: Journal, Conference Paper and Poster

Journal Paper 1

C. M. Chang, 2015, Innovation of A Smartphone App Design as used in Face-to- face Communication for Deaf/Hard of Hearing. Online Journal of Art and Design, Volume: 3, Issue: 4, October 2015, pp. 1-16. (ISSN: 2301 - 2501)

Presented in the 4th International Conference on Communication, Media, Technology and Design (ICCMTD), Dubai, United Arab Emirates, 16th-18th May 2015

Innovation of A Smartphone App Design as used in Face-to- face Communication for the Deaf/Hard of Hearing

Author: Chia-Ming Chang
Supervisors: David Downes, Julius Ayodeji, Alison Oddey
School of Art and Design, Nottingham Trent University, United Kingdom
chia-ming.chang2011@my.ntu.ac.uk

ABSTRACT

In recent years, our daily communication methods and behaviours have been transformed through new forms of communication media and technologies such as social media and smartphones. New communication technologies have opened new communication opportunities. On the other hand, communication is the main problem for Deaf/Hard of Hearing (D/HoH) people. Are new communication technologies able to address this problem? This study is a practice-based research project that aims to explore new communication opportunities for bridging the face-to-face communication gap between D/HoH and hearing people by developing a smartphone app. Creative practice (via interaction design) combined with ethnography (via interview) is the primary research method utilised in this study. The results of this study propose a solution, which is a smartphone application (app) that can be used to assist face-to-face communication between D/HoH and hearing people. This smartphone app provides an innovative way of using computer-mediated communication (CMC) in face-to-face communication, this allows conducting and incorporating physical interaction with nonverbal messages. In addition, it provides various ways of inputting messages that facilitate communication process and it provides a specific mode for the elderly.

Keywords: Computer-mediated Communication (CMC), Deaf/Hard of Hearing (D/HoH), Face-to-face Communication, Interaction Design, Smartphone Application (App)

1. INTRODUCATION

The smartphone has become a popular digital mobile device in our daily lives. People use their smartphones anytime and anywhere for different purposes. Communication is one of the most significant purposes of using a smartphone. Digital mobile communication has been acting an important role in our daily communication. People are spending increasing time communicating with others through their smartphones, leading to a reduction in face-to-face interaction. In the meantime, the smartphone communication technologies have opened new communication opportunities (Baym, Zhang and Lin 2004; Keating, Edwards and Mirus 2008; Pierce 2009; Turkle 2012). On the other hand, communication is a primary problem for D/HoH people due to their hearing loss. There is a communication gap between D/HoH and hearing people (Bouvet 1990). Digital mobile communication technology such as social media (e.g. Facebook) on smartphones has opened new communication opportunities and partly reduced the communication gap between D/HoH and hearing people (Chang 2014). However, most of digital mobile communication technologies (communication apps on smartphones) are mainly designed for non-face-to-face communication. There is still a further communication gap in face-to-face communication between D/HoH and hearing people even when they communicate via digital mobile communication technologies. The aim of this study is to explore a real solution through a creative practice of interaction design, the result is a smartphone app design that can be use to bridge the face-to-face communication gap between D/HoH and hearing people.

The primary research questions in this study is:

How can digital mobile communication technology (a smartphone app) be used to bridge face-to-face communication between D/HoH and hearing people?

2. DIGITAL MOBILE COMMUNICATION

Digital mobile communication by definition is part of CMC but is specifically based on mobile devices. The rapid development of mobile technologies has brought new forms of communication. In recent years, a mobile phone is not just a communication device but is a multi-function device like a small computer. Goggin and Hjorth (2009, p.9) indicate that a 'mobile phone increasingly becomes a platform for mobile media.' Webb (2010, p.65) states, 'The mobile becomes a portal and the networks become data pipes that enable the basic connectivity.' Mobile devices include various digital devices, such as smartphones, tablets, laptops and so on. A smartphone is a type of mobile phone that offers more advanced functions than feature phones, usually with a bigger multi-touch screen, better camera, faster Internet connection and app support. An app is a programme specifically designed to be run on smartphones that offers a wide range of functions and services to smartphone users and is similar to software on desktop or laptop computers. Smartphone apps are gateways that people use to easily access online services (e.g. email and websites) without using a web browser.

Nowadays, people can convey information immediately available anytime and anywhere by using their smartphones (Dominick 2009). Digital mobile communication has advanced from a simple communication form to a variety of communication forms. Short message service (SMS) is a simple and basic text-based communication form specifically used on feature phones and smartphones. Smartphones can not only run standard SMS but also run various social networking service (SNS) (e.g. Facebook, Twitter and Linkedin) and communication apps (e.g. WhatsApp, LINE and WeChat), these provide advanced communication features and supportive functions. In addition, voice and video calls are two important ways of using smartphones. However, this study will not focus on it because of the limited speech capability of D/HoH people.

3. FACE-TO-FACE COMMUNICATION

Face-to-face communication is a type of communication via which people transmit information directly by using oral speech and gestural language. CMC is a type of communication via which people transmit information indirectly through digital devices by using text and multimedia messages. The different communication methods are the essential differences between face-to-face communication and CMC. Both face-to-face communication and CMC are multimodal communication with various communication methods that can be divided into verbal and nonverbal messages. Verbal messages include text and speech, whilst nonverbal messages include facial expressions and body gestures. CMC generally allows people to communicate by using a single form, such as text-only communication. Face-to-face communication generally combines more than one form in a conversation, such as speech involving eye contact and facial expressions (Dohen, Schwartz and Bailly 2010). Whittaker and O'Conaill (1997) also indicate that the main difference between CMC and face-to-face communication is the physical information used in face-to-face communication.

Nonverbal messages consist of physical information that includes eye contact, facial expressions, handshakes, head nods and smiles. Eye contact is an essential component of face-to-face communication, it is a 'special stimulus' in visual sense affecting communication (Bailly, Raidt and Elisei 2010). Jiang et al (2012) highlight the two major differences between face-to-face communication and other types of communication. First, face-to-face communication involves the 'integration of multimodal sensory information.' Sensory information includes facial expression and body gestures that can activate information during communication. Second, face-to-face communication involves 'more continuous turn-taking behaviors between partners.' Turn-taking is communication behaviour in a conversation that helps people decide who will speak next. Turn-taking behaviours play a vital role in social interaction. Bailly, Raidt and Elisei (2010) indicate that eye contact plays a pivotal role in turn-taking behaviours.

Mehrabian (1972) explains that nonverbal communication is part of 'nonverbal behavior'. Nonverbal messages in face-to-face communication can sometimes be more powerful than verbal messages. Morris (2002) notes that nonverbal messages, such as body language, can help people understand other people much better. Okdie et al (2011) suggest that nonverbal messages combine richer and more abundant emotional information than verbal messages. Dohen, Schwartz and Bailly (2010, p.477) indicate that people integrate information in face-to-face communication 'not only from the speakers but also from the entire physical environment in which the interaction takes place.'

Speech in face-to-face communication is an easier and faster way to transmit information than text in CMC because typing messages takes much longer than spoken messages. The time issue is another significant difference between face-to-face communication and CMC. Face-to-face is real time communication via which speakers and listeners can immediately send and receive messages. CMC is not real time communication (except for video calls such as when using Skype), even though some CMCs provide near real time communication, such as IM, people still need to spend time typing messages and waiting for responses.

4. RESEARCH METHODOLOGY

This study is designed as practice-based research and aims to generate new knowledge through a creative practice of interaction design. The purpose of conducting the interaction design is to explore specific communication requirements in the target population and provide a possible solution to them. The target population (D/HoH people) will be involved in the designing process via ethnographic interviews, which includes user-centred design (UCD) and participatory design (PD) approaches in different design steps. UCD is a design approach of 'designing for users' and PD is an approach of 'designing with users' (Sanders 2002).

There are five design steps used in this creative practice to develop a smartphone app: a. Defining Requirements, b. Providing Alternatives, c. Alternatives, Testing and Deciding d. Prototype Development and e. Prototypes, Testing and Modification. See Figure 1 below.

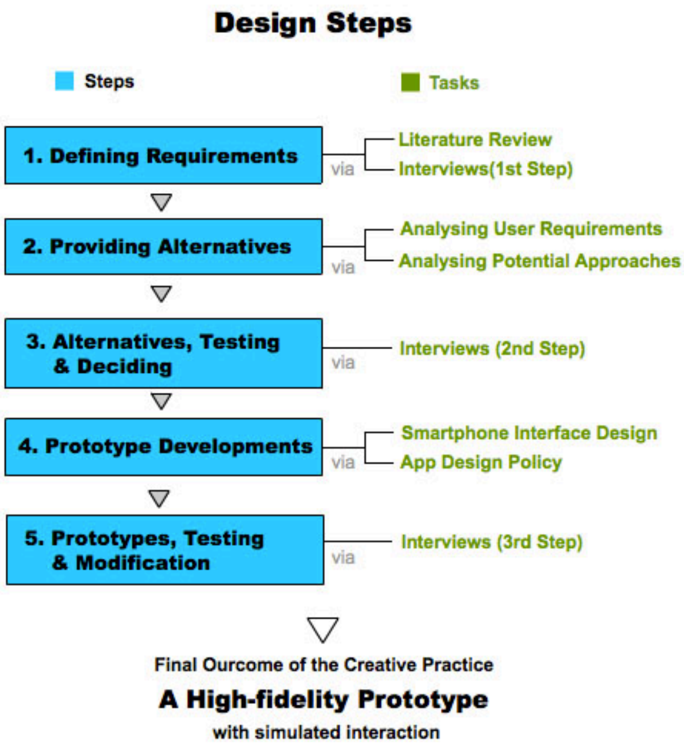


Figure 1. Design Steps

a. Defining Requirements
The first design step is to define user requirements via a literature review and interviews. The literature review will help understand face-to-face communication and how communication occurs within the D/HoH community. The interviews will help explore the mmunication difficulties and requirements of the D/HoH that are specific in face-to-face communication.

b. Providing Alternatives
The second design step will provide potential alternatives via analysing user requirements and analysing potential approaches. Analysing user requirements will help in the design of the potential features of this smartphone app. Analysing potential approaches will help explore relevant technologies that can be used to implement the design features.

c. Alternatives, Testing and Deciding
The third design step is to test and decide on the alternative potential features via the interviews. The interviews will help to evaluate original design concept and find best design features for end-users.

d. Prototype Developments
The forth design step is to further develop prototype via the smartphone interface design and app design policy. The interface design process will help understand the specific requirements of interface on smartphones. The app design policy will help to understand basic design regulation of a smartphone app. Finally, the designed features will be presented via a visual-based prototype that will present a realistic impression of this interactive product to users for testing.

e. Prototypes, Testing and Modification
The fifth design step is to test and modify the visual-based prototype via interviews. The interviews will help evaluate the visual-based prototype for developing a high-fidelity prototype (with simulated interaction), which will be the final outcome of the creative practice in this study.

Basing on the design steps, there were 9 interviewees (end-users) involved in the developing process of this smartphone app, with a total of 27 interviews in three different design steps (9 interviews per each step). The 9 interviewees were recruited from three specific groups: a. Experts, b. D/HoH People and c. Hearing People. The experts are professionals in the D/HoH field. As an interview process is time consuming, the three interviewee groups allow for the precise and efficient collecting of data. Details of the 9 interviewees are shown in Table 1 below.

Groups	People	Background/Details	Interview forms
Experts	Person 1	• A sign language interpreter (hearing person) • BSL degree awarded • More than 14 years of experience • Female / Age: 40-49	Face-to-face & Online Interview
	Person 2	• A communication development officer (hearing person) in the Action on Hearing Loss (a Deaf organisation in the UK), also a sign language interpreter • Issues in Deafness degree awarded • More than 17 years of experience • Female / Age: 50-64	Online Interview
	Person 3	• A manager at the British Deaf Association (Deaf) • More than 32 years of experience • Male / Age: 50-64	Online Interview
D/HoH People	Person 4	• A university student • Male / Age: 18-29	Online Interview
	Person 5	• A university student • Female / Age: 18-29	Online Interview
	Person 6	• A college teacher • Male / Age: 30-39	Online Interview
Hearing People	Person 7	• A deaf child's mother • Female / Age: 40-49	Online Interview
	Person 8	• A designer who usually works with a Deaf/Hard of Hearing colleague • Male / Age: 30-39	Face-to-face & Online Interview
	Person 9	• A Deaf person's friend • Male / Age: 30-39	Face-to-face & Online Interview

Table 1. Interviewee Details

5. SPECIFIC COMMUNICATION REQUIREMENTS

Understanding user requirements is the first step when developing an interactive product. 'A requirement is a statement about an intended product that specifies what it should do or how it should perform' (Rogers, Sharp and Preece 2011, p.355). Defining the target user and target activity are two necessary parts of understanding user requirements when developing this smartphone app. D/HoH people are the primary target users and hearing people the secondary users; and face-to-face communication between D/HoH and hearing people is the target activity.

According to the first design step, there is a main user requirement for developing this smartphone app:

To provide a communication tool that can be used to assist face-to-face communication between the D/HoH and hearing people, particularly in common (informal) one-to-one conversations

The main user requirement contains the following two sub-requirements:

- **A solution to integrate and support different communication methods in an accessible communication channel that can be used in face-to-face communication between D/HoH and hearing people.**

- **A solution to conduct and incorporate physical interaction with nonverbal messages into communication when using this smartphone app.**

6. DESIGN FEATURES OF THIS SMARTPHONE APP

According to the second to fifth design step for concept testing, feature evaluating and prototype modifying (via sketching, visual-based, web-based and app-simulated prototypes), there are three significant features designed in this smartphone app for achieving the above user requirements: a. Various Ways of Inputting Messages, b. Rotating to Show Messages and c. Large Text Mode for the Elderly.

a. Various Ways of Inputting Messages
This feature is the basic feature designed in this smartphone app for users to input messages. It aims to facilitate the communication process (increasing the speed of inputting messages) when using this smartphone app by providing effective ways of inputting messages for both D/HoH and hearing users. It includes four ways of inputting messages.

- Text Typing (with predictive support)
  Test typing is a basic way of inputting messages in this smartphone app, which includes predictive text support that aims to increase text typing speed by giving suggestive words and sentences during the typing process.

- Emoticon
  Emoticon provides a quicker and easier way to input contextual emotional information, as well as enriching the content of messages by using various pictures.

- Stored Message (with categorising support)
  Stored message is an innovative way of inputting messages. This feature aims to increase speed of inputting messages by selecting existing messages from an archive (user creates archives in advance).

- Voice Recognition (with correcting support)
  Voice recognition provides a way in this smartphone app that hearing users can use speech to input messages and the messages will be translated to text for D/HoH users.

Table 2 below shows interfaces of these four ways of inputting.

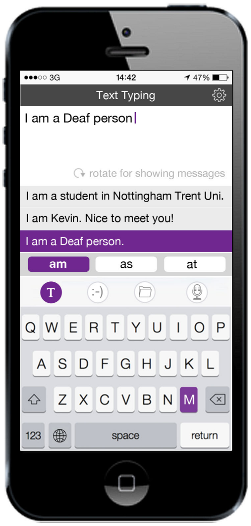
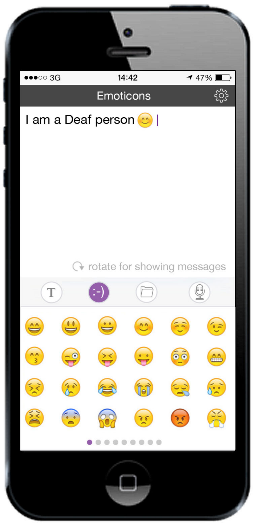
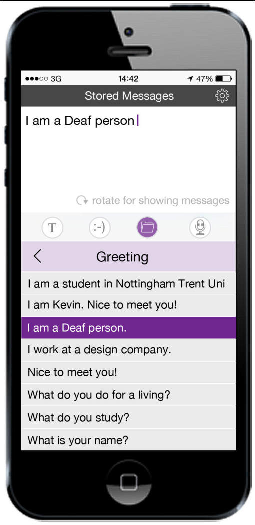
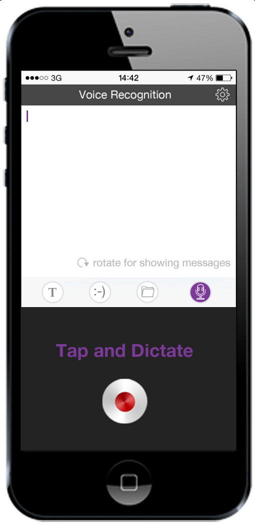
Text Typing	Emoticon	Stored Message	Voice Recognition
			

Table 2. Four Ways of Inputting Messages

The ways of text typing, emotion and stored message are designed to be mainly used by the D/HoH because of their limited speech capabilities. The way of voice recognition is designed to be mainly used by hearing people. Voice recognition includes basic text typing and emotions but does not include predictive and stored messages due to privacy issues.

b. Rotating to Show Messages

This is the most significant feature in this smartphone app, it promps users to conduct and incorporate physical interaction with nonverbal messages when using this smartphone app during face-to-face communication. It integrates CMC and face-to-face communication in an innovative way during communication between D/HoH and hearing people. Rotating to show messages is activated via the accelerometer sensor. Users are restricted to inputting messages in the portrait orientation and shown messages in the landscape orientation. See Figure 2 below.

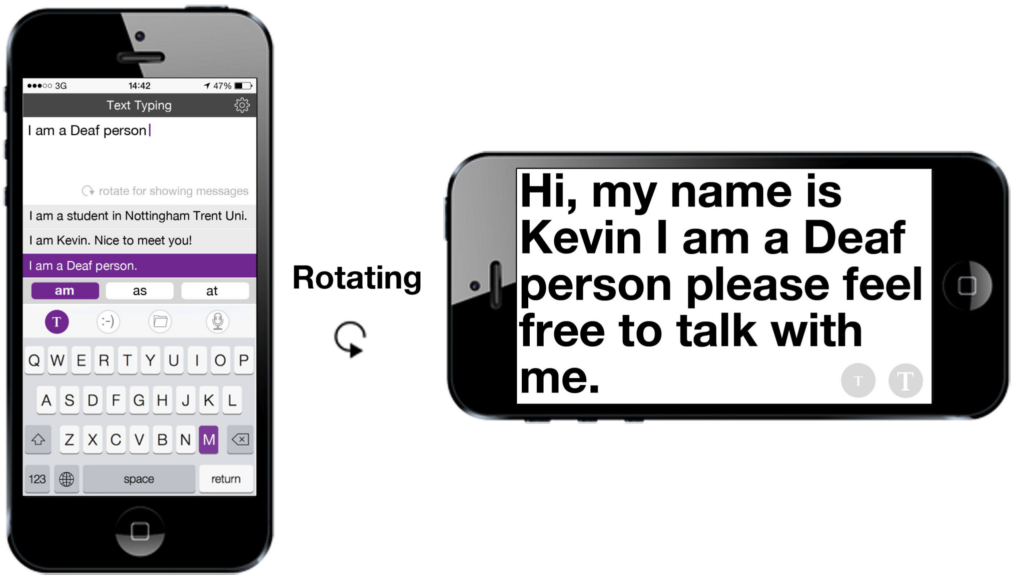


Figure 2. Rotation for Showing Messages 1

Showing messages via a single phone without connection technologies (e.g. GSM, 3G, Wifi & Bluetooth) is designed to be used between D/HoH and hearing people. It is the primary purpose for designing this smartphone app. A scenario showing messages via a single phone is presented in Table 3 below.

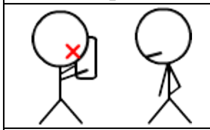
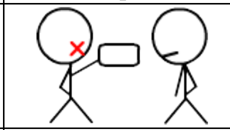
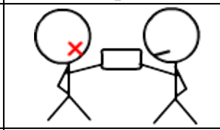
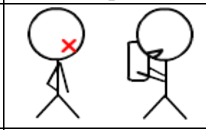
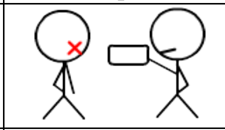
Step 1	Step 2	Step 3	Step 4	Step 5
				
A D/HoH person inputs messages via text.	The D/HoH person shows messages to a hearing person.	The hearing person reads messages and takes the phone.	The hearing person inputs messages via voice recognition.	The hearing person shows messages back to the D/HoH person.

Table 3. Scenario for Showing Messages via A Single Phone

Showing messages via two phones is designed to be used between Deaf and Hard of Hearing people. It is the secondary purpose for designing this smartphone app. A scenario showing messages via two phones is shown in Table 4 below.

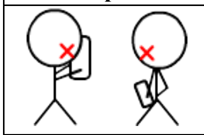
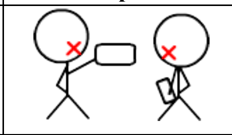
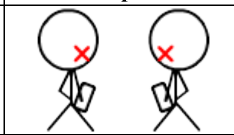
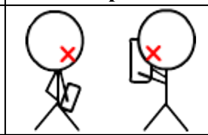
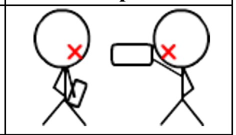
Step 1	Step 2	Step 3	Step 4	Step 5
				
A Deaf person inputs messages via text.	The Deaf person shows messages to a Hard of Hearing person.	Both the Deaf and Hard of Hearing people use their own phones.	The Hard of Hearing person inputs messages via text.	The Hard of Hearing person shows messages back to the Deaf person.

Table 4. Scenario for Showing Messages via Two Phones

In addition, the text-to-voice (speaker) and flexible text size features are two further supports to increase the usability of showing messages. See Figure 3 below.

Figure 3. Text-to-Voice (Speaker) and Flexible Text Size

c. Large Text Mode for the Elderly

This feature is a further assistance designed in this smartphone app specifically for older users. The large text mode aims to reduce difficulties faced by older users when using a smartphone app by providing bigger text size and interfaces. The large text mode specifically focuses on increasing the size of message text and key feature buttons. See Figure 4 below.

Figure 4. Standard Mode vs. Large Text Mode

The standard mode (text size 17 pt and button size 68x68 px) is designed by following the Apple iOS Human Interface Guidelines. The large text mode (text size 25.5 pt and button size 130x130 px) is designed by following the design guideline for older users proposed by Jin, Plocher and Kiff (2007).

7. A SCENARIO OF THIS SMARTPHONE APP

This section presents a typical scenario for using this smartphone app in face-to-face communication between a D/HoH person and a hearing person. See the Table 5 & 6 below.

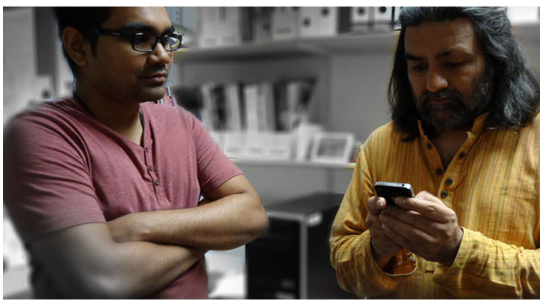
	
Step 1 The D/HoH person (right side) inputs a message via this smartphone app (in portrait orientation).	**Step 2** The D/HoH person (right side) shows the message to the hearing person (left side) via this smartphone app (in landscape orientation).

Table 5. Scenario of Using this Smartphone App: Step 1-2

	
Step 3 The hearing person (left side) inputs a message (voice recognition) via this smartphone app (in portrait orientation).	**Step 4** The hearing person (left side) shows the message to the D/HoH person (right side) via this smartphone app (in landscape orientation).

Table 6. Scenario of Using this Smartphone App: Step 3-4

In addition, a video description of this smartphone app is available online at http://youtu.be/KJ1klK5aORM

8. CONCLUSION

This practice-based research has resulted in a real solution, which is a smartphone app that can be used to bridge the face-to-face communication gap between D/HoH and hearing people. This study contributes a new understanding in the integration of CMC and face-to-face communication and provides an innovative way of using CMC in face-to-face communication that combines physical interaction with nonverbal messages during communication.

There were three comments by the D/HoH interviewees that provided significant positive feedback on three specific features designed as part of this smartphone app: a. Various Ways of Inputting Messages b. Large Text Mode for Older Users and c. Rotating to Show Messages.

'The various inputting ways on this app are good, especially the text typing with predictive words/sentences and the stored messages.'

'The large text mode is a very useful feature. I always feel text size is too small to read on my phone and the buttons are also too small for my stupid fingers sometimes.'

'I am really looking forward to using it. The rotating to show messages is a great idea and the messages shown using bigger text size with full screen display is very useful. Go for it! '

This smartphone app obtains very positive feedback from the end-users. This study has provided a solution to bridge the face-to-face communication gap between D/HoH and hearing people and a specific interface design for the elderly. However, there is a limitation in this study as a standard smartphone virtual keyboard brings difficulties for older users (Harad et al 2013). This issue would be a significant direction for future research.

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Journal Paper 2

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NEW MEDIA, NEW TECHNOLOGIES AND NEW COMMUNICATION OPPORTUNITIES FOR DEAF/HARD OF HEARING PEOPLE

Author: Chia-Ming Chang
Supervisors: David Downes, Julius Ayodeji, Alison Oddey
School of Art and Design, Nottingham Trent University, United Kingdom
chia-ming.chang2011@my.ntu.ac.uk

New media communication technologies have been given increased prevalence in recent years and have brought new forms of communication in our lives such as Social Networking Service (SNS) and Smartphones. As part of this research it is shown there is a communication gap between Deaf/Hard of Hearing people and the hearing community. This paper focuses on the field of new media communication technologies (SNS and Smartphones), investigating the new communication methods by comparing traditional and social communication technologies and aims to explore new communication opportunities that bridge the communication gap between Deaf/Hard of Hearing people and the hearing community. The results of this study show SNS on Smartphones have opened new communication opportunities to Deaf/Hard of Hearing People by providing specific interfaces, such as in the case of the Facebook app on a Smartphone.

1. INTRODUCATION

Our everyday ways of interacting and communicating have been radically transformed through new forms of communication media and technologies, such as SNS and Smartphones. People are spending more time communicating through these means without face-to-face interaction (Turkle 2012). These new media communication technologies offer various communication features of 'non-speaking' communication such as text-based messages as well as multimedia contents. On the other hand, communication is the main problem of Deaf/Hard of Hearing people, as Vernon and Andrews (1990, p1) indicated 'the very essence of the disability of hearing impairment is its effects on communication and the resulting impact of communication on behavior.' People who are Deaf/Hard of Hearing use various forms to communicate and interact with the hearing community. However, the primary communication methods (sign language, limited speech with lip movements/reading) used in the Deaf/Hard of Hearing community are different from the primary communication method (speech) used in the hearing community. There might be a communication gap between Deaf/Hard of Hearing and hearing people. Arthur (2009, p.9) suggested 'the technology has obvious promise for impaired people,' the new media communication technologies might bring new communication opportunities to bridge the communication gap between these two groups. Perhaps the new forms of media and the advent of mobile technologies have changed to allow new possibilities for richer communication experiences between Deaf/Hard of Hearing and hearing people. The aim of this study is to explore new communication opportunities between Deaf/Hard of Hearing and hearing people by using new media communication technologies (SNS and Smartphones). The original contribution to knowledge in this study is a new understanding of how SNS and Smartphones provide new ways of communication and how SNS and Smartphones bridge the communication gap between Deaf/Hard of Hearing people and the hearing community. Comparison of traditional and social communication technologies and their specific communication interfaces is the primary method used in this study.

The research questions in this study are:

(1) How do SNS and Smartphones provide new communication opportunities?
(2) How does SNS on a Smartphone bridge the communication gap between Deaf/Hard of Hearing and hearing people?

2. NEW MEDIA COMMUNICATION

New media can be defined as digital media that Manovich (2011, p.19) suggested 'the popular understanding of new media identifies it with the use of a computer for distribution.' New media is a new form of electronic media where people can distribute information through digital devices and the Internet. New media brings new forms of communication to people through digital devices. Computer-Mediated Communication (CMC) is a new media communication that enables people to communicate in various ways through a computer, for example, Short Message Service (SMS), instant message (IM), email and online forums. Barnes (2003) has indicated that digital communication is ubiquitous in our daily lives. New media and new technologies are bringing new forms of communication to enrich change people's communication methods and behaviours as Baym, Zhang and Lin (2004) have pointed out people's communication behaviours have been transformed. However, the computer and the Internet are not really 'new' media technologies as the Internet as we currently know it has been developing for around 30 years since it was started by Tim Berners-Lee who proposed the World Wide Web (WWW) in 1984. In this study, SNS and Smartphones are defined as 'new' media communication technologies because they have become extremely popular and have opened various new forms of communication in recent years.

SNS is an online platform where users can create profiles and build personal connections with friends to communicate and interact via various forms of communication technologies. Ahn, et al. (2007, p.835) have indicated that 'The Internet has been a vessel to expand our social networks in many ways. Social networking services (SNSs) are one successful example of such a role.' SNS is a fast-growing communication medium on the Internet that people use to communicate and interact with each other. Richter and Koch (2008, p.96) pointed that 'the key intention for the usage of a SNS is to keep contact with friends or colleagues.' SNS is one of the new media communication technologies investigated in this research project that provides an online communication platform through digital devices. It is also a popular mobile app on mobile devices, The Nielsen Company (2013) has reported that SNS site Facebook is the most popular mobile app on Smartphones. There are large varieties of SNS sites on the Internet, some of which are very large, for example, the three largest SNS sites in the world—Facebook has 750,000,000 members, Twitter has 250,000,000 members and Linkedin has 110,000,000 members (eBizMBA, 2012).

The rapid development of mobile technologies has brought new forms of communication to people. In recent years, mobile phones are not just a communication device, it is a multi-function device. Goggin and Hjorth (2009, p.9) indicated the 'mobile phone increasingly becomes a platform for mobile media.' This study is focused on a specific mobile phone which is known as a Smartphone. The Smartphone is a mobile phone that offers more advanced functions than a feature phone, usually with bigger and multi-touch screen, better camera, faster Internet connection and a mobile application (app) catalogue. Apps are software that can be installed on a Smartphone that offers a wide range of functions, similar to software used on a desktop/laptop computer. Moreover, apps on Smartphone can be a gateway that people use to effortlessly access online services, for example, Facebook and Twitter. Webb (2010, p.65) suggested 'The mobile becomes a portal and the networks become data pipes that enable the basic connectivity.' Nowadays, people can convey and make information immediately available anytime and anywhere through Smartphones (Dominick 2009).

3. THE COMMUNICATION GAP BETWEEN DEAF/HARD OF HEARING PEOPLE AND THE HEARING COMMUNITY

There are many types of deafness with nuanced differences in their communication behaviours due to their communication abilities being different. The *Congenital Deaf*, for example, learn sign language as their primary communication method when they are born and the *Acquired Deaf* become deaf after first being able to hear and speak without impairment. According to the different level of hearing impairment all types of deafness can be divided into two groups—Deaf people and Hard of Hearing people. See Table 1.

Definition	Level of Hearing Impairment
Deaf	'Profound'—hearing loss can only hear sound equivalent to or over 95 decibel (dB).
Hard of Hearing	'Mild'—hearing loss can only begin to hear sound if it is between 20 and 40 dB. 'Moderate'—hearing loss can begin to hear sound between 41 and 70 dB. 'Severe'—hearing loss can begin to hear sound between 71 and 95 dB.
Hearing	No hearing loss.
Conversational speech can be measured as having a loudness of approximately 60 dB (see Middleton 2010, p.1-2)	

Table 1. Definition of Deaf, Hard of Hearing and Hearing People

In other words, Deaf people can be defined as people with hearing loss who receive no useful linguistic information from sound and use in face-to-face communication sign language as their primary method; Hard of Hearing people can be defined as people with hearing loss who can still receive limited linguistically useful information from speech and use limited speech with lip movements/reading (also use some physical information as well as sign language as supplement) as their primary communication method (Barnett 2002). Communication is the main problem of Deaf/Hard of Hearing people.

Deaf/Hard of Hearing people using two systems to communicate, one is to communicate with Deaf/Hard of Hearing people and another is to communicate with hearing people (Schiff and Ventry, 1976). The communication methods used by Deaf/Hard of Hearing people not only depends on their communication abilities but also depends on people who they communicate with. Deaf/Hard of Hearing people are allowed to use their primary communication methods (sign language and limited speech with lip movements/reading) to communicate and interact with hearing people if hearing people can understand and use theses communication methods. However, there is a communication gap between Deaf/Hard of Hearing people and the hearing people as most of hearing people do not understand the communication methods used in Deaf/Hard of Hearing community (Bouvet 1990). Barnett (2002) proposed another two methods possibly used between Deaf/Hard of Hearing and hearing people—written communication and signed communication with interpreters.

Communication channels between Deaf, Hard of Hearing and hearing people can be divided into seven categories: (1) Deaf-to-Hard/Hearing, (2) Deaf-to-Hearing, (3) Hard of Hearing-to-Hearing, (4) Deaf-to-Deaf, (5) Hard of Hearing-to- Hard of Hearing, (6) Hearing-to-Hearing and (7) All Three, see Figure 1 below.

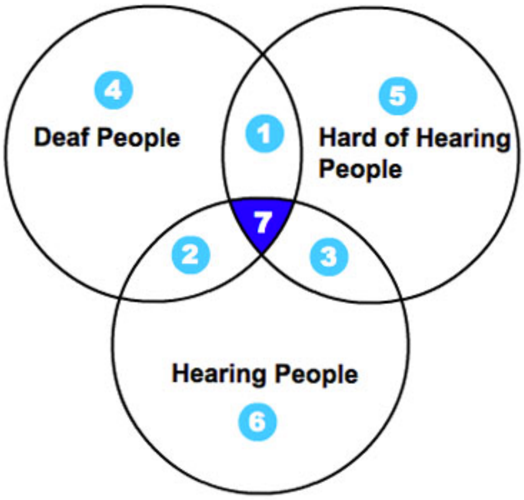


Figure 1: Categories of Communication Channels between Deaf, Hard of Hearing and Hearing People

The Table 2 below shows there are four communication methods used and how they relate to the seven communication categories, the communication methods being: (1) Speech, (2) Sign Language, (3) Limited Speech (With lip movements/reading) and (4) Written Note (including graphic messages).

These four methods are basic communication forms without any assistant (e.g. sign language interpreter). Written note is the only methods that can be used between these three groups. Limited speech can be used between Deaf/Hard of Hearing and hearing people, while speech only can be used by hearing people and sign language only can be used by Deaf people or sign language interpreters.

	Categories (see Figure 1)						
Communication Methods	1	2	3	4	5	6	7
1. Speech						√	
2. Sign Language				√			
3. Limited Speech (With lip movements/reading)			√		√		
4. Written Note (Include graphic messages)	√	√	√	√	√	√	√

Table 2. Communication Methods between Deaf, Hard of Hearing and Hearing People

It can be seen the methods of speech and sign language are the two main communication barriers between Deaf, Hard of Hearing and hearing people. Use of a sign language interpreter is a typical solution to solve this problem. The Table 3 below shows when sign language interpreters are provided the four methods are available to use on these seven communication categories.

	Categories (see Figure 1)						
Communication Methods	1	2	3	4	5	6	7
1. Speech		√	√			√	√
2. Sign Language	√	√		√			√
3. Limited Speech (With lip movements/reading)	√		√		√		√
4. Written Note (Include graphic messages)	√	√	√	√	√	√	√

Table 3. Communication Methods with Sign Language Interpreters between Deaf, Hard of Hearing and Hearing People

Although sign language interpreters can solve most of communication barriers between Deaf, Hard of Hearing and hearing people, sign language interpreters are not always provided during our daily communication. Moreover, some people feel awkward that interpreters play a role of mediator during more private communication (Barnett 2002). Sign language interpreters may be a good solution for specific communication (e.g. symposiums and workshops) but it may not be a good solution for common communication. On the other hand, limited speech with lip movements/reading is also a communication barrier for Hard of Hearing people because it only can transmit very limited information as Barnett (2002, p.670) indicated 'With English, many sounds are formed behind the lips, in the throat and mouth, making them indistinguishable on the lips. Without sound, at best only 30% of English is readable on the lips'.

Of the four communication methods discussed above it is shown that written note is the only method that logically can be used to communicate with Deaf, Hard of Hearing and hearing people, while the other three methods are still with some communication limitations.

4. COMMUNICATION TECHNOLOGIES

Technology is an application of science that aims to make people's life better. Arthur (2009, p.11) indicated 'We place our hope in technology. We hope in technology to make our lives better, to solve our problems, to get us out of predicaments, to provide the future we want for ourselves and our children.' Arthur (2009, p.9) has pointed out that 'technology has obvious promise for impaired people'. Technology includes various types of implementation that support people's lives. Keating, Edwards and Mirus (2008, p.1067) have indicated that 'Digital technologies are influencing aspects of communicative behavior through new contexts for social interaction.' Digital technologies have created new contexts for human communication and interaction through new media.

Communication technologies can be divided into traditional and social communication technologies and will be discussed with reference to nine communication features (see Table 4 below). This study aims to explore the differences between traditional and social communication methods.

Communication Features	Explanation
(1) Text Message	Text message includes texts and simple symbols.
(2) Multimedia Message	Multimedia message includes texts, photos, audios and videos.
(3) One-to-One Messaging	One-to-one messaging is private message system that people can send messages to a single person.
(4) One-to-Many Messaging	One-to-many messaging is private message system that people can send messages to two or more people.
(5) Broadcast Messaging	Broadcast messaging is public information distribution system that people can send messages to a specific media platform that all people can read and reply it.
(6) Real Time Messaging	Real time messaging in this study is defined as an instant message transmitting process that people can send and receive messages instantly when people are online.
(7) Non-Real Time Messaging	Non-real time messaging in this study is defined as a message transmitting process that people can send offline messages and not to expect to get reply instantly. For example, Email.
(8) Social Communication Interfaces	Social communication interfaces are specific interfaces designed to allow people easily to communicate by sharing, receiving and reading information with text-based and multimedia contents.
(9) Integrated Multimedia Contents	Integrated multimedia contents provide a service that people can create their own contents and store it online, such as profile, blog or multimedia album that people can use as a part of communication.

Table 4. Nine Communication Features

Email and SMS are two basic traditional communication technologies. Email is an electronic mail system that people use to send and receive information through digital devices. Dabbish, et al. (2005) indicated 'Email as a Task-Management Tool' that people originally used for business for example as a formal letter in organisations. Nowadays, people also use it as a tool to communicate with friends in their personal lives. SMS is a short message telecommunication system on mobile phones using text that people use to communicate with each other. It is the simplest and easiest text-based communication technology on mobile phones. On the other hand, social communication is a new form of communication technology that people use to communicate with each other via social media. SNS is one of the successful social media (Ahn, et al. 2007). Facebook and Twitter are the two largest SNS sites in the world and allow people to share and connect with people through a variety of communication features. The Table 5 below shows availability of the 9 communication features on Email, SMS, Facebook and Twitter.

Communication Features / Availability	Email	SMS	Facebook	Twitter
(1) Text Message	√	√	√	√
(2) Multimedia Message	√	√	√	√
(3) One-to-One Messaging	√	√	√	√
(4) One-to-Many Messaging	√	√	√	
(5) Broadcast Messaging			√	√
(6) Real Time Messaging			√	
(7) Non-Real Time Messaging	√	√	√	√
(8) Social Communication Interfaces			√	√
(9) Integrated Multimedia Contents			√	

Table 5. Communication Features of Email and SMS

The table shows Email and SMS provide five same communication features: (1) Text Message, (2) Multimedia Message, (3) One-to-one Messaging, (4) One–to-more Messaging and (7) Non-real Time Messaging. The advantages of traditional communication technologies are simple and easy to use as they are pure communication tools, while Facebook fully provides the nine communication features and Twitter provides six communication features: (1) Text Message, (2) Multimedia Message, (3) One-to-one Messaging, (5) Broadcast Messaging (7) Non-real Time Messaging and (8) Social Communication Interfaces.

Social communication technologies fully include communication features of traditional communication technologies. Broadcast messaging, real time messaging, social communication interfaces and integrated multimedia contents are four specific communication features of social communication technologies. These extra communication features have opened new communication opportunities.

5. COMMUNICATION INTERFACES

Gibson (1979, p.127) originally introduced the term affordance is ‘the “values” and ”meanings” of things in the environment can be directly perceived’. It is such as a substance that can afford an action in the environment. Rogers, Helen and Preece (2011, p.29) suggested affordance is used to ‘refer an attribute of an object that allows people to know how to use it.’ For example, a door handle affords pulling, a cup handle affords grasping, and a mouse button affords pushing. Affordance in interaction design is to explain how interfaces on an interactive product obviously should be used, such as buttons/icons afford clicking and scrollbars afford moving up and down on web pages (Rogers, Helen and Preece 2011). In addition, Gaver (1991, p.97) indicated ‘the concept of affordances can provide a useful tool for user-centered analyses of technologies.’ The traditional and social communication technologies on digital devices are created using principle of interaction design. Rogers, Helen and Preece (2011, p.9) explained interaction design is ‘designing interactive products to support the way people communicate and interact in their everyday and working lives.’ This part of the study is concerned with how the interfaces are designed that present the communication features.

There are many kinds of interfaces that have been classified, Rogers, Helen and Preece (2011) indicated Graphical User Interface (GUI) is a versatile interface primarily used to support all manner of computer-based activities such as SNS on Smartphones that allow people to interact with a digital device through visual icons and indicators. The Table 6 and 7 below are the homepage interfaces of the Facebook app and SMS on a Smartphone. The main difference of the interface between Facebook app (social communication) and SMS (traditional communication) is the homepage interface on Facebook app provides eleven versatile features while the homepage interface on SMS only provides three basic features.

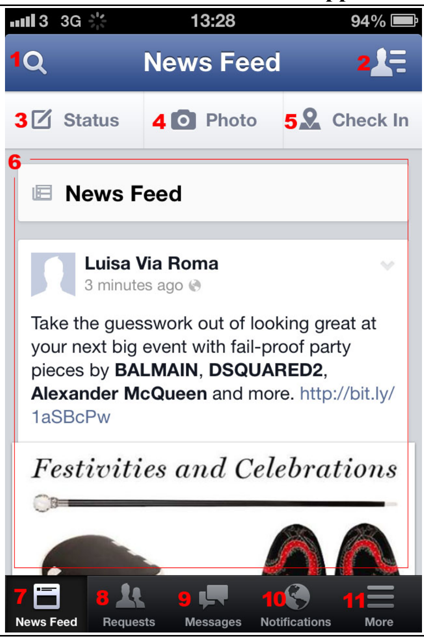
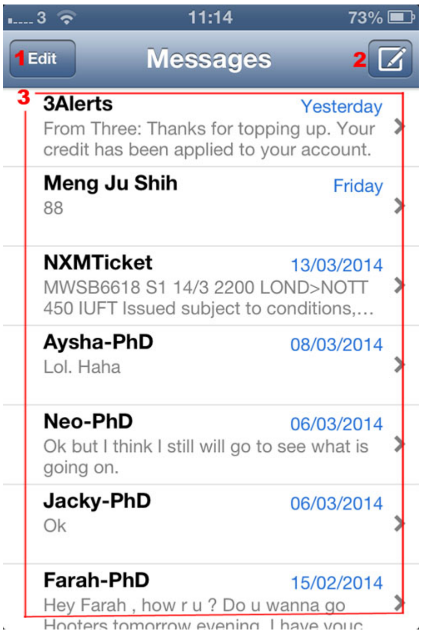
<table>
<tr><th>Interfaces of Facebook App</th><th>Features/Affordances</th></tr>
<tr><td>
</td>
<td>1. Search: it allows users to search people or information from users’ network and outside.
2. Friends: it allows users to communicate with friends through sending messages.
3. Status: it allows users to post broadcast information.
4. Photo: it allows users to post photos.
5. Check In: it allows users to present their current location.
6. Display Area: it allows users to read information and give comments.
7. News Feed: it presents new information posted by friends or subscribed pages.
8. Requests: it allows users to add people into their network as friends.
9. Messages: it allows users to send real time and non-real time messages.
10. Notifications: it notices users new activities happened on their relevant contents e.g. friends give a comment.
11. More: further supports that allow users to organise their social network with extra features.</td></tr>
</table>

Table 6. Homepage Interfaces of Facebook App

<table>
<tr><th>Interfaces of SMS</th><th>Features/Affordances</th></tr>
<tr><td>
</td><td>1. Edit: it allows users to edit (delete) the receiving messages.
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3. Message Archive: show all receiving messages</td></tr>
</table>

Table 7. Homepage Interfaces of SMS

The eleven features on the Facebook app combine three specific interfaces.

(a) Multimedia Contents Display Interface
The multimedia contents display interface is the main part of the homepage on Facebook app that provides a big display area allowing people to read and post information (text-based and multimedia contents) with broadcast messages also appearing.

(b) Posting Interface
The various inputting interface supports different ways to post information via different shortcuts such as the Status, Photo and Check In (see Table 6) that allows people to post multimedia contents easily.

(c) Multi-function Organisation Interface
The multi-function interface combines various features in a single page that provides multiple functions user easily communicate with friends and build their social network. The multiple functions also include traditional communication technologies and editing tool for organising their social network.

These three specific interfaces enable people to communicate in ways which combine social and traditional communication technologies (see Table 5).

6. CONCLUSION

The results of this study show new media communication technologies (SNS on Smartphones) are able to open new communication opportunities as well as reduce the communication gap between Deaf/Hard of Hearing people and the hearing community. This is because SNS provides social communication technologies through its specific interface design such as the case of Facebook app with three specific interfaces: (a) multimedia contents display interface, (b) posting interface and (c) multi-function organisation interface. These interfaces provide new forms of communication that allows people to easily send and receive information via using the traditional and the social communication technologies. It has opened a new way of communicating for the Deaf/Hard of Hearing, as the main communication methods (text-based and multimedia contents messages) used on SNS are mostly accessible between Deaf, Hard of Hearing and hearing people. Moreover, Smartphone technologies such as bigger screens, better cameras, faster Internet connections and mobile apps support the new forms of communication much better than previous feature phones. In this study, it has been shown that SNS and Smartphones have brought new communication opportunities to the Deaf/Hard of Hearing.

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Interfaces of New Media Communication for Deaf/Hard of Hearing People

Author: Chia-Ming Chang
Supervisors: David Downes, Julius Ayodeji, Alison Oddey

New media communication technologies have been given increased prevalence in recent years and have brought new forms of communication in our lives such as Social Networking Service (SNS) and Smartphones. As part of this research it is shown there is a communication gap between Deaf/Hard of Hearing people and the hearing community. This paper focuses on the field of new media communication technologies (SNS and Smartphones), investigating the new communication methods by comparing traditional and social communication technologies and aims to explore new communication opportunities that bridge the communication gap between Deaf/Hard of Hearing people and the hearing community. The results of this study show SNS on Smartphones have opened new communication opportunities to Deaf/Hard of Hearing People by providing specific interfaces, such as in the case of the Facebook app on a Smartphone.

Keywords: new media communication technologies, social networking service (SNS), Smartphone, communication interfaces, Deaf/Hard of Hearing people

1. INTRODUCATION

Our everyday ways of interacting and communicating have been radically transformed through new forms of communication media and technologies, such as SNS and Smartphones. People are spending more time communicating through these means without face-to-face interaction (Turkle 2012). These new media communication technologies offer various communication features of 'non-speaking' communication such as text-based messages as well as multimedia contents. On the other hand, communication is the main problem of Deaf/Hard of Hearing people, as Vernon and Andrews (1990, p1) indicated 'the very essence of the disability of hearing impairment is its effects on communication and the resulting impact of communication on behavior.' People who are Deaf/Hard of Hearing use various forms to communicate and interact with the hearing community. However, the primary communication methods (sign language, limited speech with lip movements/reading) used in the Deaf/Hard of Hearing community are different from the primary communication method (speech) used in the hearing community. There might be a communication gap between Deaf/Hard of Hearing and hearing people. Arthur (2009, p.9) suggested 'the technology has obvious promise for impaired people,' the new media communication technologies might bring new communication opportunities to bridge the communication gap between these two groups. Perhaps the new forms of media and the advent of mobile technologies have changed to allow new possibilities for richer communication experiences between Deaf/Hard of Hearing and hearing people. The aim of this study is to explore new communication opportunities between Deaf/Hard of Hearing and hearing people by using new media communication technologies (SNS and Smartphones). The original contribution to knowledge in this study is a new understanding of how SNS and Smartphones provide new ways of communication and how SNS and Smartphones bridge the communication gap between Deaf/Hard of Hearing people and the hearing community. Comparison of traditional and social communication technologies and their specific communication interfaces is the primary method used in this study.

The research questions in this study are:

1. How do SNS and Smartphones provide new communication opportunities?
2. How does SNS on a Smartphone bridge the communication gap between Deaf/Hard of Hearing and hearing people?

2. NEW MEDIA COMMUNICATION

New media can be defined as digital media that Manovich (2011, p.19) suggested 'the popular understanding of new media identifies it with the use of a computer for distribution.' New media is a new form of electronic media where people can distribute information through digital devices and the Internet. New media brings new forms of communication to people through digital devices. Computer-Mediated Communication (CMC) is a new media communication that enables people to communicate in various ways through a computer, for example, Short Message Service (SMS), instant message (IM), email and online forums. Barnes (2003) has indicated that digital communication is ubiquitous in our daily lives. New media and new technologies are bringing new forms of communication to enrich change people's communication methods and behaviours as Baym, Zhang and Lin (2004) have pointed out people's communication behaviours have been transformed. However, the computer and the Internet are not really 'new' media technologies as the Internet as we currently know it has been developing for around 30 years since it was started by Tim Berners-Lee who proposed the World Wide Web (WWW) in 1984. In this study, SNS and Smartphones are defined as 'new' media communication technologies because they have become extremely popular and have opened various new forms of communication in recent years.

SNS is an online platform where users can create profiles and build personal connections with friends to communicate and interact via various forms of communication technologies. Ahn, et al. (2007, p.835) have indicated that 'The Internet has been a vessel to expand our social networks in many ways. Social networking services (SNSs) are one successful example of such a role.' SNS is a fast-growing communication medium on the Internet that people use to communicate and interact with each other. Richter and Koch (2008, p.96) pointed that 'the key intention for the usage of a SNS is to keep contact with friends or colleagues.' SNS is one of the new media communication technologies investigated in this research project that provides an online communication platform through digital devices. It is also a popular mobile app on mobile devices, The Nielsen Company (2013) has reported that SNS site Facebook is the most popular mobile app on Smartphones. There are large varieties of SNS sites on the Internet, some of which are very large, for example, the three largest SNS sites in the world—Facebook has 750,000,000 members, Twitter has 250,000,000 members and Linkedin has 110,000,000 members (eBizMBA, 2012).

The rapid development of mobile technologies has brought new forms of communication to people. In recent years, mobile phones are not just a communication device, it is a multi-function device. Goggin and Hjorth (2009, p.9) indicated the 'mobile phone increasingly becomes a platform for mobile media.' This study is focused on a specific mobile phone which is known as a Smartphone. The Smartphone is a mobile phone that offers more advanced functions than a feature phone, usually with bigger and multi-touch screen, better camera, faster Internet connection and a mobile application (app) catalogue. Apps are software that can be installed on a Smartphone that offers a wide range of functions, similar to software used on a desktop/laptop computer. Moreover, apps on Smartphone can be a gateway that people use to effortlessly access online services, for example, Facebook and Twitter. Webb (2010, p.65) suggested 'The mobile becomes a portal and the networks become data pipes that enable the basic connectivity.' Nowadays, people can convey and make information immediately available anytime and anywhere through Smartphones (Dominick 2009).

3. THE COMMUNICATION GAP BETWEEN DEAF/HARD OF HEARING PEOPLE AND THE HEARING COMMUNITY

There are many types of deafness with nuanced differences in their communication behaviours due to their communication abilities being different. The *Congenital Deaf*, for example, learn sign language as their primary communication method when they are born and the *Acquired Deaf* become deaf after first being able to hear and speak without impairment. According to the different level of hearing impairment all types of deafness can be divided into two groups—Deaf people and Hard of Hearing people. See Table 1.

Definition	Level of Hearing Impairment
Deaf	'Profound'—hearing loss can only hear sound equivalent to or over 95 decibel

	(dB).
Hard of Hearing	'Mild'—hearing loss can only begin to hear sound if it is between 20 and 40 dB. 'Moderate'—hearing loss can begin to hear sound between 41 and 70 dB. 'Severe'—hearing loss can begin to hear sound between 71 and 95 dB.
Hearing	No hearing loss.
Conversational speech can be measured as having a loudness of approximately 60 dB (see Middleton 2010, p.1-2)	

Table 1. Definition of Deaf, Hard of Hearing and Hearing People

In other words, Deaf people can be defined as people with hearing loss who receive no useful linguistic information from sound and use in face-to-face communication sign language as their primary method; Hard of Hearing people can be defined as people with hearing loss who can still receive limited linguistically useful information from speech and use limited speech with lip movements/reading (also use some physical information as well as sign language as supplement) as their primary communication method (Barnett 2002). Communication is the main problem of Deaf/Hard of Hearing people.

Deaf/Hard of Hearing people using two systems to communicate, one is to communicate with Deaf/Hard of Hearing people and another is to communicate with hearing people (Schiff and Ventry, 1976). The communication methods used by Deaf/Hard of Hearing people not only depends on their communication abilities but also depends on people who they communicate with. Deaf/Hard of Hearing people are allowed to use their primary communication methods (sign language and limited speech with lip movements/reading) to communicate and interact with hearing people if hearing people can understand and use theses communication methods. However, there is a communication gap between Deaf/Hard of Hearing people and the hearing people as most of hearing people do not understand the communication methods used in Deaf/Hard of Hearing community (Bouvet 1990). Barnett (2002) proposed another two methods possibly used between Deaf/Hard of Hearing and hearing people—written communication and signed communication with interpreters.

Communication channels between Deaf, Hard of Hearing and hearing people can be divided into seven categories: (1) Deaf-to-Hard/Hearing, (2) Deaf-to-Hearing, (3) Hard of Hearing-to-Hearing, (4) Deaf-to-Deaf, (5) Hard of Hearing-to- Hard of Hearing, (6) Hearing-to-Hearing and (7) All Three, see Figure 1 below.

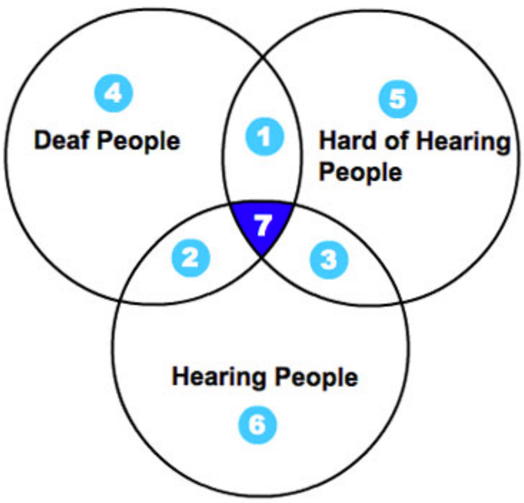


Figure 1: Categories of Communication Channels between Deaf, Hard of Hearing and Hearing People

The Table 2 below shows there are four communication methods used and how they relate to the seven communication categories, the communication methods being: (1) Speech, (2) Sign Language, (3) Limited Speech (With lip movements/reading) and (4) Written Note (including graphic messages). These four methods are basic communication forms without any assistant (e.g. sign language interpreter). Written note is the only methods that can be used between these three groups. Limited speech can be used between Deaf/Hard of Hearing and hearing people, while speech only can be used by hearing people and sign language only can be used by Deaf people or sign language interpreters.

	Categories (see Figure 1)						
Communication Methods	1	2	3	4	5	6	7
1. Speech						√	
2. Sign Language				√			
3. Limited Speech (With lip movements/reading)			√		√		
4. Written Note (Include graphic messages)	√	√	√	√	√	√	√

Table 2. Communication Methods between Deaf, Hard of Hearing and Hearing People

It can be seen the methods of speech and sign language are the two main communication barriers between Deaf, Hard of Hearing and hearing people. Use of a sign language interpreter is a typical solution to solve this problem. The Table 3 below shows when sign language interpreters are provided the four methods are available to use on these seven communication categories.

	Categories (see Figure 1)						
Communication Methods	1	2	3	4	5	6	7
1. Speech		√	√			√	√
2. Sign Language	√	√		√			√
3. Limited Speech (With lip movements/reading)	√		√		√		√
4. Written Note (Include graphic messages)	√	√	√	√	√	√	√

Table 3. Communication Methods with Sign Language Interpreters between Deaf, Hard of Hearing and Hearing People

Although sign language interpreters can solve most of communication barriers between Deaf, Hard of Hearing and hearing people, sign language interpreters are not always provided during our daily communication. Moreover, some people feel awkward that interpreters play a role of mediator during more private communication (Barnett 2002). Sign language interpreters may be a good solution for specific communication (e.g. symposiums and workshops) but it may not be a good solution for common communication. On the other hand, limited speech with lip movements/reading is also a communication barrier for Hard of Hearing people because it only can transmit very limited information as Barnett (2002, p.670) indicated 'With English, many sounds are formed behind the lips, in the throat and mouth, making them indistinguishable on the lips. Without sound, at best only 30% of English is readable on the lips'.

Of the four communication methods discussed above it is shown that written note is the only method that logically can be used to communicate with Deaf, Hard of Hearing and hearing people, while the other three methods are still with some communication limitations.

4. COMMUNICATION TECHNOLOGIES

Technology is an application of science that aims to make people's life better. Arthur (2009, p.11) indicated 'We place our hope in technology. We hope in technology to make our lives better, to solve our problems, to get us out of predicaments, to provide the future we want for ourselves and our children.' Arthur (2009, p.9) has pointed out that 'technology has obvious promise for impaired people'. Technology includes various types of implementation that support people's lives. Keating, Edwards and Mirus (2008, p.1067) have indicated that 'Digital technologies are influencing aspects of communicative behavior through new contexts for social interaction.' Digital technologies have created new contexts for human communication and interaction through new media.

Communication technologies can be divided into traditional and social communication technologies and will be discussed with reference to nine communication features (see Table 4 below). This study aims to explore the differences between traditional and social communication methods.

Communication Features	Explanation
(1) Text Message	Text message includes texts and simple symbols.
(2) Multimedia Message	Multimedia message includes texts, photos, audios and videos.
(3) One-to-One Messaging	One-to-one messaging is private message system that people can send messages to a single person.
(4) One-to-Many Messaging	One-to-many messaging is private message system that people can send messages to two or more people.
(5) Broadcast Messaging	Broadcast messaging is public information distribution system that people can send messages to a specific media platform that all people can read and reply it.
(6) Real Time Messaging	Real time messaging in this study is defined as an instant message transmitting process that people can send and receive messages instantly when people are online.
(7) Non-Real Time Messaging	Non-real time messaging in this study is defined as a message transmitting process that people can send offline messages and not to expect to get reply instantly. For example, Email.
(8) Social Communication Interfaces	Social communication interfaces are specific interfaces designed to allow people easily to communicate by sharing, receiving and reading information with text-based and multimedia contents.
(9) Integrated Multimedia Contents	Integrated multimedia contents provide a service that people can create their own contents and store it online, such as profile, blog or multimedia album that people can use as a part of communication.

Table 4. Nine Communication Features

Email and SMS are two basic traditional communication technologies. Email is an electronic mail system that people use to send and receive information through digital devices. Dabbish, et al. (2005) indicated ‘Email as a Task-Management Tool’ that people originally used for business for example as a formal letter in organisations. Nowadays, people also use it as a tool to communicate with friends in their personal lives. SMS is a short message telecommunication system on mobile phones using text that people use to communicate with each other. It is the simplest and easiest text-based communication technology on mobile phones. On the other hand, social communication is a new form of communication technology that people use to communicate with each other via social media. SNS is one of the successful social media (Ahn, et al. 2007). Facebook and Twitter are the two largest SNS sites in the world and allow people to share and connect with people through a variety of communication features. The Table 5 below shows availability of the 9 communication features on Email, SMS, Facebook and Twitter.

Communication Features / Availability	Email	SMS	Facebook	Twitter
(1) Text Message	√	√	√	√
(2) Multimedia Message	√	√	√	√
(3) One-to-One Messaging	√	√	√	√
(4) One-to-Many Messaging	√	√	√	
(5) Broadcast Messaging			√	√
(6) Real Time Messaging			√	
(7) Non-Real Time Messaging	√	√	√	√
(8) Social Communication Interfaces			√	√
(9) Integrated Multimedia Contents			√	

Table 5. Communication Features of Email and SMS

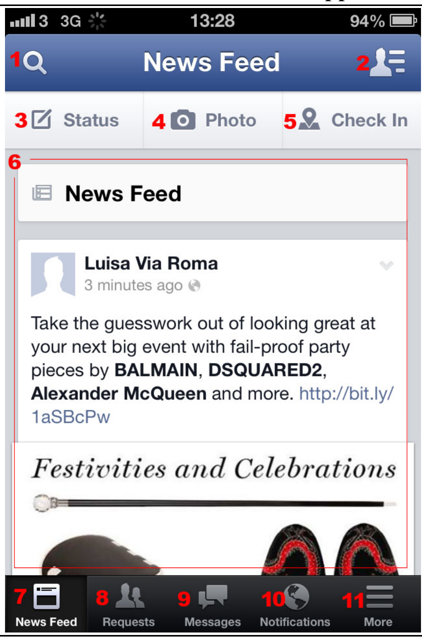
The table shows Email and SMS provide five same communication features: (1) Text Message, (2) Multimedia Message, (3) One-to-one Messaging, (4) One–to-more Messaging and (7) Non-real Time Messaging. The advantages of traditional communication technologies are simple and easy to use as they are pure communication tools, while Facebook fully provides the nine communication features and Twitter provides six communication features: (1) Text Message, (2) Multimedia Message, (3) One-to-one Messaging, (5) Broadcast Messaging (7) Non-real Time Messaging and (8) Social Communication Interfaces.

Social communication technologies fully include communication features of traditional communication technologies. Broadcast messaging, real time messaging, social communication interfaces and integrated multimedia contents are four specific communication features of social communication technologies. These extra communication features have opened new communication opportunities.

5. COMMUNICATION INTERFACES

Gibson (1979, p.127) originally introduced the term affordance is ‘the “values” and ”meanings” of things in the environment can be directly perceived’. It is such as a substance that can afford an action in the environment. Rogers, Helen and Preece (2011, p.29) suggested affordance is used to ‘refer an attribute of an object that allows people to know how to use it.’ For example, a door handle affords pulling, a cup handle affords grasping, and a mouse button affords pushing. Affordance in interaction design is to explain how interfaces on an interactive product obviously should be used, such as buttons/icons afford clicking and scrollbars afford moving up and down on web pages (Rogers, Helen and Preece 2011). In addition, Gaver (1991, p.97) indicated ‘the concept of affordances can provide a useful tool for user-centered analyses of technologies.’ The traditional and social communication technologies on digital devices are created using principle of interaction design. Rogers, Helen and Preece (2011, p.9) explained interaction design is ‘designing interactive products to support the way people communicate and interact in their everyday and working lives.’ This part of the study is concerned with how the interfaces are designed that present the communication features.

There are many kinds of interfaces that have been classified, Rogers, Helen and Preece (2011) indicated Graphical User Interface (GUI) is a versatile interface primarily used to support all manner of computer-based activities such as SNS on Smartphones that allow people to interact with a digital device through visual icons and indicators. The Table 6 and 7 below are the homepage interfaces of the Facebook app and SMS on a Smartphone. The main difference of the interface between Facebook app (social communication) and SMS (traditional communication) is the homepage interface on Facebook app provides eleven versatile features while the homepage interface on SMS only provides three basic features.

Interfaces of Facebook App	Features/Affordances
	**1. Search:** it allows users to search people or information from users’ network and outside. **2. Friends:** it allows users to communicate with friends through sending messages. **3. Status:** it allows users to post broadcast information. **4. Photo:** it allows users to post photos. **5. Check In:** it allows users to present their current location. **6. Display Area:** it allows users to read information and give comments. **7. News Feed:** it presents new information posted by friends or subscribed pages. **8. Requests:** it allows users to add people into their network as friends. **9. Messages:** it allows users to send real time and non-real time messages. **10. Notifications:** it notices users new activities happened on their relevant contents e.g. friends give a comment. **11. More:** further supports that allow users to organise their social network with extra features.

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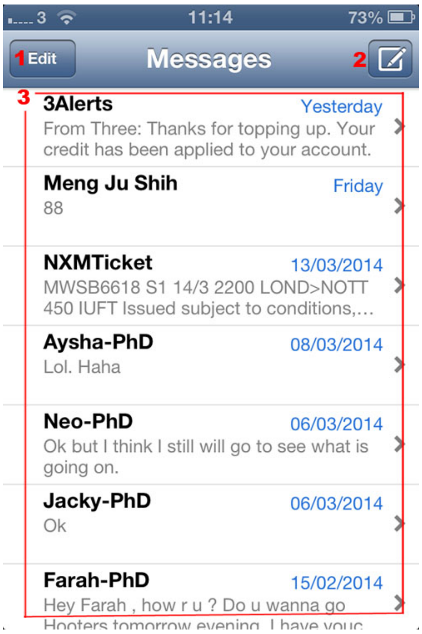	**1. Edit:** it allows users to edit (delete) the receiving messages. **2. Write Messages:** it allows users to send messages. **3. Message Archive:** show all receiving messages

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(d) Multimedia Contents Display Interface
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Conference Paper 2

C. M. Chang, 2013, 'EyesTalk' A Potential Application (App) to bridge Communication Gap between Deaf/Hard of Hearing People and the Hearing Community through New Media Communication—Social Networking Services (SNS) and Smartphones, Research and the Researcher: 5th Annual Research Practice Course Conference, Nottingham Trent University, Nottingham, UK, 17th May.

'EyesTalk' a Potential Application (App) to Bridge Communication Gap between Deaf/Hard of Hearing People and The Hearing Community through New Media Communication—Social Networking Services (SNS) and Smartphones

Author: Chia-Ming Chang
Supervisors: David Downes, Julius Ayodeji, Alison Oddey

Keywords: New Media Communication, Social Networking Services (SNS), Smartphones, Mobile Applications (Apps), Deaf/Hard of Hearing people

Abstract

Our everyday ways of interacting and communicating have been radically transformed through new forms of communication media, including Social Networking Services (SNS) and Smartphones. People are spending more time communicating through these means without face-to-face interaction (Turkle 2012). The communication behaviours of Deaf/Hard of Hearing and Hearing people are getting closer when people communicate through the new media on their Smartphones without speech. Moreover, this might be a new communication opportunity for Deaf/Hard of Hearing people, as Arthur (2009, p.9) suggested 'The technology has obvious promise for impaired people.' New communication technologies are enabling Deaf/Hard of Hearing people to engage in mainstream society in ways that they have been traditionally excluded in the past.

This research is based on the new media communication of SNS and Smartphones. It proposes to explore silent communication through a practice-based creative work—a communication app that I have titled 'EyesTalk'. This research will provide an opportunity to explore the broader concerns of SNS and Smartphones due to it becoming more popular and important in our lives (Eastman and Ferguson 2009). The aim of this study is to explore a potential communication app for Deaf/Hard of Hearing people as a tool to communicate with the hearing community.

1. Introduction

People 'write themselves and their community into being' (Dansh 2007, p.2) through the way people communicate. 'Every aspect of our daily lives is affected by our communication with others' (Littlejohn and Foss 2007, p.2). Communication is one of the most commonplace everyday behaviours of human life that aims to convey people's thoughts and information. 'People communicate in many different ways. One of the most important ways, of course, is through language' (Miller 1973, p. 231). Miller (1973, p.10) also indicated 'Human language is the most effective means of communication'. However, today, things are changing, people are spending more and more time communicating through machines. Computer-Mediated Communication (CMC) enables people to communicate in various ways through digital media—the Internet on computer; and digital communication is ubiquitous in our daily lives (Barnes 2003). Digital media can be defined as 'new media' as Manovich (2011, p.19) suggested 'The popular understanding of new media identifies it with the use of a computer for distribution'. New media, new technologies, bring new communication methods and behaviours to human beings, from traditional body language and face-to-face communication to digital communication through digital devices (Baym, Zhang and Lin 2004). Now, people can make

information immediately available anytime and anywhere by using a cell phone or a PDA or by sending an e-mail or Instant Message (IM) (Dominick 2009). People rely on the new media communication much more than before; and the text is the main communication medium. SNS and Smartphones are the new media communication methods that obviously stand out in out recent daily life. Silent communication may be a communication bridge between Deaf/Hard of Hearing people and hearing community.
This paper analyses the technology affordances of SNS and Smartphones and demonstrates a prototype of a potential communication app, which provides a new communication tool for Deaf/Hard of Hearing people to communicate with hearing community.

2. Literature Review

1.1 SNS and Smartphones

'The technology has obvious promise for impaired people' (Arthur 2009, p.9). Arthur (2009, p.11) 'We place our hope in technology. We hope in technology to make our lives better, to solve our problems, to get us out of predicaments, to provide the future we want for ourselves and our children'. 'New communication technologies have created new contexts for social interaction and new challenges for understanding the role of technology in human activity' (Keating, Edwards and Mirus 2008, p.1067), such as SNS, which is an online platform where users can create profiles and build personal connection net with friends to communicate, interact and share a wide range of information. SNS not only provides online social tools but also bring a new wave of communication behaviours to people, that people spend more time communicating with friends through it. Richter and Koch (2008, p.10) indicated that 'the key intention for the usage of a SNS is to keep contact with friends or colleagues'.
The convergence of Smartphones and new types of mobile technology create what Goggin and Hjorth (2009, p.9) believe is a form of media, wherein the technology devices such as 'mobile phone increasingly becomes a platform for mobile media'. Short Message Service (SMS) is a basic communication technology on mobile phone whilst most of Deaf/Hard of Hearing people relay on it for communicating (Goggin and Newell 2003). Moreover, the mobile app is a new technology on Smartphone that offers a wide range of functions, similar to the software used on computers. It is like a gateway on Smartphones people can effortlessly access any online service as Webb (2010, p.65) suggested 'The mobile becomes a portal and the networks become data pipes that enable the basic connectivity.'

1.2 Deaf/Hard of Hearing people

Ludwig Wittgenstein said 'The limits of my language are the limits of my world' (Park 1998, p.59). However, the new technology, the new media, has been bringing new communication methods and behaviours to people. Communication is a main problem for Deaf/Hard of Hearing people (Table 1) as Vernon and Andrews (1990, p.1) indicated 'The very essence of the disability of hearing impairment is its effects on communication and the resulting impact of communication on behaviour'. People who are Deaf/Hard of Hearing use various forms to communicate with people. Goggin and Newell (2003) pictured that mobile telecommunication has open up new space and uses of communication for Deaf/Hard of Hearing people be able to communicate with hearing community even with Deaf/Hard of Hearing people with the communication technologies. Moreover, digital technologies are influencing aspects of communicative behaviour through new contexts for social interaction, especially for the Deaf community (Keating, Edwards and Mirus 2008).

Definition	Level of hearing impairment
Deaf	• 'Profound'—hearing loss can only hear sound equivalent to or over 95 decibel (dB).
Hard of Hearing	• 'Mild'—hearing loss can only begin to hear sound if it is between 20 and 40 dB. • 'Moderate'—hearing loss can begin to hear sound between 41 and 70 dB. • 'Severe'—hearing loss begins to hear sound between 71 and 95 dB.
Conversational speech can be measured as having a loudness of approximately 60 dB (see Middleton 2010, p.1-2)	

Table 1: Definition of Deaf and Hard of Hearing People

3. Technology Affordances

'The concept of affordances was introduced by J. J. Gibson to explain how inherent "values" and "meanings" of things in the environment can be directly perceived, and how this information can be linked to the action possibilities offered to the organism by the environment' (Şahin, Çakmak, Doğar, Uğur and Üçoluk 2007 p.447). It can be defined as the features/functions of technology linked to human beings, as Gaver (1991, p.97) 'the concept of affordances can provide a useful tool for user-centered analyses of technologies'. The technology affordances, for example, as the Figure 1 shows below—different pens suggest different affordances for different purposes. Technology affordance can be a research method used to understand the interactions between technologies and human beings.

Figure 1: Technology Affordances—Different Pens

3.1 SNS

This is a sample of technology affordances used in this research to understand SNS communication. This sample is based on a SNS website—Facebook. Firstly, the primary communication features of Facebook are listed to analyse its supporting communication functions as shown in Table 2. The different communication features support different communication functions.

Communication Features/Functions on Facebook	
Main Features:	**Supporting Functions:**
Status updates/Wall Allow users post information including texts, photos and URL.	1. Enables to communicate/interact with friends through your post by giving comments.
Tagging/Mention Allow users to tag their friends on photos/videos/comments. When people tag/mention their friends on photos/videos/comments their friends will receive a notice that somebody is tag them.	2. Enables to communicate/interact with friends through the specific action 'tagging' and 'mention' to notice you that your friends' photos/videos/comments are related to you.
Messages/Inbox/Chat Allow users to send a private message, such as email.	3. Enables to communicate/interact with friends by sending messages.

Table 2: Technology Affordances of Facebook

As Figure 2 shows, for example, the communication feature of 'Status updates/Wall' is to allow users to post information, which includes texts, photos and URL that enables people to communicate/interact with friends through their post by giving comments.

Figure 2: The communication feature/function on Facebook

3.2 Smartphones and Apps

This is another sample of technology affordances used to understand new communication technologies on Smartphones. This sample is based on communication apps—WhatsApp, LINE and Viber (Table 5), which are three popular communication apps that can simultaneously running on OS of Google Android, Apple iOS, RIM Blackberry OS.

Apps	Main Features
WhatsApp	1. Chats: group chat, text, icon, photo, video, audio, share contact and share location 2. Status: As the feature on SNS, users can write short information to show their friends
LINE	1. Chats: group chat, text, icon, photo, video, audio and share location 2. Free Call (Internet connection) 3. Status: as the feature on SNS, users can write short information to show their friends 4. Support PC/MAC
Viber	1. Free Call (Internet connection) 2. Message (including group chat): Text, Icon, Photo

Table 3: Main features of WhatsApp, LINE & Viber

The features of WhatsApp, LINE and Viber are very similar to the basic mobile communication technologies—Short Message Service (SMS) and Multimedia Messaging Service (MMS). However, there are three significant points can be seen on these communication apps—Free Calls & Messages, Extra Supports (apps) and User-friendly Interface.

4. Prototype

This prototype is a potential communication app for Deaf/Hear of Hearing people as a tool to communicate with hearing community. The concept of this communication app as the figure (Figure 3) shown below, this app is given a name 'EyesTalk' because it will be a silent communication app on Smartphones. According to the technology affordances the concept of this app is divided into two parts—'Direct-Communication' and 'Indirect-Communication' (Table 4). This app will base on the two communication environments.

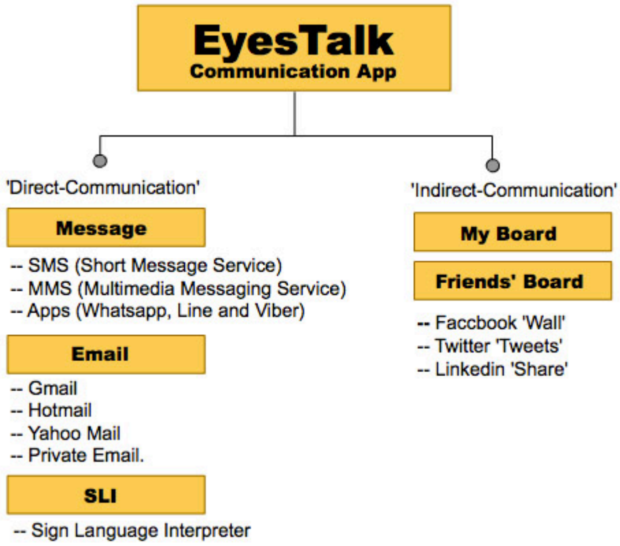


Figure 3: Concept of the Communication App

Analysis of the Technology Affordances	
'Direct-Communication'	**'Indirect-Communication'**
The 'direct-communication' means that people use to communicate/interact with people directly without any on-line behaviour. For example, people communicate/interact through messages or emails.	The 'indirect-communication' means that people use to communicate/interact with people with specific on-line behaviours. For example, people communicate/interact by giving replies or comments.

Table 4: Analysis of the Technology Affordances

The 'Direct-Communication' includes Message, Email and Sign Language Interpreter (SLI). The features of Message in this app contain the basic mobile communication technologies—Short Message Service (SMS) and Multimedia Messaging Service (MMS), and communication apps (WhatsApp, LINE and Viber). The features of Email in this app combine different email system providers (Google Mail, Hotmail, Yahoo Mail and Private Mail). The features of SLI in this app contain sign language-to-voice and voice-to-text systems that can support Deaf/Hard of Hearing people when they need to use sign language to communicate with hearing community. The 'Direct-Communication' environment in this app will provide people to communicate with people directly as a 'real' communication tool. The 'Indirect-Communication' includes My Board and Friends' Board. The features of My Board and Friends' Board in this app are similar to the Wall feature on Facebook, the Tweets feature on Twitter and the Share feature on Linkedin. The 'Indirect-Communication' environment in this app will provide people to communicate with people indirectly through some social activities as a 'social' communication tool. A low-fidelity prototype is shown below (Table 5).

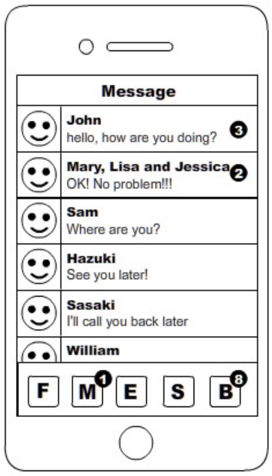
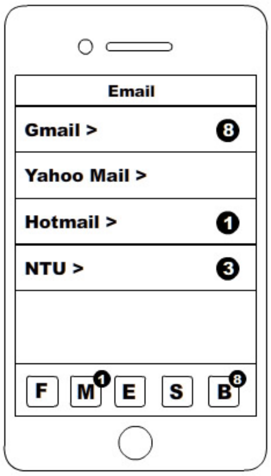
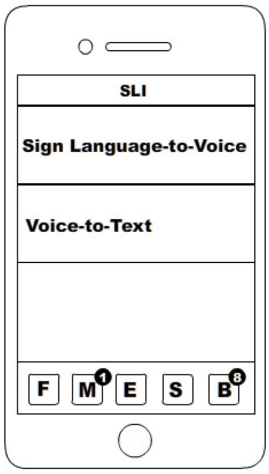
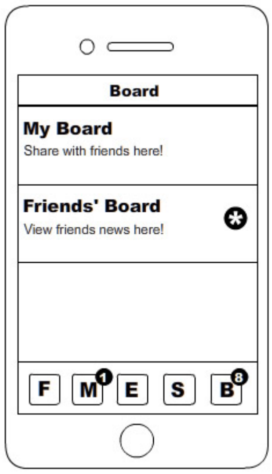
Prototype of the Communication App		
Index Page	Friend Page	Message Page
		
Email Page	SLI Page	Board Page
		

Table 5: Prototype of the Communication App

5. Conclusion

This paper has shown the forms of new media communication—SNS and Smatphones, which provide multi-communication approaches to people as the two communication methods I described in this paper—the 'direct-communication' and the 'indirect-communication', especially in the 'indirect-communication' that is a social communication environment offers various communication features. In addition, the new mobile technology, App, has stood in a pivotal position for everyday communicating and interacting. A potential communication app for Deaf/Hard of Hearing people has been demonstrated through a prototype in this paper to show the concept of the new media communication.

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Conference Poster

C. M. Chang, 2012, 'Silent Song' The Influence of New Media Communication on Deaf or Hard of Hearing People, Oral & Poster presented at Material World, Art & Design and Built Environment: 3rd College Research Conference and Festival, Nottingham Trent University, Nottingham, UK. 28th June.

Appendix 23: Design Awards

Design Award 1

A’ Design Award 2014 - 2015, Silver Award Winner.

Please check it via the link at https://competition.adesignaward.com/design.php?ID=36574

It will be presented in the A’ Design online exhibition and published in the annual A’ Design Yearbook.

Design Award 2

IxDA Interaction Award 2015, Shortlisted.

15 INTERACTION AWARDS SHORTLISTED

Please check it via the link at http://awards.ixda.org/entry/2015/talk2me/

It was shared publicly for People's Choice leading up to Interaction15 (an international conference in interaction design) in San Francisco in February 2015.

Design Award 3

iF Student Design Award 2015, Shortlisted.

(Shortlist of 300 entries from 12000 entries)

301-3-154209 Talk2Me 3.04 Apps / Software

It will be digitally shown in the iF design exhibition in Hamburg/Germany in 2015 summer.

Below is a poster presented in the iF Design.

Design Award 4

INDEX Award 2015, Nominated.

INDEX: AWARD 2015

Please check it via the link at http://award.designtoimprovelife.dk/nomination/541

INDEX
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TALK2ME: AN APP FOR DEAF/HARD OF HEARING

A SMARTPHONE APP FOR BRIDGING THE COMMUNICATION GAP BETWEEN DEAF/HARD OF HEARING AND HEARING PEOPLE.

CATEGORY COMMUNITY
CHALLENGE COMMUNICATION
KEYWORDS SMARTPHONE APP, DEAF/HARD OF HEARING PEOPLE, FACE-TO-FACE COMMUNICATION GAP
REGION OF USE EUROPE
DESIGNED BY CHIA-MING CHANG IS A RESEARCH DESIGNER AND A DESIGN RESEARCHER BASED IN THE UK. CURRENTLY HE IS A PHD CANDIDATE IN INTERACTION DESIGN IN NOTTINGHAM TRENT UNIVERSITY. CHANG OBTAINED HIS MA IN INTERACTIVE MEDIA FROM UNIVERSITY OF THE ARTS LONDON IN 2006. HE HAS BEEN CREATING VARIOUS DESIGN WORKS AND WEB PLATFORMS (WEB2.0) SINCE HE GRADUATED FROM NATIONAL TAIWAN UNIVERSITY OF ARTS IN 2002. HIS CURRENT RESEARCH SPECIFICALLY LOOKS AT INTERACTION DESIGN (UI/UX DESIGN) AND NEW MEDIA COMMUNICATION.
LINK HTTP://ADONISCHANG.COM/TALK2ME.HTML

Appendix 24: Other Research Achievements

Research Achievement 1

Media Exposure

A Practice-based Research: Talk2Me. Featured in Yle TV, Finland, 25th January 2016

Please check it via the link at http://areena.yle.fi/1-3273671

Research Achievement 2

Research Demonstration

Talk2Me: a novel communication app for deaf/hard of hearing people in face-to-face communication, Xmas Demo Day, Media Lab Helsinki, Aalto University, Finland, 15th December 2015

Appendix 25: A CD-ROM (Prototypes)