PERCEPTIONS OF AUDIO NOTIFICATIONS WITHIN A MOBILE MESSAGING EXPERIENCE

by

Marlo Owczarzak

A Thesis

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Master of Science

Department of Computer Graphics Technology

West Lafayette, Indiana

May 2019

THE PURDUE UNIVERSITY GRADUATE SCHOOL
STATEMENT OF COMMITTEE APPROVAL

Dr. Paul Parsons, Chair

    School of Computer Graphics Technology

Dr. Colin Gray

    School of Computer Graphics Technology

Dr. Austin Toombs

    School of Computer Graphics Technology

Approved by:

    Dr. Colin Gray & Prof. Nicoletta Adamo

        Head of the Graduate Program

Dedicated to my family, friends, and professors who believe I can succeed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Author: Owczarzak, Marlo, E. MS
Institution: Purdue University
Degree Received: May 2019
Title: Perceptions of Audio Notifications Within a Mobile Messaging Experience
Committee Chair: Paul Parsons

User interfaces often incorporate sound to notify users of application updates, to enhance games, and to assist complex interactions. Sound exists as a medium that can provide information that humans cannot understand through a purely visual interaction, and in a mobile interface context, using another medium could be useful to mitigate visual limitations in screen space and the amount of users' attention focused on screen. There are many articles available across the user experience industry that advocate for good user interface sound design, but there is minimal research on users' emotional responses and opinions regarding these sounds, especially within a mobile space. Smartphones are now a ubiquitous part of people's lives, and sound interactions can play an important role within these experiences. This study conducts research on users' interactions with supplemental sounds in both synchronous and asynchronous instant messaging, and in different environments, specifically while using Facebook Messenger. Facebook Messenger is the most popular messaging app in the United States, and its design includes a variety of unique user interface sounds. The goal of this study is to explore and describe users' perspectives regarding instant messaging audio notifications in order to better inform user interface sound design practice for smartphones. This study contributes design considerations for both researchers and industry professionals to apply to further research or the application of audio within a mobile messaging space.

CHAPTER 1.　　INTRODUCTION

This chapter outlines the background details of this research study. It consists of the statement of the problem, research questions, scope and significance, assumptions, limitations, delimitations, and definitions.

1.1　Statement of the Problem

User experience designers often aim to give a user the most fulfilling experience available when engaged with a technology. The experience is subjective to the nature of interaction with a technology; the user may be assigned a task, the user may be exploring, or using a device for the first time. However, regardless of the user's purpose, most technologies strive to be intuitive and create a positive experience. Historically, and in current design practice, user experience is generally focused on visual interactions with devices, and non-visual elements are often supplementary features (Pirhonen, Tuuri, Mustonen, and Murphy, 2007). The relationship between a dominant visual interface and supplementary non-visual elements (such as sound or haptics) is a standard interface experience, but there is little research that examines how users feel about these supplementary features, specifically audio notifications on mobile devices. Typical research regarding audio and technology involves information representation, user performance, and semantics, but does not draw directly upon the users' emotional responses and perception of the sounds as a supplemental part of their interaction experience.

However, in user experience articles and blogs, industry professionals give guidelines for incorporating user interface sound design, the "do's and don'ts" of using non-verbal sounds to enhance user experience, and provide libraries of notification noises across all genres to be incorporated into application designs (Zimarev, 2018; Ahva, "Please design notifications responsibly," n.d.; Lachman, 2018). Industry professionals advocate for designing supplemental audio, and designing it well (Zimarev, 2018; Ahva, "Please design notifications responsibly," n.d.; Lachman, 2018), but structured research regarding user interfaces that use supplemental sounds is limited. This study attempts to address the gap between industry advocacy for user interface audio implementation and the lack of research available by exploring users' typical interactions with supplemental sounds. This will be done by analyzing users' emotional

responses and communication habits as they use a mobile messaging interface, Facebook Messenger, during interviews about their perceptions as well as an in-situ recordings of their habits. Facebook Messenger is a widely used messaging platform, and incorporates many unique sounds into its interface ("Leading mobile messengers," 2018). Since communication, especially on mobile devices such as smartphones, can take place across many different contexts, the study includes both synchronous and asynchronous situations, which also enables the user to hear supplemental user interface sounds in rapid succession or spaced out across time, mimicking real-use scenarios. Synchronous communication is exemplified by a person texting with someone else, back and forth, emulating an in-person conversation. Asynchronous communication can describe the flow of a person receiving a message, responding to the message, and engaging in other activities, postponing further communication for a later time. Although the definitions may be blurred, the main difference between synchronous and asynchronous communication is response time; during communication, the farther a conversation moves away from real-time interactions, the more it emulates asynchronous communication. Oftentimes these communication styles are naturally occurring and users may be participating in both synchronous and asynchronous conversations with different people at the same time, and they may not be conscious of this fact. Context and time spent interacting with sound notifications is a variable that could impact user enjoyment, and will therefore be studied as separate use cases.

This study attempts to better understand mobile interface users' habits and experiences as they interact with audio-supplemented communication platforms by analyzing their emotional responses as they communicate in different contexts and environments. This research aims to provide evidence for the current advocacy of user interface sound design, or evidence that current sound design does not generally suit user needs and preferences. As mobile devices improve and change, communication is impacted; understanding what sounds users regard positively or negatively in different contexts or environments, and why, can shape future sound design in practice.

1.2   Research Questions

There are two research questions for this study.

- RQ 1: How do Facebook Messenger's sounds shape the user's use of the app?
  - RQ 1.1: What sounds do the users recognize and interact with frequently?

- RQ 2: What are the emotional responses to hearing and interacting with Facebook Messenger sound notifications?
    - RQ 2.1: How do these emotional responses change in different environments and contexts?
    - RQ 2.2: What underlying social rules affect users' responses to sound emitted from their phones?

1.3   Scope and Significance

Since the first computers, incorporating audio into technologies has been an area of interest. From the 1980s to the 2010s, research in this area focused on how audio fits into the world of technology and how users received audio information, used these audio and visual technologies, and how they could learn from audio instruction. For example, Korhonen, Holm, & Heikkinen (2007) established that audio feedback can be used to enhance a visual display by improving usability, and that audio generates another level of information for the user. More recently, as user experience design as a field has shifted to involve a better understanding of users beyond usability and into incorporating user values (Rogers, 2011; Vazquez-Alvarez et. al, 2012, Ren et. al, 2018). To align with this increased trend of interest, this study will seek to describe emotional responses and communication habits in an audio-supplemented visual mobile messaging app, Facebook Messenger, in different contexts and environments, to gather data that can inform the design of audio in user interfaces in the future.

The context of this study will be messaging apps on a mobile device, specifically testing the integrated sounds and how they supplement communication through the app Facebook Messenger. As of September, 2018, Facebook Messenger is the most popular mobile messaging app in the United States, with 110.95 million monthly users ("Leading mobile messengers," 2018). Messaging apps allow for asynchronous communication while the user is participating in other tasks; in certain cases, a user must be aware of their physical surroundings and not looking at their mobile device, but are still interacting with the device in some way. Audio naturally aligns with mobile devices, because users are distracted and looking away from their screen (Ballard, 2007), but have the potential to still be connected to the content through headphones, or through external sound sources. In a distracted user context, audio notifications alert the user to an incoming message outside of the app. In opposition, users may find themselves

communicating back and forth in the app, carrying on a conversation synchronously in real time, in which audio plays a different role. Within a conversation, audio acts as a confirmation of messages being sent, delivered, and received, or as an app environment enhancement. Facebook Messenger's mobile app has a variety of user interface sounds, including alerts for new messages while the user is out of the app, alerts for new messages while the user is still in the app, feedback when the user selects the box to type into, feedback that the user's message has been sent, and more, including different sounds for selecting a photo, a sticker, sending a "chat emoji," etc.

This research does not necessarily aim to explore the audio composition of these audio notifications, or which types of Facebook Messenger audio notifications are the "best" or "worst," but rather the emotional response from interacting with sounds in messaging as a whole. If there is evidence to suggest that a certain type of sound, for example the specific "message sent" sound, is reported as overwhelmingly positive or negative, that will be noted in data analysis as a common segment of a potentially larger theme. In addition, the second research question aims to explore the context and environment in which a user is situated while they are using Facebook Messenger. The environment in which a user is messaging may change not only the content of the messages themselves (perhaps content would be more work-related while the user is at their office, or more casual on the weekends, etc.), but also if they message continuously or sporadically. These contextual differences may influence the user's overall perception, positively or negatively, of interacting with sounds, and is important to consider when attempting to understand the participants' experiences.

Although there has been research conducted on audio and its role in technologies across different devices and contexts, research that focuses on users' reactions to audio-supplemented visual interfaces on mobile devices is not common. This study focuses on the user experience of audio as the user engages in everyday instant messaging in multiple environments, which includes the user's overall perception of interacting with a smartphone while engaging the listener with aural information (International Standard, 2009; Gill, Stewart, Treasure, & Chadwick, 2008). In this study, the aim is for the user to reflect upon their emotional responses when using an audio-supplemented visual experience in real-life contexts. The participants will self-report on their messaging habits and emotional responses while using Facebook Messenger, with a focus on their interactions with sound throughout the experience. Studying users' habits

and preferences in this context can provide designers with an understanding of smartphone users and their relationship to audio, and potentially inform design decisions involving user interface sound design. This research also has the potential to better understand users' relationships to their smartphones as they reflect upon the role of sound in different contexts and environments, moving beyond research regarding aspects of usability and into the overall emotional experience.

1.4   Assumptions

The assumptions for this study include:
- The study attempts to examine audio experience of users within the context of messaging applications alone.
- The participants that will volunteer to be a part of this study are familiar with audio-supplemented visual interfaces on mobile devices.
- The participants that will volunteer to be a part of this study are familiar with using Facebook Messenger, and use it frequently in different contexts and environments.

1.5   Limitations

The limitations for this study include:
- Due to time constraints, the diary portion of the study will be limited to a one-week period, however, previous research has shown that similar time periods are sufficient. This limitation possibly impacts the richness of data. I will mitigate this limitation by interviewing participants about their experiences after the diary study, to gather any missed details or context.

1.6   Definitions

The following terms are defined for the context of the work:

User Experience (UX): "A person's perceptions and responses that result from the use or anticipated use of a product, system or service" (International Standard, 2009).

Audio: "Audio is a participatory medium which actively engages the listener in the on-going processing of aural information" (Gill, Stewart, Treasure, & Chadwick, 2008).

Feedback: "Feedback sounds are played in response to some user action" (Korhonen, Holm, &
    Heikkinen, 2007).

Notifications: "Visual, auditory, and/or haptic alerts to inform mobile users about new,
    unattended messages or events, even when the user is not actively using the application in
    question" (Pielot, Church, and de Oliveira, 2014).

Environment: "The surroundings or conditions in which a person, animal, or plant lives or
    operates" (Environment, n.d.).

Context: "The circumstances that form the setting for an event, statement, or idea, and in terms
    of which it can be fully understood" (Context, n.d.).

Emotional Response: "a reaction to a particular intrapsychic feeling or feelings, accompanied by
    physiological changes that may or may not be outwardly manifested but that motivate or
    precipitate some action or behavioral response" (Emotional Response, n.d.).

1.7   Chapter Summary

Audio design within user experience can be an important aspect of interface design, whether it is to alert a user of a new message, to confirm that messages have been sent and received, or for hedonistic elements of experience. The scope of this research is to explore users' habits and perceptions of an audio-supplemented visual mobile messaging app, Facebook Messenger, as well as exploring how this changes in relationship to the user's environment or context. The significance of the work relates to informing sound design decisions for mobile applications, as well as building upon previous audio-supplemented mobile technology research. Evaluating users' responses, positive or negative, to audio on mobile interfaces is grounded in previous research to further explain and support this study. The next chapter provides background on the existing literature surrounding audio and its role in technology, mobile devices, and user experience as it relates to this study, as well as existing evaluation methods.

CHAPTER 2.   LITERATURE REVIEW

This chapter outlines an overview of previous literature as it pertains to this research study. The following literature is broken down into audio and technology, mobile interfaces, frameworks of user experience and hedonic systems, and then provides an overview of existing evaluation methods. These evaluation methods provide a foundation for the evaulation methods used in this study. This chapter concludes with a breakdown of the pilot study done for this research, and how this study evolved from the pilot.

2.1   Audio and Technology

In the book *Voice User Interface Design*, Cohen, Giangola and Balogh (2007) distinguishes between auditory interfaces and multimodal interfaces. The former is an interface that exclusively uses sound for interaction, and the latter involves a combination of both audio and visual interactions. In contrast, this paper will examine research on multimodal interfaces to propose that additional research be conducted to further understand user experiences of these combined audio and visual interfaces, and the potential for audio's influence on an overall messaging user experience. Audio has been incorporated into computer development since early models, and some current interfaces still use sound as a method of engaging users. For example, both Apple and Microsoft technologies have distinct start-up sounds when their respective devices turn on. Thomas Rickert (2010) argues that the Microsoft start-up music does not have an obvious purpose, but in fact involves the user in understanding what the technology offers. Similarly, Beckerman and Gray (2015) discuss how the sonic environment is much more important than we realize, and share the evolution of Apple's start-up tone as an example of evoking emotion in the user as they engage with the interface for the first time. These examples show supplemental sound as a method of further expanding a user's relationship with a technology; pushing interactions beyond inputting and outputting data on a computer.

However, the relationship between audio and technology did not begin with applications towards improving an overall experience, but rather audio was analyzed in the 1980s to understand if sound could be useful in presenting information to a user (Bly, 1982). This was followed by research analyzing the cognitive load of users, and an exploration of audio cues and

its effects on reducing visual workload (Brown, Newsome, & Glinert, 1989). Brown, Newsome, and Glinert (1989) found that incorporating audio information into visual displays allowed users to use the display for multiple tasks simultaneously, establishing the importance of a combined experience. The 1980s and 1990s generally focused on improving usability through the application of audio; Nyshadham (1998) found that audio in addition to a visual display did not influence a decision making process, but did reduce the time of the decision making process. A discussion surrounding "auditory icons" and "earcons" emerged during the late 1990s, diving deeper into understanding the application of non-speech sounds, sonification, to support technology. Auditory icons use sound as an analogy for interactions on a computer interface; for example, a user may hear a clicking sound when they use the mouse to press a button on a screen. A sound is mapped to an event that resembles a real-life interaction (Gaver, 1997). This is similar to a sound effect, but with a clear link between the subject matter of the audio and visual media. Earcons are even more arbitrary in their relationship to events on a visual interface, the relationship between the audio and visual interaction exists, but without the analogy that auditory icons suggest (Gaver, 1997). It is interesting to take a moment and examine current technologies that one relies on every day, and begin to recognize different auditory icons and sound effects that are heard on a regular basis. For example, one listens for the "swish" of an email being sent, or a "ping" when a new text message is received. Non-speech sounds provide information in a different way than speech audio, which led to further research in understanding audio and visual interfaces in different contexts.

For example, in 2000, a study was conducted on text and audio comparisons within computer-based instruction. Participants were presented with one of three different ways to complete their instructional course on graphic design topics, a Text Only version, an Audio Only version, and a blended Text and Audio version. This moved past sonification and into speech audio, and this study reached the conclusion that for instructional design, Text Only was sufficient, and that redundant audio could possibly hinder instruction (Koroghlanian & Sullivan, 2000). Years later, Carter (2012), recommends four design principles for instructional audio guidelines. The guidelines included focusing on the narrative nature of audio content, the fleeting nature of spoken words, the environmental soundscape of the instructional environment, and the understanding of the difference between hearing and listening. These design recommendations were formulated based on a sound-based instructional case study, and perhaps if considered in

the audio comparison study discussed above, would have influenced the results (Carter, 2012). These studies specifically frame audio as a tool that shares language, but audio is not confined to a language-based instructional use.

Across the larger timeline of sound and technology, audio-specific efforts have also risen out of a need to service people with disabilities such as visual impairment. Edwards (1989) explored speech and non-speech sounds in Soundtrack, an interface designed for the blind, and Mynatt (1990) revealed several factors that could affect usability of auditory cues, such as identifiability, conceptual mapping, and sound quality. Audio-only interfaces have continued to be explored to serve this community; recent studies include research on a blended speech and non-speech system for the blind (Hussain, Chen, Mirza, Chen, & Hassan, 2015), and are still being explored in different technological contexts. However, this specific application of sound in technology is not a focus of this study, as it will use a multi-modal interface that requires interactions with a visual display. What this study does build on from this literature is the acknowledgment and understanding of the differing roles of auditory cues when designed with visual displays in mind, and in their absence. This study acknowledges and examines audio cues as a supplemental factor of design, rather than a crucial element for understanding information.

More recent studies examine sound as a factor in experience, and as potential influence for enjoyment or entertainment. Sound has often been a method to enhance gaming, and gaming has grown to incorporate the broader user experiences. Gaming has recently explored sound in interactive first-person shooter games, hrough multi-player audio channels, and as a means of gaming accessibility (Nacke, Grimshaw, & Lindley, 2010, Bernhaupt, Ijsselsteijn, Mueller, Tscheligi, & Wixon, 2008, Ekman, 2007). As augmented and virtual reality have become more popular, research surrounding these technologies in general has increased. Two studies focused their efforts on exploring how audio effects these experiences. The first focuses on tourism applications, and users' experiences with sound without a visual component, and the second with sound and a mixed reality component (Ren et. al, 2018). Their findings outlined that different combinations of sound were preferred, and that when in a mixed reality setting, the placement of sound spatially was significant. A study similar in the technology involved testing four different auditory displays in a sound garden, in which the user is prompted to explore their surroundings in an audio-augmented space. They found that 3D spatial cues with other auditory cues created the best combination for users to explore this virtual space (Vazquez-Alvarez et. al, 2012). As

technologies change and become more advanced and immersive, the applications of audio change along with them, however, some core goals of using audio remain – conveying information to the user in a different, sometimes related, method, as well as improving the overall experience of the technology in use.

Results from these studies show the influence of sound in different experiences, but there has not been a more extensive effort into understanding users' perspectives when considering audio. Sound exists as a medium that can provide information that humans cannot understand through a purely visual interaction (Gaver, 1997). Audio has the capability to instruct, orient, and inform users within different user interfaces, as shown in the wide variety of research done on its application to technologies. The history of relevant audio and technology research provides foundational work for further exploration in this domain, especially in the more specific application of mobile interfaces. Many mobile apps use some kind of sound component, whether it is simple sonification or complex voice-to-text speech recognition; however, users' attitudes towards sound in this mobile space, and even more specifically, messaging, has not been a focus, even though mobile devices have been incorporated into our everyday experiences, and the incorporation of interaction sounds into smartphone applications is standard.

2.2   Mobile Interfaces

Mobile interfaces have their own set of characteristics that align with audio in a different way than desktop interfaces. Research has shown that smartphones have become a part of our everyday lives and therefore embody a seamlessness and invisibility (Barkhuus & Polichar, 2011). Seamlessness and invisibility are design principles that help explain the nature of users that interact with mobile devices. There are many contexts for which a user may interact with their mobile device, and because of this, mobile devices have their own set of challenges when being designed for, especially due to the inherent diversity of features and uses of mobile devices.

Ballard (2007) discusses mobile technologies and all their facets; the devices themselves, the users and their characteristics, and designing for mobile devices. First, this section will explore the definition of mobile devices and elaborate on their unique characteristics to better frame the scope of the study. The defining qualities of a mobile device are that it is personal,

handheld, communicative, and wakable. The device belongs to one person, affords portability, affords messaging back and forth, and can move from sleep mode to an active mode so it can be used quickly (Ballard, 2007, p. 4). This definition is broad and can encompass a variety of different technologies that have developed since Ballard's book in 2007, but for the sake of this study, this definition will apply to the modern smartphone. Ballard (2007) also outlines components of mobile devices that effect how applications are designed for a carriable device; the device is small, its features are prioritized, its capabilities are more limited than larger computers, it often has a single, small user interface, and the device must suit the user's needs as they change. Mobile devices are carried with the user through changing contexts that impact the user's desires for the purpose of the device (Ballard, 2007, p. 5). This multi-functionality was the foundation for Barkhuus and Polichar's (2011) study seeking to understand the affects and affordances of mobile devices as a whole. Through interviews, data logs, and diaries, the results of the study reflect the diversity of use that mobile devices afford. Even if participants were using the same app to text, the subject matter, amount of time spent texting, and frequency of texting was varied. They explain this situation as follows, "by collecting functionality together in one platform, each mobile phone acts as a portfolio in the hands of each particular user, with different functions used and others ignored" (Barkhuus & Polichar, 2011, p. 637). When interacting with one's mobile device, the user is in control of the context of use. Ballard gives several key indicators to characterize a device as mobile, but stresses that mobile is more about the user than the hardware, and Barkhuus and Polichar echo this sentiment through their work.

Mobile users are likely to be in a situation where their use of a mobile device can be interrupted or distracted. This can vary based on the context of the user, and is situated, which presents a unique challenge for mobile design. "A primary principle of user-centered design is to understand 'users and their needs,' a process which starts with watching users at work and understanding what they want to do and how they want to do it. The variety of ways in which our participants approached a task makes design using this principle a challenge" (Barkhuus & Polichar, 2011, p. 638). Ballard (2007) expands on this by discussing how not only are mobile users usually in a situation in which they are sociable and easily to be drawn away from their device, but they are also very available to those wanting to contact them. These characteristics of mobile users give a contextual foundation for understanding the needs of the user. An understanding of mobile interfaces and mobile users is important to provide a greater context for

the application of audio to this technology. This study aims to take this foundation and use it to frame and understand where users' interactions with audio-supplemented visual mobile interfaces is rooted and it creates implications for the future of mobile displays.

Instant messaging on smartphones can fall into two communication styles; synchronous communication and asynchronous communication. These methods of communication inherently involve notifications alerting users to new messages. Notifications are shown to be very important to the communication experience on smartphones; Sahami et al. (2014) used experience sampling to gather the preferences of over 40,000 Android smartphone users, and determined that notifications from communication applications are the most valued of notifications from different applications on one's phone. IJsselsteijn, van Baren, and van Lanen (2003) discuss how properties of technologically-mediated communication go beyond the limitations of face-to-face communication, and how different contexts and social measures afford synchronous or asynchronous communication situations. For example, they discuss designing for a minimized attention demand, stating, "systems should blend into the background and are effectively intended to be ignored until the user feels like communicating, i.e. asynchronous communication" and "drawbacks of using existing media for staying in touch included their synchronous nature (not practical for both parties at the same time) and their need to be tied with explicit communication interactions," (IJsselsteijn, van Baren, & van Lanen, 2003, p. 4). Since communication contexts vary, understanding users' preferences with audio as it supplements instant messaging should be studied in these independent use cases.

2.3   User Experience and Enjoyment

The previous sections discussed audio and its role in technology over time, as well as the defining characteristics of mobile interfaces and mobile users, as well as the ability for contexts and environments to change users' perspectives. This section will provide relevant intersections of user experience theory and audio and mobile technologies to better frame this study. Many of the applications audio and technology referenced above are situated within the first two waves of human-computer interaction, in which relationships between man and machine, usability, and information processing were the core focus (Harrison, Phoebe, & Tatar, 2007). User Experience is part of the third wave of human-computer interaction, and moves beyond the interactions

between users and computers to explore how these interactions are situated within context and human values and experiences.

In research on user loyalty and instant messaging, Zhou and Lu (2011) discuss how not only do users participate in mobile instant messaging for practical communication, but also to gain enjoyment, and that users message more as a form of entertainment and less as a form of productivity. From this perspective, mobile instant messaging can be understood as a hedonic system. In a paper regarding user acceptance models, van der Heijden (2004), describes hedonic systems as aiming, "to provide self-fulfilling value" to the user, and values experiencing fun and having a pleasurable interaction (van der Heijden, 2004, p. 696). Hedonistic value can also be expressed through the opposite; negative emotions of fear or frustration (Kim, 2015). This research validates an exploration into emotional responses as it relates to audio-supplemented instant messaging, by discussing how users intend to use messaging for self-fulfillment. In addition, identifying the contexts and environments in which these emotions change can potentially explain shifting of hedonistic values. Understanding the emotions of users as they interact with supplemental audio instant messaging aligns with the situated nature of human experiences that third wave human-computer interaction promotes.

2.4   Existing Evaluation Methods

The previous sections discussed audio and its role in technology over time, mobile interfaces, and user experience frameworks as they relate to both audio and mobile interfaces that are a blend of functional and hedonic systems. This section will outline the existing self-report evaluation methods that will be used in this study. These methods include diaries and interviews as they relate to understanding user experiences.

Diary entries are used in Human Computer Interaction research to record situations where technology is used on the go in different real life situations, as well as when the research questions explore emotional responses that are not easily quantifiable (Lazar, Feng, and Hochheiser, 2017). Understanding users through their direct response to interacting with audio notifications aligns with this study's research questions. In other studies in the mobile technology space, diaries have been used to collect and understand mobile information needs and the changing use of mobile features in everyday life (Sohn, Li, Griswald, et al., 2008, Barkhuus and

Polichar, 2011). Diaries are good for understanding data that changes over time in a natural setting, and can give insight into understanding the "why" behind user interactions and feelings. However, diaries have disadvantages as well; participants may not record enough diary entries, may not be introspective enough, and are generally more intrusive on day-to-day activities than other methods (Lazar, Feng, and Hochheiser, 2017). The researcher hopes to combat these disadvantages by keeping the diary entries as unobtrusive as possible, recording snippets and linking participants to diary entries through Facebook Messenger. The researcher also hopes to mitigate these disadvantages by including interviews as another method of data collection. Interviews allow for further clarification of diary entries, expanding upon the participant's experience, and confirming the participant's experience.

Interviews are an important method to gain user feedback, and are useful in that they can vary in structure and formality. Interviews can also take steps to remove researcher bias by hearing direct responses from the participant (Goodman, Kuniavsky, and Moed, 2012). This method also affords naturally asking questions that align with the study's thematic research questions, and that directly ask about the participant's thoughts and experiences. The idea will be to create interview questions that relate back to the research questions, without confusing or straining the interviewee, and making the conversation flow naturally for the best responses from the participant (Kvale and Brinkmann, 2007). The interview questions were developed with McCarthy and Wright's (2004) "threads of experience" as a foundation in order to "provide ways of talking about technology that heighten sensibility to people's experience of it" and include sensual, emotional, compositional, and spatio-temporal threads (McCarthy & Wright, 2004, p. 80). Interviewing the participants before the diary entry period will allow for them to verbally elaborate and express their understanding of the diary entry method and self-reflection of the audio notifications within Facebook Messenger. Interviewing the participants after the diary entry period will allow for them to verbally elaborate on the entries created, and clarify any points of confusion for the researcher.

2.5   Chapter Summary

Audio has been incorporated into technology design with different goals for usability, information retention, and experience since there have been visual interfaces. This literature

provides a contextual understanding of the changes in supplemental sound application throughout the history of technologies, but also exemplifies that supplemental sound has not often been explored in an hedonistic context within mobile devices, specifically smartphones. Mobile devices have exploded in popularity, and have been integrated into the rhythm of everyday life, which justifies the importance of understanding their unique characteristics when designing and testing these interfaces. User experience has also changed in reflection of how technology has been used and how the user has been perceived over time, and provides the framework for which this study will explore emotional responses to sound and how this feeds into conversation habits.

CHAPTER 3.   METHODOLOGY

The previous chapter discussed existing research in the space of audio applied to technology, the characteristics of mobile interfaces and mobile users, and user experience frameworks to address this research goal. It also discussed literature about existing evaluation methods, which will be implemented within the following methodology. This chapter will include the methods that the researcher used to answer the study's research questions, which include interviews and a diary study. It also consists of the data sources, which includes researcher's perspective, sampling, analysis, and validation.

3.1   Data Collection

Data was collected through a series of pre-interviews, messaging snippets, daily diary entries, and post-interviews. Each participant took part in a demographic recruitment survey, one pre-interview, one week of snippet reports and daily diary entries, and one post interview. Interviews were structured in the style of Carspecken's (1994) critical ethnography, which included topic domains of different lead-off questions, follow-up questions, and covert categories. This style affords exploration of a topic at first, and then a deeper dive into details (Carspecken, 1994). The method of gathering snippets through the medium studied, as well as the diary entries, was modeled after Sohn, Li, Groswold, et. al's (2008) methodology, and was modified to fit within the scope of this study. Each step in the data collection process is further explained in the following paragraphs.

Participants were recruited for this study with a preliminary demographic survey distributed by the researcher through personal networks. This step ensured that potential participants met the qualifications for the study. This recruitment demographic survey can be found in Appendix A. To qualify for the study, participants needed to be within the target age demographic of 18-29, and use Facebook Messenger to communicate regularly (at least a few times a week, daily preferred). Once the researcher confirmed with the participant that they met the qualifications, a pre-interview time was set up. A representation of the data collection process is shown below, for further clarification of the timeline.

Table 1. Data Collection Breakdown

Pre-interview with participant	One-week daily diary study	Post-interview with participant
Pre-interview Breakdown: 1. 30-60 minute interview to establish study and gauge the awareness of notification sounds 2. Participant asks any questions regarding the study design or study content	Daily Breakdown: 1. Snippet prompt sent from the researcher 2. Response to snippet prompt from the participant (Steps 1, 2 repeat twice) 3. Diary prompt sent from the researcher 4. Response to diary prompt from the participant	Post-interview Breakdown: 1. 30-60 minute interview to confirm and expand upon data collected 2. Participant asks any questions regarding the study design or study content

The data was collected in three phases, a pre-interview, a one-week diary study, and a post-interview. The study began with a pre-interview with each participant. The pre-interview was semi-structured and followed a set of questions regarding the participant's phone use and audio consumption, and inquired about their familiarity with Facebook Messenger, as well as other messaging applications. It began with an overall introduction of the study and the format, allowing the participants to better understand the time frame and commitment of the study. This introduction gave context to the researcher's interest in the participants' instant messaging habits, and served as an opportunity to fully explain the diary entry process. Then the researcher addressed any questions the participant had regarding the study, and allowed the participant to sign a consent form to participate in the study and for the interview to be recorded. The researcher began with an effort to build rapport with the participant by asking the participant to give a summary of their habits, and then reciprocating with a similar breakdown of their own. The interview was then guided through three topic domains: Facebook Messenger as an App, Awareness of Audio Notifications, and Messaging and Environment. At the conclusion of the

interview, the researcher asked the participant to share any other information that was related to this topic, and if there were any other topic domains that held importance to the user. Each pre-interview was audio-recorded to retain accuracy of the participants' contribution, for the following analysis. The pre-interview protocol is listed in Appendix B. During this first stage, of data collection, participants were shown the researcher's breakdown of sounds, as shown in Table 2, and discussed their knowledge and understanding of the different types of sounds emitted by the messaging app. This step was included to ensure a base level of awareness that these sounds existed across all participants. At this time, the researcher set up a connection between the Res Owczarzak Facebook Messenger account and the participant's Facebook Messenger account, and sent test messages to ensure the participant was receiving researcher updates and prompts for snippets.

The one-week diary study was semi-structured, and involved participants in instant messaging as a method to record data. Hyldegård (2006), conducted a study to explore different diary arrangements, and suggests that a two-week diary study is a suitable amount of time, and that more of a free form entry style can generate more descriptive data and commentary on activities (Hyldegård, 2006). However, due to time and resource constraints, this study was limited to a one-week timeline. Participants were messaged requests for small snippets of their Facebook Messenger instant messaging interactions, and were prompted to identify and report on their frequency of messaging during their reports. In this study, "snippets" refer to a small extract of information that can be used to better contextualize the participants' daily messaging habits. This could include environment, context, content, or reflections regarding their messages throughout the day. Participants were also asked to identify the environment in which these interactions took place. This style of data collection was modelled after Sohn, Li, Groswold et. al's, 2008 study, in which diary entries were partially recorded in an in-situ "snippet" style, to minimize the effort of recording diary entries (Sohn, Li, Groswold, et. al, 2008, pg. 434). In addition, following Sohn, Li, Groswold, et. al's (2008) methodology, reminders from the researcher were sent through the medium being studied, in this case, Facebook Messenger. The purpose of this methodology was to lower the barrier to entry for participants, and facilitate quick, contextual responses. These snippets served a dual purpose; snippets sent throughout the day acted as notetaking for the participant's daily diary entry, as well as providing a more in-situ perspective for the researcher.

In this study, a total of four Facebook messages were sent to the participants daily, spaced out in intervals, prompting them to record snippets and remind them of the final diary entry to be completed at the end of the day (Sohn, Li, Groswold, et. al, 2008, pg. 434). Mirroring the pilot study, reminder prompts were sent to the participants around 10:00 AM – 11:00 AM, 1:00 PM – 2:00 PM, 4:00 PM – 5:00 PM, and the final message was sent at 7:00 PM – 8:00 PM; since the 7:00 PM – 8:00 PM message was the last of the day, it served as the diary entry prompt. The researcher also adjusted this timeline for remote participants by adjusting the reminder prompts to match the proposed schedule in their local time zone. With each new day of the diary study, the researcher declared the day (Day 1 – Day 7) to the participant, to keep both the researcher and the participant organized, and sent an opening reminder prompt. Reminder prompts were sent with the same language to each participant to retain consistency; this message is shown in Figure 4 below.
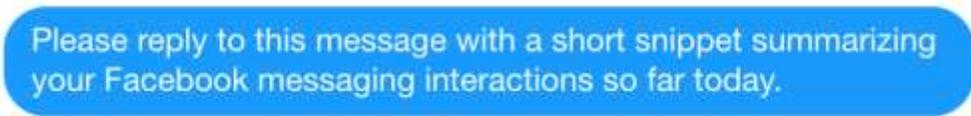
Please reply to this message with a short snippet summarizing your Facebook messaging interactions so far today.

Figure 1. Snippet Reminder Prompts.

Again mirroring the pilot study, reminders from the researcher were sent from the Facebook Messenger account "Res Owczarzak" (short for Research Owczarzak), so the participant could distinguish these messages from messages received by personal connections. This account also afforded participants to explore different notification sounds if desired. For example, a participant could send a GIF or a sticker to hear its corresponding sound to the research account without any judgement or confusion that might come with messaging a friend. If the participants asked clarification questions to the researcher within the researcher account, the researcher would respond. Otherwise, the researcher only sent snippet reminder prompts and daily diary entry prompts. These snippets were recorded and compiled by the researcher, and were later used as prompts for clarification or expansion during the post-interview process.

The participants were asked to complete a final long-form diary entry at the end of each day, to further elaborate upon the snippets recorded, noting different contextual elements and reflecting upon their daily habits and experiences. As in the pilot study, diary entries were

completed through a Qualtrics survey. However, this survey was updated to contain a mix of check-listed items of potentially repetitive information, as well as questions for open-ended responses. As stated above, the link to the survey was sent to the participant with the final researcher reminder message, between 7:00 PM – 8:00 PM each day. The survey asked for a general description of the messaging interaction, as well as some more specific follow-up questions, that may or may not be relevant on specific days. The first 4 days of the study contained the same questions, to establish a norm of routine reflection. Days 5, 6, and 7 each contained different questions than the day before. The last three days explored questions regarding the audio notifications in more specificity. Participants were expected to answer these questions to the best of their abilities. The diary entry questions are listed in Appendix C.

After the one-week diary entry period, a post-interview was conducted for each participant, as the third phase of data collection. The researcher used the post-interview to ask questions in response to the diary entries, and follow-up with the user regarding their thoughts on enjoyment as well as strong positive or negative emotions. The post-interview was also semi-structured, with the goal of giving the participant a platform to express any thoughts not given in the diary entries, or reiterate points in need of clarification. As with the pre-interview, the researcher began by building rapport with the participant by asking the participant to reflect upon any new experiences during the diary study, and then reciprocating with their own insights from snippets or diary entries. The interview was then guided through three topic domains: Snippet and Diary Entry Clarification, Facebook Messenger Experience, and Emotional Responses to Sound. The interview questions were developed with McCarthy and Wright's (2004) "threads of experience" in mind (McCarthy & Wright, 2004). This provided some structure to guide questions and enabled the participant to share feedback and reflect upon different dimensions of the overall process. The threads of experience also reflect upon the hedonistic value of understanding this experience, and can help situate feelings that arise in this study compositionally (Kim, 2015). Since communication and smartphone messaging use differs contextually, understanding the broader experience at play can help explain common themes. To conclude the interview, the researcher asked the participant to share any other aspects of their experience over the past week, or ask any last questions. The post-interview was audio-recorded to retain accuracy of the participants' contribution, for the following analysis. The post-interview protocol is listed in Appendix D.

3.2   Data Sources

The data collected for this research included the demographic recruitment survey, transcribed audio recordings of both pre- and post-interviews, Facebook Messenger snippets, and diary entries. In addition, the researcher took notes during the interviews that were considered for data collection. The researcher notes included any hesitance or emphasis made by the participants through behaviors that would not have translated through audio recordings. All eight participants consented to audio recordings during the interviews, which is the main source of the data collected. The recordings were done with an audio digital recorder from the researcher's laptop.

Messenger snippets were copied from Facebook Messenger and into an Excel spreadsheet made by the researcher, which compiled all of the de-identified participants' snippets and answers to diary entry questions. Diary entry answers were extracted from Qualtrics and into respective daily entry spreadsheets, which the researcher compiled into the main data collection spreadsheet. From there, the researcher noted any snippets or diary entries that stood out. The next section includes further detail about the analysis of the transcriptions, snippets, and diary entries.

3.3   Sampling

The population sample is eight adults, all regular mobile phone users with varying degrees of how often they use their mobile device with audio. Use of audio ranged from using a few times a day, to every day, framed within the time span of weekly use. When the researcher recruited potential participants, individuals were asked to share a brief summary of their phone usage habits, through the aforementioned online recruitment survey. The researcher informed the participants of the research goals and what the researcher is trying to gain from this study, and provided an overview of the interview and diary processes.

The researcher used the sampling strategy of purposeful random sampling to find adults interacting with Facebook Messenger on their mobile phones regularly. Purposeful random sampling is used here to reduce bias in this category of mobile phone users ages 18-29 years old and affords a small sample size (Patton, 2001). Since this study is designed to be quite small due

to time constraints, the sample does not aim for representativeness, but rather credibility and manageability, a main characteristic of purposeful random sampling (Patton, 2014). The goal is to increase credibility without scaling the study to be too unmanageable for the time frame of this course, while meeting the criteria for smartphone users that regularly use Facebook Messenger to communicate in different contexts.

<p align="center">3.4   <u>Analysis</u></p>

Analysis was conducted on the pre and post interviews from each participant, as well as the snippets and diary entries submitted by each participant. Data was analyzed through Braun and Clarke's (2006) method of thematic analysis to identify patterns and form themes from the qualitative data across six phases. Thematic analysis can be done deductively or inductively; this analysis was done inductively, through the interpretation of the data guiding the coding structure and process. Before beginning the six phases of thematic analysis, the researcher engaged in some preliminary jottings during the interviews to better remember initial thoughts and feelings about the data from that portion of the study. As outlined in Saldaña's (2016) book, *The Coding Manual for Qualitative Researchers*, these jottings helped the researcher remember the data, and helped form tentative ideas for codes moving into the familiarization phase of thematic analysis. The phases of data analysis include familiarization with the data, generation of initial codes, searching for themes, reviewing potential themes, and defining and naming themes (Braun and Clarke, 2006). In this study, all phases of thematic analysis were completed in individual categories of pre-interviews, snippets and diary entries, post-interviews respectively.

The analysis was broken into three sections, the pre-interview, the snippets and diary entries, and the post-interview, to reflect the different phases of data collection, in which the participants may have different perspectives. The pre-interview focused on exploring general user habits, setting up the study, informing the users of diary protocol and expectations, but still contained important data to contextualize each participant's habits. The snippets and diary entries focused more on an in-situ perspective of Facebook Messenger use and the participants' daily interactions with sound in their messaging experience. The post-interview focused on a reflection of the past week, as well as their emotional responses to sound, and their understanding of the purpose of sounds within Facebook Messenger. Since each section of the

study varies in methodology, subject matter, and the perspective of the participant, the researcher chose to analyze each section independently.

To complete the first phase of thematic analysis, the researcher transcribed and read through the pre-interviews for each participant, and compared them with the notes taken during each interview session. This same method was done for post-interviews. The researcher also re-familiarized themselves with each participant's snippets and diary entries by reading through the each participants' snippets and entries, and then compiling them into a single spreadsheet organized by participant. Revisiting the data not only allowed the researcher to be further familiarized with the data, but also generated some opening ideas regarding participant behavior and patterns. The goal was to identify semantic themes within each section of data, which the researcher kept in mind while reading through and taking notes on each data set respectively. The second phase is generating initial codes, which was done for each individual section. The initial codes were broad and informed a general idea of the patterns that exist in the data sets. The third phase rearranged codes into more significant themes, and in the fourth stage, in alignment with Braun and Clarke's (2006) recommendations, the researcher reviewed and refined the themes. For the fifth phase of thematic analysis, themes were further refined, and defined what they actually represent (Braun & Clarke, 2006). The goal of this thematic analysis is to find any repeating and important sentiments about the participants' feelings or actions regarding the use of audio to supplement a visual mobile experience, across different environments and contexts.

3.5   Perspective and Validity

The researcher is within the target age demographic and uses their smartphone daily to communicate through Facebook Messenger. Because of this, the researcher is familiar with the mechanisms of Facebook Messenger and the use of audio in this supporting context. However, the researcher seeks to understand other smartphone users' experiences, and does not want to impose their own habits and reasons why they use audio-supplemented visual interfaces while interviewing, observing, or analyzing the participants' data. While reading prior research, the researcher has reflected upon their own experiences and values as they interact with these multimodal interfaces on their own smartphone. This has helped the researcher to understand and

hypothesize what other young adults could experience as well, especially by reading about generalized mobile device user characteristics, but does acknowledge that smartphone use, and communicating through Facebook Messenger, is different for each person and can vary based on environmental factors. The goal of this study is to collect different participants' user experiences to find any themes involving enjoyment of supplemental audio designs on a mobile device.

In addition, validity is an important concern in this study; the following section describes the methods used to further ensure the validity of the data collected and analyzed. One threat to validity could be a loss of nuances of the experience through reductive data collection (Maxwell, 2012). The goal to counteract this was to collect rich data, which was done through interview transcripts as well as diary entries. The post-interview also gave the participant the opportunity to validate their experience by confirming their interactions and thoughts throughout the one-week diary entry period (Maxwell, 2012). The analysis process included techniques to ensure credibility, and a representative understanding of the collected data. Lazar, Feng, and Hochheiser (2017), express the validity of diaries by stating that, "diaries are a very good method for recording measurements that cannot be accurately collected by experimental or observational means, or may result in increased overall validity when used in conjunction with these other methods" (Lazar, Feng, & Hochheiser, 2017, p. 139). Interview transcripts and diary entries provided different perspectives of the same experience, affording triangulation to prevent misinterpretation (Patton, 2001). Triangulation has been achieved through using these multiple, self-reported, accounts of the participants' messaging habits and emotional responses of audio within messaging to locate themes within the data (Creswell & Miller, 2000). In addition to multiple data sources, participants were given the opportunity to confirm their experiences through member checking. After the raw data was collected, participants were asked to confirm that the data set represents their experience accurately (Creswell & Miller, 2000, pg. 127). In conclusion, validity measures were taken to uphold the rigor of this qualitative research, through the nature of diary recordings capturing user experiences in-situ, triangulation, and member checking. The researcher's personal goal is to represent the participants' actions and thoughts as best as they can, and was active in reflecting upon the validity methods discussed above throughout the data analysis process.

3.6   Pilot Study

3.6.1   Purpose

The purpose of this pilot study was to explore and validate protocol and methodology for the future of this research. Although this study models its methodology on existing diary studies, such as Sohn, Li, Groswold et. al's 2008 study, working with Facebook Messenger as the primary form of communication between the participants and the researcher presents a different context. Anticipated elements in need of clarification include: how to establish awareness of audio messaging notifications at a consistent level across all participants, the amount of reminders sent by the researcher per day, the method of collecting diary entries, and the level of guidance needed for diary entries.

3.6.2   Research Design

The two participants selected for the pilot study were known by the researcher, and were selected due to their frequent use of smartphone messaging, and in particular, their use of Facebook Messenger. Although they were recruited directly by the researcher, they were asked to fill out the Recruitment Survey, so they could give feedback about its effectiveness for the study moving forward. The survey has been modified based on participant feedback and is now listed in Appendix A. Both participants were female between the age range of 18-29. Participant 1 was 23 years old, in medical school, and used Facebook messenger daily to communicate with classmates, work-related events, and her sisters. Participant 2 was 24 years old, working as a software engineer, and used Facebook messenger daily to communicate with friends. Despite both being active Facebook Messenger users, both participants did not often keep their sound volume up to hear audio notifications, and were not aware of the different sounds made in the mobile app interface.

The pilot study included a shortened version of a pre and post interview, as well as a shortened diary study. Each participant engaged in a 20 to 30 minute pre-interview the day before the diary study began. Each participant engaged in a two day diary study that consisted of diary "snippets" and one diary entry at the end of each day. Each participant also engaged in a 20 to 30 minute post-interview after the diary study concluded. Portions of the interviews were audio-recorded, and later transcribed by the researcher through the transcription service Temi,

and checked for accuracy. The following table provides a visual representation of the pilot study schedule including all three shortened phases of data collection.

Table 2. Pilot study interview and diary schedule.

	Pre-Interview (30-60 minutes)	Diary Study (Day 1)	Diary Study (Day 2)	Post Interview (30-60 minutes)
Researcher Actions	- Introduce research - Establish expectations - Establish awareness of audio (share samples of audio) - Establish reminder messaging system with participant	- Send four reminders to document snippets at 3 hour intervals throughout the day - Establish guided questions for longer diary entry - Collect both snippet and diary responses	- Send four reminders to document snippets at 3 hour intervals throughout the day - Establish guided questions for longer diary entry - Collect both snippet and diary responses	- Inquire about overall habits or experience - Clarify any unclear data from snippets or entries
Participant Deliverables	- Share understanding of messaging habits and awareness of messaging notifications audio - Agree to participate in diary study	- Share snippets regarding their experience and habits throughout the day, ideally 3+ snippets - Complete diary entry at the end of the day; reflecting upon their experience and habits	- Share snippets regarding their experience and habits throughout the day, ideally 3+ snippets - Complete diary entry at the end of the day; reflecting upon their experience and habits	- Share any reflections regarding habits or experience - Confirm data from snippets and entries - Confirm/deny that the researcher's understanding of data is correct
Timeline	30 minutes	Reminders sent at: 10:00 AM, 1:00 PM, 4:00 PM, 7:00 PM Final diary entry to be completed by the participant by the end of the day	Reminders sent at: 10:00 AM, 1:00 PM, 4:00 PM, 7:00 PM Final diary entry to be completed by the participant by the end of the day	30 minutes

The pre-interview allowed the researcher to ask more questions about the participants' daily Facebook Messenger use beyond the information obtained from recruitment, and to introduce the unique Facebook Messenger audio notifications to the participants. The researcher followed the Pre-Interview Protocol, listed in Appendix B. After the pre-interview, the researcher sensitized the participants with the distinct Facebook Messenger notification sounds, as shown in the table below. This acted as a foundational discovery phase of sound awareness. It is important to note that there are not standardized terms for audio notifications, across the industry or through Facebook directly, and the sound descriptions were made by the researcher.

Table 3. Messenger actions and corresponding notification sounds.

Action	Sound	Timing
New Message Alert (out-of-app)	Pop-Ding	A small pop sound followed by a high pitched ding
Tap on Typing Space	Soft rapid clicks (2 or 3 tones)	Clicks in rapid succession on initial tap into typing space
Message Send	Soft click	Often occurs together with Message Delivered
Message Delivered	Soft click	Often occurs together with Message Send
Typing Anticipation Bubble Appears	Soft clicks (2 tones, low then high, reverberation)	Occurs when another person is typing, but has not sent a message
Message Received	Soft pop	Pop when a message has been received
Customizable Chat Emoji (one tap)	Pop, click	Pop on initial selection, then click to signal Message Delivered
Customizable Chat Emoji (hold and release)	Wind-up whistle slide, pop	Wind-up whistle on initial selection and hold, then release with pop to signal Message Delivered
Sticker Send	Click, rolling click tones gradually higher	Click on initial selection, then clicks with tones gradually higher
GIF Send	Soft click	Often occurs together with Message Send

Table 3 continued

Emoji Send	Soft click	Often occurs together with Message Delivered
Photo Send (taking photo, camera roll)	Soft click	Often occurs together with Message Delivered
Hearts/Balloons/Snow (emoji, sticker)	Click, bubbling tones gradually higher	Click on initial selection, then bubbling with tones gradually increasing as hearts/balloons/snowflakes fill screen
Mentioned Sound (out-of-app)	Pop pop-mid level ding	Two consecutive pop sounds followed by a mid-level ding
Read Sound	Two-toned bubble sound	Low tone to higher tone, occurs as another person reads a message
Audio Clip (hold)	High hollow tone	Hold on icon to record, tone in response
Audio Clip (send)	Low slide	Often occurs together with message sent and delivered
Phone Call	Ringing	Different ringing tones upon selection
Video Call	Ringing	Different ringing tones upon selection

After the pre-interview questions and orientation with the messenger sounds, the researcher set up a connection with the participants on Facebook Messenger. Reminders from the researcher were sent from the Facebook Messenger account "Res Owczarzak" (short for Research Owczarzak). This method was used in an attempt to lower the resistance of the study; since users were being asked about their Facebook Messaging habits, the reminders were integrated into this existing messaging system. The researcher familiarized the participant with the messages from this account in the pre-interview by ensuring that they received the reminders from this account, and that the participants could successfully respond to the account. Reminder prompts were sent to the participant at 3 hour intervals, at 10:00 AM, 1:00 PM, and 4:00 PM. The participant was expected to send snippets as replies to this messaging account. These snippets serve as notes for the participants to use to help fill out the diary prompts later in the day, as the snippets will be written more in real time than the diary reflection. The snippets also give the researcher more insight into the daily actions of the participant.
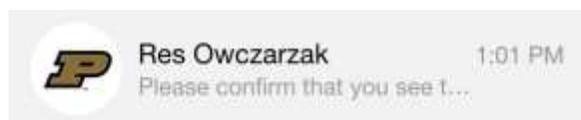
Figure 2. Researcher messaging account example.

Figure 3. Researcher introductory message example.

Diary entries were completed through a Qualtrics survey; the link was sent to the participant with the final researcher reminder message, at 7:00 PM each day. The survey asked for a general description of the messaging interaction, as well as some more specific follow-up questions, that may or may not be relevant on specific days. Participants were expected to answer these questions to the best of their abilities.

Figure 4. Pilot study diary study question example.

The post-interview allowed the researcher to ask more questions about the participants' diary entries and experiences. The researcher followed the Post-Interview Protocol, listed in Appendix C. The first topic domain (Snippet and Diary Entry Clarification) was not emphasized, due to the shortened time period of the study, and because the researcher did not believe that any "snippets" or entries were confusing or in need of explanation. The researcher also asked the participants questions regarding the study structure and its effectiveness.

3.6.3   Results

The pre-interview revealed that both participants were less aware of audio notification sounds on Facebook Messenger than anticipated, and this theme carried into the post-interviews as well. After the two days of diary entries, the participants both reported that they were not more aware of the different notification sounds, but they were more aware of the audio existing in general. Therefore, both participants did not have strong feelings regarding their enjoyment of the audio notifications. Both participants were also not accustomed to having their audio volume up to hear notifications often, which impacted this study.

Participant 1 responded to all research reminders with snippets, and Participant 2 responded to all but one research reminder. Both participants felt that the amount of daily reminders was appropriate, and the study structure was also appropriate. Both participants completed the daily diary entries for both days.

During the post-interview, both participants expressed that their awareness had not changed for different distinct sounds, but they were more aware of sound notifications in general, and gave suggestions to improve diary entry questions and the research questions as a whole. They also both described their relationship to audio notifications negatively, describing hearing the audio as distracting and overwhelming.

Major insights that emerged from the pilot study include a minimal awareness of notifications, and the preference to keep their audio notifications off in general. Both participants reported in their diary entries and in the post-interview that they kept their audio notifications off for most of their days, which limited their interaction with notification audio. They also reported that they were not aware of the messenger notification sounds before the study, and during and after, their awareness has raised, but not enough to fully recognize differences in sounds within the app. However, when the notification sounds were on, participants described them in a negative manner. Participant 1 described her experience in the post-interview as *"more negative"* and *"I prefer silence,"* although something *"fun"* every once in a while was positive – P1. She gave an example of confetti and noise when the user writes *"congratulations,"* – P1 which is similar to an effect on Apple iMessage. Participant 2 described her experience in the post-interview as *"usually annoying and distracting, so I associate the sound with distraction."* – P2. Both participants preferred to keep their sound off in professional settings, but kept their sound on at home, and mostly messaged in a synchronous manner. When asked how the audio in

the app could be better designed for future use, Participant 2 suggested a selective feature that the user could set that would allow sound if the sets another person as important, that way she wouldn't have to hear notification sounds from everyone.

In regards to the research methodology, both participants felt that what was expected of them was clear. The amount of reminder notifications from the researcher was sufficient, and a daily diary entry was not too overwhelming. However the participants reported they felt they were being repetitive and that they may not be giving enough information, because they were asked for a snippet update and they hadn't used their messaging within that time period. Both suggested that diary entries could include some checklists for information, referring to information that could be repeated day to day, like environment, context, and frequency of messaging for the day. This suggestion will be taken into consideration for the final study, especially since the study with participants will be one week, rather than the two day limit for this pilot study. In addition, both participants were not convinced that they were at a stage of awareness to comment on their emotional response to audio notifications.

3.7   Chapter Summary

This chapter discusses the process and methodology that were used in this research study to answer the research questions, including data collection, data sources, sampling, analysis, and perspective and validity. Participants fit the criteria of adults ages 18-29, and were recruited through purposeful random sampling. The study was composed of a pre-interview, a one-week diary study including snippets and long-form diary entries, and a post-interview, which was analyzed through Braun and Clarke's (2006) method of thematic analysis. The next chapter will discuss the results of the study.

CHAPTER 4. RESULTS

This chapter provides the results of the research study, beginning with a summary of the sample from which the data was collected. The following sections describe the themes that came from analysis. These themes were broken into three phases to reflect the phases of the data collection in the study, resulting in themes from pre-interviews, the snippets and diary entries, and the post-interviews. The pre-interview themes include: choosing to use Facebook Messenger, the role of sound for the individual, and the role of sound for the public. The snippets and diary entry themes include: in-situ sound comprehension, and in-situ sound reactions. The post-interview themes include: reflection on messaging interactions and sound as a design element. The themes described give insight regarding the relationship between messaging in audio within the environments and contexts in which the participants experienced them. Each theme contains direct quotes from participants in the interviews and any relevant snippets or diary study entries, and were not altered or changed.

4.1   Sample

As previously mentioned in the methodology, participants were recruited through an online survey that collected demographic information and inquired about their Facebook Messenger habits, and outlined the interviews and the one-week diary study commitment. In selecting users as subjects, the researcher specified that they should be daily smartphone users who frequently use Facebook Messenger on their smartphone to communicate. Through the survey, the researcher also inquired about participants' habits regarding keeping the audio functionality on to hear notifications and supplemental audio while communicating. Nine people responded to the survey, and eight qualified and were contacted. All of the eight participants were between the target age range of 18-29 years old. Five participants identified as female, two as male, and one as neither female nor male. The sample included three participants identifying as Asian, two participants identifying as White, one participant identifying as Hispanic, and one participant identifying as two or more races. All eight participants completed each section of the study, the pre-interview, the diary study, and the post-interview.

The researcher selected users to participate based on the aforementioned criteria. In summary, the data source is eight adults, all within the age range of 18-29, five female, two male, and one identifying as neither, who are daily smartphone users that could interact with audio while using Facebook Messenger to communicate daily, and that agreed to participate in interviews and a one-week long diary study. The recruitment survey questions are listed in Appendix A.

4.2   Pre-Interviews Theme 1: Choosing to Use Facebook Messenger

The foundation of this study relies on participants regularly using Facebook Messenger to communicate. Even though many apps and messaging platforms use sound as an interface tool, Facebook Messenger uses supplemental sounds for almost all of their interface functions. This first theme from the results describes why participants choose to use Facebook Messenger to communicate rather than other messaging applications. This is elaborated upon in regards to the dominance of Facebook Messenger as the choice communication app, as well as an understanding of Facebook Messenger's functionality as an interface. The following two subthemes explain this first theme further.

4.2.1   Communication App Dominance

Participants slightly varied in their use of Facebook Messenger as their dominant form of instant messaging communication. The range of use is on a spectrum, from one participant saying, *"I don't really use it as like a dominant method of communication for anybody"* – P1, to one participant confidently expressing, *"I actually like don't ever use SMS texting unless like someone literally doesn't have [Facebook] Messenger"* – P5. Most participants fell somewhere in the middle, with one participant quantifying their use of communication methods in percentages; *"60/40… 60 [percent] Facebook Messenger"* – P6. When asked to elaborate on why they chose different messaging apps, three participants acknowledged their preference for Facebook Messenger stemmed from a formed habit based on their reliance on Facebook for communication while growing up in the age of social media. Participant 7 shares, *"I think it's because in middle school when like, that's when like the whole communication through social media started, it started with Facebook. And so that's just something I've become very familiar with even through all their updates and changes."* – P7. Another referenced their age, claiming,

"it's more of a generational thing. So we set [Facebook Messenger] as my friend group; set [Facebook Messenger] as a standard." – P4. One participant cited their hometown, saying, *"I use messenger every day, especially since, kind of where I'm from, it's a very technology heavy place."* – P2. The connection to a broad set of people from the area in which they grew up was echoed by Participant 3, who said, *"it just seems in my experience that more people are using Facebook."* – P3. The sentiment of a broad connection to people, of whom the participants could have either deep or shallow connections with, is elaborated upon more in the next subtheme, Interface Functionality, which was the most cited reason for using Facebook Messenger.

4.2.2   Interface Functionality

Facebook Messenger as an app is functionally different from other communication apps. For example, it uses Wi-Fi to send and receive messages, rather than traditional SMS messaging that requires a cellular network connection. It was also distinctly formed from private messaging on Facebook, then developed into its own entity. However, it still retains the ability to connect with one's Facebook friends, and beyond; one can search for a Facebook user to message, even if there is no established "friendship" between the two people. This property was mentioned by three participants, expressing their preference for Facebook Messenger because of this reason. For example, one participant said, *"you have the most friends on Facebook messenger."* – P3. Participant 2 pushed this further by discussing the ability to communicate beyond friendship; *"I usually default to messenger because if I don't have someone's number I can just search their name."* – P2. Another participant framed this same idea by understanding this global access as an open-ended contacts list all in one place by saying, *"it's kind of like having all of the contacts in the world… I feel like I have access to anyone at any time."* – P3. With access to the whole of Facebook, there would seem to be concerns of security. One participant expressed that they feel the opposite; *"it's not really anonymous because your name is attached, but like there's that layer of protection since it's not attached to a phone number"* and when taken to the extreme, *"you can much more easily block someone too."* – P3.

Beyond the preference for the accessibility it affords, participants described liking graphic elements of the interface as well. From the broad declaration of, *"it's not overwhelming"* – P3 to the more specific, *"I prefer messenger because then I can send stickers"* – P6, users are drawn to Facebook Messenger because of its interface. Graphic elements of the Facebook

Additional messenger interface that the users preferred include the contact's photo next to the message chain (P3), the green "light" or small circle next to a contact's photo designating that they are online (P3), the read receipts that are shown when another person reads your message (P5), the ability to switch between a phone app and a desktop site (P2, P5), and a preference for the chat bubble interface rather than using iMessage to talk to friends who are Android users – *"I really don't like seeing the green bubble."* – P6.

Participants gave reasons for gravitating towards Facebook Messenger for its ease of connection, establishment of pre-formed social groups, and well-designed interface; their attitude towards these two factors feed into their choice to use Facebook Messenger as their dominant form of communication for instant messaging. These factors are perceived as benefits by the these participants, who are regular users. This first pre-interview theme gives some context as to why users have chosen Facebook Messenger; creating a foundation to understand how the supplemental sounds of this interface can play into the experience overall. The next theme explores users' perceptions of sound within the app as it applies to their individual feelings and messaging habits.

4.3   Pre-Interviews Theme 2: The Role of Sound for the Individual

This study focuses on the role of supplemental sounds within Facebook Messenger, and the pre-interview in this study gave the researcher the opportunity to discuss sounds with the participants. At this stage, most participants were unaware of the multitudes of sounds that the interface offers, but could name one to three main functional sounds, such as the send or received message sounds. All participants said that the majority of their interactions with Facebook Messenger were done with the sound off; participants habitually left their phones on silent or vibrate modes. This theme explores the relationship between the individual and the Facebook Messenger sounds, particularly at this beginning stage of the study, when the participants are perhaps less aware of their habits and interactions with sounds in this interface. This is further explored through conversation habits, as well as environments in which users do, or would, have their sound on to hear audio notifications. The following two subthemes explain this second pre-interview theme further.

4.3.1   Conversation Habits

This relationship between sound and the individual is set up for further detail by contextual elements, such as the individual's conversation habits. This can be broken down into an understanding of how frequent the participants are messaging, and the styles of conversations that they are having. What the researcher labeled as synchronous or asynchronous conversation styles, participants frequently discussed their conversation styles as "active" or "passive." All participants reported that their messaging habits were occurring every day, for several hours, however these were not continuous messaging periods. This question of frequency of use was not limited to specifically Facebook Messenger, but all communication messaging throughout the day. This reflection upon frequency was met with different levels of concern. One participant casually noted that their messaging time equaled a *"couple hours, not continually, yeah"* – P8, while one admitted they were messaging *"pretty much all day. Um, yeah, I'm kind of addicted to that thing."* – P1. However, as to be expected, participants are not spending every moment messaging, and have naturally categorized their habits into more active or passive conversations.

All participants described communication that falls into both synchronous and asynchronous styles, and they each discussed how their instinct to turn sound on or off in respect to this style would change. The general consensus was that sound was more likely to be turned on or paid attention to during synchronous, or as the participants described, active, conversations, whereas sound was more likely to be turned off when the individual was taking part in passive conversations.

4.3.2   Environments for Sound

At this stage in the research, the researcher would describe the participants' awareness of the role of sound in the individual's messaging habits was vague, and was roughly attached to conversation styles, active and passive. However, participants were able to identify distinct environments in which they felt that keeping their sound volume up was appropriate; at home or a public space in which a level of noise was expected. In these environments, the participants were more likely to keep their sound on for their own needs. Many participants cited their home as their space to leave sound on (P1, P2, P3, P4, P5, P7), but also included spaces in which they were alone, like in the car or a private room (P1, P2, P3, P8). This "alone" space could also include when they were wearing headphones, and they are alone in hearing their own sounds

(P4). Participants also named various public spaces, and one participant identifies the caveat to the broad description of a public space by saying, *"it depends more on like, I think the activity within the place rather than the physical context itself. I'd say anywhere like outside, in public where there's a level of noise expected, I see [having sound on] as okay."* – P1. Public spaces in which a level of noise is expected were identified as walking on the street (P1, P7), the gym (P1), certain workplace environments (P2, P4, P7), loud restaurants (P2), waiting in lines (P2), and a friend's house (P5).

Some participants also discussed instances in which they would keep their sound on for their personal benefit despite the environment, usually stemming from an expectation to hear from someone. Participant 5 generally described prioritizing sound by describing keeping sound on, *"if it's like an important situation, if I'm like waiting for a response about something that's kind of important, like I need information about like a date or time of something."* – P5. Participant 6 described more specific scenarios regarding transportation. They said sound was a priority, *"when you're hanging out with people, and, you're like, 'oh, I need to go soon and my ride,'"* and also when the role was reversed, *"if I'm like supposed to be picking people up or something."* – P6. They also added the humorous scenario of when, *"you're on a really sh*tty date and you're like, 'I need to get out.' 'Oh, I'm so sorry, they called me, I've got to go!'"* – P6. The consensus regarding the environments in which participants feel welcome hearing audio notifications being spaces in which they are alone, mostly at home, or in public when their noise will blend into others' noises. In addition, participants will often prioritize sound for notifications that they deem important, regardless of environment. The next theme will explore the role of sound for the public, rather than as it relates specifically to the individual's needs and desires, and describe the participant's feelings toward inappropriate environments to hear sounds, and why they feel this way.

4.4   Pre-Interviews Theme 3: The Role of Sound for the Public

Throughout their frequent messaging, and despite the active or passive style of communication in which they were messaging, if the environment changed to a public or professional setting, sound emitted from their phones was not desired. All participants admitted to constantly having their sound off on their phones – in public, if they wanted an indication of a message, they would most likely turn their phone on vibrate. This theme explores the

relationship between the setting in which sounds are heard, and actually hearing the Facebook Messenger sounds. This is broken down into an understanding of participants' perceptions of inappropriate environments to have sound on, and the social norms that play into these perceptions. The following two subthemes explain this second pre-interview theme further.

4.4.1   Environments to Avoid Sound

As with environments in which participants felt sound was welcome, participants had a few consensual places in which they found sound to be inappropriate. Participants more readily contributed to this conversation, perhaps because it was easier to identify the places in which their sound was off, since that is their most common state of messaging. Participants identified key spaces in which keeping their sound off was most important to them; at work or class, and quieter public spaces. In these spaces, participants reported to be self-conscious about the sounds emitted from their phone. Many participants said it was inappropriate to have their sound on at work or in class (P2, P3, P4, P5, P7, P8), and some discussed public spaces in which the expectation was to be quiet, such as movie theaters (P2), a library (P7), a professional meeting (P8), or a funeral (P7). One participant generalized to spaces that were in public, but were closed spaces (P1). Another common factor was that regardless of the environment, there are some situations in which interactions with other people dictated the inappropriateness to emit sound. For example, several participants mentioned spending time with their friends or significant other (P1, P3, P5). In this sense, the silencing of sounds was more conscious due to the context of their situation.

4.4.2   Context and Social Norms

The reasons for silencing audio notifications can vary due to context, but also due to an expectation to fulfill social norms. For some, the application Facebook Messenger itself has a specific connotation, and therefore the sounds do as well. This connotation varies between participants, for example, one said, *"even if I'm texting someone on a messenger about something and I want to switch domains to like something work related, I'm usually going to switch to Slack."* – P2. In contrast, one participant routinely uses Facebook Messenger at their workplace and said, *"it's like the equivalent to our Slack… there's some business undertones too, you're supposed to reply within like 30 minutes or an hour… If someone 'pings' you at*

work, it's because they need something." – P4. Some participants also categorize their contacts by their messaging apps, and therefore their respective sound notifications. For example, one participant shares, *"I guess because I divided my friends into different applications, so I know what sound is who… So by hearing a specific sound, I'm like, 'oh, [it's] this person.'"* – P4. And another shares that, *"sometimes I will turn off my family notification[s] or my friends' notification[s] because they just come a lot* [*sic*]*"* – P8. These different contexts and connotations frame typical communication strategies that feed into a larger set of social expectations of which the participants partake.

Without specifically naming the idea of social norms, participants described their feelings in relationship to audio notifications in public that alluded to this concept. Generally, the participants cited negative feelings towards hearing audio notifications when they were in the aforementioned public environments. For example, one participant said, *"there were times today where I've come to the office and then my phone's gone off. I'm like, I'm so, not exactly embarrassed, but like, I feel really bad because I've interrupted somebody's workflow, then I worry about it."* – P1. Feelings of guilt or a fear of disruption were echoed by other participants; *"I don't want to bother other people"* – P4, and *"I would say just work is the only [place] where I feel guilty as if I'm bothering somebody, I guess."* – P5. In a similar vein, one participant reflects not only on the impact on others, but also themselves by saying, *"I don't want to disrupt the people around me, but also I don't want to disrupt myself… If I hear that noise pop into my brain and say in the back oh, you have a message, check it."* – P7. In addition to guilt and fear of disruption, words like "courtesy" (P1), "discreet" (P2), "annoy" (P5), and "impolite" (P8) describe a general understanding that sound is not expected in these environments, and that notification sounds may lead to some type of consequence. This complicates the interaction between the user and the Facebook Messenger soundscape.

The next themes will be generated from the snippets and diary entries completed throughout the second phase of data collection.

4.5   Snippets and Diary Entries Theme 1: In-Situ Sound Comprehension

The purpose of the snippets provided by the participants were twofold, one benefit was for the researcher to have some context regarding individuals' habits, and one was for the participants to have small notes of their activities throughout the day to reference during the

diary entry process. Not all participants provided consistent snippets throughout the seven day period, but when they did, the snippets usually focused on content and context of their messaging habits. The purpose of the diary entries was to have structured reflections over a week of normal messaging interactions. Five out of the eight participants completed each day of diary reflection, and three out of the eight participants missed one day of the diary entry respectively. The researcher asked these participants the questions that received no response during the post-interview, in an attempt to understand their perspective on these diary questions. However, since these reflections were no longer within the seven-day diary period, the researcher did not analyze these responses with the other snippets and diary entries, and have recorded and analyzed them with the post-interviews.

The snippets and diary entries included information that can be organized into two themes; this first theme details how participants comprehended hearing audio notifications within their messaging habits. This theme hinges on a baseline awareness of sounds, and the participants' encounters with sounds, and is broken into two subthemes: moments in which participants were aware of sounds, and their interpretation of the purpose of these sounds. These subthemes will be further elaborated upon below.

4.5.1   Awareness of Sounds

Since each participant was given a table of sounds within the app (Table 2) and were walked through a demonstration of the variety of sounds with the researcher, at this stage in the study, an awareness of the existence of sounds within the app was established. Participants moved from this general awareness to an in-situ awareness during the seven-day diary study, and reported different moments in which they heard sounds. Some participants reflected on their routine messaging habits and how sound played a role, and some mentioned situations that were less common in which they noticed sound. For example, Participant 2 said, *"the subtle sounds are not distracting because they're almost like background noise - extra confirmation/feedback that I did an action"* – P2 on Day 6. Also on Day 6, they said, *"I feel like over time using Messenger some of the sounds have gotten more complete or realistic - instead of being a single tone the sounds are more complex."* – P2. Here, Participant 2 has shifted from an awareness that different sounds exist to a more specific awareness of the different tones and complexities of the sounds they are hearing. Participant 3 reflected upon their day-to-day habits by saying, *"I don't*

mind the dings back and forth if you're messaging one or two people; I do like the 'mention' sound when my phone is on because I can click on the specific message intended for me." – P3 on Day 5. This "mention" sound was previously not recognized by the researcher as a feature, and was later added to the table of sounds.

Some participants mentioned unique situations in which sound was noticed, rather than their typical interactions. For example, Participant 1 shared an experience during their commute, saying, *"during my conversation on the bus my internet was pretty poor, so the two separate sounds used to indicate the successful sending and delivering of a message was helpful."* – P1 on Day 3. Participant 4 also shared an experience during their commute, saying of the sounds, *"it ping[ed] over my music which was nice i was in the train so i wasnt looking at my phone [sic]."* – P4 on Day 1. These individual moments may have gone unnoticed if these users were not participating in the study, but their recognition and reflection of the sounds leads into a further discussion into the purpose of these sounds. On the final day of the study, Participant 6 reflected upon hearing sounds from Facebook Messenger over the course of the study, saying, *"starting to not mind hearing the sound of people texting me back because then I know if I should stay in the app."* – P6 on Day 7. This sentiment moves this analysis into an understanding of the purpose of Facebook Messenger sounds, in which the participants were prompted to think about in their final days of diary entries. This is further elaborated upon in the next subtheme.

4.5.2   Purpose of Sounds

Throughout the diary study, participants were asked different questions to prompt reflection regarding the purpose of Facebook Messenger sounds. On Day 5, participants were directly asked the following two questions: What do you think the purpose of different sounds within the interface are? Does your interaction with the app fulfill that purpose mentioned above? Responses varied, but generally aligned with ideas of giving feedback to the user, and possibly for a more interactive experience. For example, one participant said, *"I felt the purpose of the sounds that I noticed in particularly were to offer feedback and confirmation on the successfully delivery of my messages, and the receipt of the ones sent to me as well."* – P1, and also confirmed that for them, the purpose was fulfilled. Another participant said, *"I believe the different sounds are to let you know that you have different notifications in Messenger."* – P3, and also confirmed fulfillment of purpose. Another participant echoed this statement saying that

the purpose is, *"to give the user another cue as to what is happening."* – P5, and also confirmed fulfillment. Participant 8 described feedback as a potential factor of interaction, by saying the purpose is, *"to provide a kind of feedback that make users feel more interesting and interactive to both the app and conversation."* – P8, and stated it was fulfilled for them sometimes. With regards to interactivity and experience, Participant 6 answered that the purpose is, *"to add to your experience using the app. Make the experience more fun and engaging/possibly rewarding,"* but added that it did not fulfill this purpose, saying, *"Nope. Noises are annoying."* – P6. Participant 6 consistently had the most negative reaction to hearing Facebook Messenger sounds throughout the diary entries.

Participants were asked a more broad question regarding purpose again on Day 7, the last day of the study: Why do you think Facebook Messenger includes all of these sounds in their interface? Answers were similar, regarding interactivity and feedback, for example saying that sounds are included, *"to enhance the experience by adding delight, supporting navigation, giving feedback to actions, and show attention to detail."* – P2, and *"to alert you of the different notifications. We might ignore the default dinging when someone is constantly messaging us, but when you hear other sounds that are different and stand out"* – P3. In response to this question, participants discussed their relationship with sound further as another layer of feedback that is not only functional, but also purposefully elicits an emotional reaction. The next theme will discuss these emotional reactions in greater detail.

4.6   Snippets and Diary Entries Theme 2: In-Situ Sound Reactions

Throughout the diary entry process, participants recorded different emotional responses to hearing sounds from Facebook Messenger. Some responses were positive, some negative; some discussed feelings overall, and some pinpointed specific sounds eliciting a response. This theme explores the different reactions to hearing the Facebook Messenger sounds, as they occurred in-situ throughout the diary study. It is dissected into two subthemes that further explain these reactions; the first is simply recorded emotional responses from the participants, and the second involves how these feelings play into social expectations.

4.6.1   Emotional Responses

Throughout each day of the diary study, participants were asked to note their messaging frequency, their frequented environments, if they were aware of sounds from Facebook Messenger, context, and if there were any messaging moments that stood out to them. In addition, each diary entry concluded with a question asking the participants to reflect on their daily interactions. All of these prompts provided opportunities for the participants to simply write about their experiences, and enabled them to describe their feelings towards sounds specifically or generally. Common words to describe their emotional responses to sound included describing sounds as "annoying," (P2, P3, P6, P8) "distracting," (P2, P3, P6) "surprising," (P2, P8) and "jarring" (P1). Although the most common descriptors bear a negative connotation, participants used positive adjectives as well, including "delightful," (P2) "fun/calm," (P3) "pleasing," (P5) and "enjoying" (P8). On Day 6 of the diary study, Participant 2 summarized their emotional responses as follows,

> *"at some times I feel surprise at the new notification sound if I don't remember my ringer or volume is on, sometimes when there is the new notification sound repeated messages in quick succession the sound can be a little annoying; I find the read sound to be a helpful indicator as I'm not paying attention usually. I find delight in the sticker sounds - it makes the interaction feel almost more whole. Otherwise, I generally feel neutral towards other sounds."*
> – P2.

Another participant described their broad feelings in response to the sounds as, *"they are pleasing to me and usually make my head tingle; sometimes like ASMR."* – P5. Beyond the general descriptors of hearing sounds, some participants shared how their feelings motivated them to take action. For example, one participant said they feel, *"irritation cuz i [sic] want to [be] lazy and sound is [telling] me to go back to work."* – P4. Another example is that sound, *"makes you want to check those notifications to see if there was anything big or new that you missed"* – P3. One participant reflected on their experience on Day 6, and described their interaction habits and corresponding responses in line with the conversation styles previously discussed in Pre-Interview Theme 2, Subtheme 4.3.1: Conversation Habits. They described hearing sound negatively in reference to asynchronous conversations by saying, *"I feel nervous*

and annoyed if I keep hearing notification sounds when I am not in that conversation," and described hearing sound more positively in reference to synchronous conversations by saying, *"when I am in a conversation, I feel positive with the sounds when I am typing and send messages, or someone is typing or send messages."* – P8. These emotional responses are varied across context and environment, and helped the researcher understand users' habits as they occur in day-to-day use. In addition to emotional responses across habits in general, the researcher asked the participants to reflect on their motivations for keeping their sound off in the presence of other people, in line with Pre-Interview Theme 3: The Role of Sound for the Public, which will be explored in the next subtheme.

4.6.2   Social Expectations

As the researcher and the participants explored more about the role of sounds from Facebook Messenger in different environments, the participants reflected upon their motivations to turn their sound off in public, and what social expectations they were ascribing to in these situations. The resounding answer was the fear of bothering other people, with one participant saying that the motivation was, *"definitely not wanting to disturb other people, my office is quite quiet and I feel bad if a jarring noise disrupts other people working."* – P1. Another participant agreed, saying, *"its [sic] impolite to have it loud because it could be distracting for others."* – P6. Impoliteness was a common thread not only if referencing a more public area, but also contextually; Participant 2 said, *"my motivations usually are contextual - whether there are people around, what environment I'm in, how loud it is in the space, whether I have headphones on, what device I am using."* – P2. Two participants mentioned ignoring the social expectation to keep their phone sound low if they were expecting important information; *"Sometimes when I'm in public, I turn my [phone] off because I don't want to be distracted or rude when talking to people. However, sometimes I keep my phone at loud volume so I can hear the messages in a noisy public environment. I usually keep the sound on when I expect important messages."* – P3, and *"if I turn off or turn down the sound, it is because I want to be polite and not to disturb other people; or make myself not too focus on the messages and use the phone too often [sic]. If I turn up the sound, it is because I want to get the feedback from others and reply [to] them immediately."* – P8. Reactions to sound change in different contexts and environments, but also

with the user's personal preferences for the sound tones themselves and timing of the notification sounds.

The next themes will be generated from the post-interviews completed in the third phase of data collection.

4.7   Post-Interviews Theme 1: Reflection on Messaging Interactions

The purpose of the post-interviews was partially to check back in with the participants after the diary study in order to clarify or elaborate on any information given in the snippets and diary entries. It was also a chance for the researcher to ask questions prompting the participants to reflect further upon their experience during the diary study, and their overall feelings regarding sound and Facebook Messenger. The post-interviews have resulted in two themes.

This first theme from the post-interview results describes the participants' overall reflection on Facebook Messenger and their interactions during messaging over the course of the study. This is elaborated upon in regards to their messaging habits, and how their perspective on their messaging habits may have changed looking back on their understanding from before the study. It also charts the participants' feelings towards sound and the app in general, in different contexts and environments. The following two subthemes explain this first theme further.

4.7.1   Messaging Habits

In the post-interview, the participants were first asked: Are there any behaviors that you can reflect upon that you were unaware of before the diary entry process? The researcher shared some examples that could help prompt the participants in an attempt to build rapport. Overall, participants seemed surprised that they did have behaviors that they were unaware of that they discovered during the diary entry process, mostly related to message frequency, or sound awareness. For example, Participant 7 was under the impression that they used messenger more frequently, saying, *"I realized that I use [Facebook Messenger] a lot less than I thought initially. And so that was kind of surprising."* – P7. Participant 6 echoed this same sentiment. In regards to sound, some cited that they thought they used sound more (P1, P2), and Participant 4 expressed the opposite, *"I didn't realize how much I actually used the sound."* – P4. Most participants reflected on their habits with audio notifications as a relationship between hearing sounds and their phone use. One participant said, *"I would keep the sound on, so kind of used as a tactic to*

not continually go to the phone. It's like, only go when like a hear of the sound, so I know there is something to be reacted to." – P1. One participant reflected on a specific situation over the course of the diary study, saying,

> *"I always like will turn my sound on when I'm doing something else that's away from my phone, but I'm having conversations with someone. So like one day I was getting ready to go out until I was doing my makeup at the mirror, but my phone was charging on the bed playing music. So that's when I turned the sound on because I was like, if somebody messages me, I would like to like know and be able to check it. But if I was like getting ready with my phone next to me, I wouldn't have the sound on."* – P7.

Other instances included hearing audio notifications from their phone while watching TV (P2), and hearing audio notifications from hyperactive group chat during work hours (P3). These situations may seem fairly obvious examples of sound interaction, but participants were unaware of their habits until this post-interview stage. A reflection on their habits creates the foundation for further exploration of emotional responses to these sounds during these habits, and across different contexts and environments in which they are messaging. Emotional responses are explored further in the next subtheme.

4.7.2   Emotional Responses

Emotional responses to hearing sounds varied for each participant, and varied as individuals changed contexts and environments during communication, as it was reported during the diary study portion of the study. Emotional responses ranged across the full spectrum, from feelings of irritation and anxiety to enjoyment and excitement. The most common feelings expressed were negative; participants described feelings like "panic," (P1) "anxiety," (P1) "jarring," (P1, P6) "annoying," (P2, P3, P5, P8) "overwhelming," (P4) "stressful," (P6) and "nervous" (P8). But there were also positive feelings describing sound as "enjoyable," (P2, P5) "fun," (P2) "exciting," (P3) "sparking joy," (P5) "happy," (P7), "satisfying" (P7). Some participants aligned more with either positive or negative overall, but most described a relationship with both.

The feeling can depend on the context of the user's state of mind; one participant explained, *"I would say it either causes me anxiety if I don't feel like talking to anybody or it like sparks joy in my head, or whatever, if it's a, if it's like somebody that I'm like excited to talk to or that I'm like waiting to hear back from. So that's like a little bit state dependent."* – P7. In addition, it can depend on the context of the messaging interaction; one participant explained, *"the only time I really feel like annoyance with messenger is… my friends have a habit of sending short messages like one after another. So if I have my ringer on and they start doing that, it's just like sound, sound, sound, sound, sound, and really quickly and that can get a little bit annoying at times."* – P2. In fact, this context of other people messaging short messages in succession was the most cited reason for negative feelings, Participants 1, 2, 3, 4, 5, and 8 all mentioned this contextual factor, generally describing it as "annoying." In that same scenario, Participant 4 specifically mentioned that their feelings were contingent on the time of day; *"in the morning it's kind of negative. I hate Facebook in the morning… 'Why are you messaging me?' I don't want this right now, since I am not a morning person, if I get a lot in a single unit."* – P4. Negative feelings were also most mentioned when discussing hearing sounds in a public environment, similar to the results in both the pre-interviews and the diary study; *"I kind of panic when it goes off in a public place, like in a really quiet public place. I get a sense of like 'ahh!'"* – P1. Beyond the audio notification received by participants to notify them of a new message, descriptions of sounds within the app were mixed between negative and positive.

The distinction from an out-of-app new message sound is that the sounds within the app are much more supplemental. For example, one participant thought the sounds were extraneous, saying, *"[sounds] actually just made everything so much more stressful and less enjoyable because I'd be like, 'well, I want to send a sticker' and then I would send to sticker around and it'd be like, 'blulululuh' and I'm like, 'Ahh! I don't want this.'"* – P6. Other participants were drawn to the supplemental sounds as a positive feature, with one participant identifying, *"the 'like button' one, it's so fun to hear. I never get tired of it… yeah the Chat Emoji? Like how it expands? So fun."* – P2. One participant reflects on another positive experience by saying, *"I would say like excitement and also like happy. So like the excitement is just like, you can hear the other person like typing and so you're anticipating their response, what they're going to say, and then the happy part comes from like sticker sending that 'pop.' It's kind of satisfying actually."* – P7. One participant also expressed that they may not have a strong emotional response to a

sound, but it confirms the functionality they expected, saying, *"I'm a lot more confident about my messages like going through, or having received things, or even them like being delivered."* – P5. Whether or not it is a strong reaction in the moment, or an overall feeling upon reflection, once aware of the supplemental sounds, participants had an opinion.

In addition, in reflection back on the study, participants not only mentioned sounds they heard, but also discussed emotional responses to not hearing the sounds that they had come to expect. For example, one participant discussed the back-to-back send and delivered sounds by saying, *"when you're used to hearing that second sound, when you don't hear it… I wouldn't say it's like, it's like an anxiety but it's like, 'right what's wrong?'"* – P1. Another participant felt the similarly, saying, *"I think there [were] a couple of days, that I kind of even missed the sound because, like I said, my phone's on silent all day, so you kind of feel ignored because you're not really hearing your phone ring."* – P3. Another participant echoed the feeling of being ignored when they didn't hear sounds, by mimicking their dejected feelings saying, *"I'm like, 'oh nobody texted me and I know that... oh.'"* – P6. Participant 5 summarized the overall understanding of their emotional responses to audio notifications at a high level, and how they relate to using Facebook Messenger specifically. They said, *"emotionally it feels a little bit more isolated or not, not like isolating, but like a little bit less like an actual form of communication. I mean I like Messenger more than texting because messenger is more expressive."* – P5. This is a stepping stone for understanding sound as a design element, which will be further discussed in the next theme.

This subtheme described a higher-level understanding of participants' emotional responses to hearing audio notifications from Facebook Messenger; the following theme will provide results that frame sound as a design element, and be more specific regarding emotional responses towards individual sounds. In addition, it will elaborate upon the idea regarding sound as a method to engage interactivity or immersion within a conversation, as it was only briefly mentioned in this section.

4.8 Post-Interviews Theme 2: Sound as a Design Element

This theme focuses on audio notifications and how participants interpreted it as a design element. This includes their interpretation of the functionality of Facebook Messenger, and how sounds play a role in that, their identification of specific sounds and their corresponding

importance, as well as how functionality and sound identification come together in creating the overall app usage experience. This theme will be broken into three subthemes to further elaborate: Facebook Messenger functionality, sound identification, and using the app.

4.8.1   Facebook Messenger Functionality

As discussed in the pre-interviews, participants use Facebook Messenger in part for its functionality and interface. This subtheme explores how participants discussed audio notifications as a part of that functionality. Some participants discussed supplemental sounds in Facebook Messenger as additional feedback to their actions (P1, P2, P4). Participant 2 said, *"when I'm messaging someone, like the focus is on the conversation, and a lot of those sounds like just kind of help supplement the navigation. Like it notifies me that I've clicked on something. So it's extra feedback, more than just with the color changing."* – P2. More specifically, participants were looking for confirmation that their messages were being sent or delivered. Participant 1 outlines a scenario in which they relied on sound for this confirmation, saying,

> *"when my internet was poor, I was looking more to see if my messages had actually been delivered... So it was useful for me to know that initial like sending has taken place but then the deliverance is confirmation that I can like leave the app, and not have to like return to make sure the message is sent, if that makes sense."* – P1.

Beyond feedback and confirmation of actions taken, there was some hedonistic reflections upon the functionality of sound during messaging. Participant 7 explained a conversation, saying, *"I think it's just kind of cool when I'm having a light conversation with a friend and like we send stickers and it'll be like, like that sound will come up, the 'pop' sound. And so like having it go like back and forth… five minutes where we were just like joking around."* – P7. Most participants gave input on how they would prefer to have more enjoyment from the sounds in the app. They gave functional examples, like, *"I would maybe make the sounds for, for delivered and sent, I would want it, I would maybe want to delay a tiny delay, even if it's just to separate the two."* – P1. Participant 4 described a feature they would like that would attach different sounds to different people, saying, *"what the [notification] does is makes me like turn to my phone and sometimes I see the name, but I wonder if like, if I can take away that interaction and*

just be like, 'oh, it's this type of thing,'" – P4, eliminating the need to look at their phone to mentally register who they were getting a message from. Two participants who often used stickers thought along the same lines for improving interactivity even more, with one saying*, "if I were to send like a more sad sticker, like there'd be some sort of like sound that'd be like, 'hmm,'"* – P7, mimicking a sound with a tone that gradually slid lower, evoking a deflated mental image. Participant 8 also wanted more interactive stickers, saying, *"[the] sticker has the sounds right. I can see their, I can hear the styles and see the stickers move. I think, yeah, I can feel that 'oh, they are, they are in that way.' Like a sticker… represents their emotion or the action behavior."* – P8. Within this functionality, participants could identify multiple distinct sounds, which will be further discussed in the next subtheme.

4.8.2   Identifying Sounds

Facebook Messenger has many audio notifications, whether that is out-of-app alerts that a user has a new message, or an in-app supplemental sound that corresponds to an action. Throughout the course of the study, the participants identified new sounds that were unknown to the researcher, and were later added to the sound identification chart (Table 2). Some of these sounds included the "name mention sound" which occurs when a user types "@" followed by a person's name, and the "emoji reaction sound" which refers to the option for users to react to a specific message by choosing different emojis. When asked to discuss which sounds stood out to them the most during this study, participants cited the "notification sound," (P2, P4, P6, P7) referring to the out-of-app alert of a new message, the "sent" and "received" sounds (P1, P5), "typing anticipation bubble," (P1, P6, P8) the "name mention sound," (P3) the "emoji reaction sound," (P3, P5) the "hearts sound," (P5, P6) and the "sticker sound" (P6, P7). Other sounds were either not noticed, or went unused by the participants.

4.8.3   Using the App

Throughout the post-interview, participants were asked to reflect on their week overall, specific sounds that stood out to them, and also how they would redesign sound functionality, all shown in the subthemes above. In addition, throughout this interview, many participants shared their thoughts on their relationship to the app overall, and how sound played a role in their app usage. For example, one participant said,

> *"I feel a lot of the sound interaction, at least for me, is subconscious and I use*
> *them. And this week made me reflect that they are valuable because they do*
> *notify me and I know when to like open a tab or like get my phone right away.*
> *Or did they make me look at my phone, look at the message and be like, 'Nah,*
> *I'll reply later.'"* – P4.

However the general consensus was that participants were either compelled to return to the app, or to stay within the app longer. One participant expressed this by saying, *"when I receive messages, you know, [it is] kind of drawing me to use the app."* – P1. Another said, *"maybe it's knowing somebody is typing… and I can just wait for [their message]. I don't need to turn off the app and do other things."* – P8. Some participants viewed this through the lens of a more positive, immersive experience, while some viewed it as a tactic by Facebook to be invested in their product. Examples of this sound as an immersive quality are as follows, *"I think it will make me feel, the stickers or the system, the app I use is very interesting to me* [*sic*]. *So I may want to try some different stickers to know their sounds."* – P8, and *"I guess it grabs my attention more and like engages me in the conversation whereas if the sound is off and I like, I'm in class, I'm sitting somewhere quiet and talking to a friend. Like it's less engaging, I feel kind of distant from the conversation."* – P7, and

> *"I think that just using it on silent can be a much less immersive experience.*
> *Like when I have sound on, and I'm not only hearing it- the messenger sounds,*
> *but like my keyboard click clacking, which I also like love the sound of. And*
> *then I'm like hearing these, like to me they read positive, like these like notes*
> *that come out of my phone when people send me messages and stuff. It just*
> *makes it like a more active experience and it almost feels more social to me for*
> *some reason."* – P5.

However, not all participants feel the same way; for example, one participant said,

> *"whenever I hear sounds or like any notifications for my phone, I'm like, 'oh, I*
> *have to respond.' Like, 'oh, I have to check it' so that I'm immediately on my*
> *phone again. So I feel like I have a lot less control over like what I can look at.*
> *But the sound like brings me back immediately to the app."* – P6.

Another participant expanded upon why users might feel this way by saying,

> *"I kind of likened to in my head, to when companies like Instagram and*
> *Facebook use color to trigger like a certain chemical reaction in the brain, I*
> *imagine that like the sounds were selected to provoke similar reactions. Um,*
> *but then again, I don't know if that just comes with connecting, interaction with*
> *other people to sounds." – P1.*

Another participant agreed with the sentiments of the above statement, further explaining their perspective by saying,

> *"[Facebook Messenger sound] kind of reminds me of how like animation is*
> *used. So like a lot of people will see animation as something like frivolous, but*
> *like, it's really not; animation can be used as a supporting tool that really*
> *guides a user throughout an application. It builds that understanding and like*
> *the skeuomorphism into the subtle ways in the application that's not*
> *distracting." – P2.*

Whether or not they felt that their interaction with the app was instigated from their own desire to use it, or Facebook facilitating their app usage, all participants mentioned sound as a supplemental element that encouraged them to look at a new message (P1, P2, P3, P4, P6), interact with a message (P4, P5, P7, P8), wait for a response in-app (P6, P8), or feel confident that their action within the app worked (P1, P2).

4.9   Chapter Summary

In this chapter, the results of the study were described through sampling details and themes from each phase of the study that resulted from the data. The pre-interview themes were: choosing to use Facebook Messenger, the role of sound for the individual, and the role of sound for the public. The snippets and diary entry themes were: in-situ sound comprehension and in-situ sound reactions. The post-interview themes were: reflection on messaging interactions and sound as a design element. The following chapter provides a discussion of the results. The themes that were presented across each phase of data collection gave an overview of participants' messaging habits and reactions that built up an understanding of how audio

notifications within a messaging experience are perceived. The role of these sounds, and the reactions they provoke in users across different contexts and environments shape the broader understanding of the role of audio notifications as a UX design element. The following chapter provides a discussion of the results.

CHAPTER 5.   DISCUSSION

This research was conducted with the goal to gain insights on Facebook Messenger users' interactions with audio notifications as a supplemental design element within a messaging interface, in order to further discover the role of sound in UX design, and how these user perspectives about audio can be used to potentially improve visual interface designs in the future, or supplement future research. The purpose of this chapter is to summarize all aspects of this study, and reiterate points to extract from the results. This section builds on the themes from each phase of data collection, including the pre-interviews, the diary study, and the post-interviews in greater detail. It also highlights takeaways from the perspective of the researcher, and establishes the significance of this works' contribution. A list of design considerations built from these themes will be discussed with respect to their impact for both researchers and industry professionals, and have been separated into broad design considerations and design considerations for a mobile messaging experience. The purpose of these considerations is to create a reference for future research on audio notifications, as well as when designing with supplemental sounds and audio notifications in future messaging systems, or potentially beyond the communication space. This chapter provides an outline of the discussion of the results, design considerations, and a discussion regarding this study's connection to previous literature.

5.1   Broad Design Considerations

From the data collected in this study, several themes were generated in which users' perspectives align with more general design considerations. These design considerations provide reflections on more general user experiences from this study, and may be of use for future research in this area.

5.1.1   Design Consideration 1: Functionality Support

Consider sound in a supplemental role to support functionality of an interface, rather than sound as the primary design element. Sound can be used to provide additional feedback, alerts, or general supplemental sounds as interactions take place. For example, when designing an app interface, sounds may be added as a final layer to the functionality.

This design consideration was formulated from a pre-interview theme that aligns with standard design values of functionality and ease of use. In this study, participants were already regular Facebook Messenger users, and participants discussed why they perceived Facebook Messenger to have a beneficial interface in Pre-Interview Theme 1: Choosing to Use Facebook Messenger. Using Facebook Messenger regularly, instead of other communication apps, is a choice made by users, and why they choose to do so is an important factor to explore as the foundation of their interactions. In this study, the role of Facebook Messenger as a primary communication app varied across all participants, with some using it to supplement SMS texting, and some who exclusively used Facebook Messenger. What is important, regardless if Facebook Messenger is their dominant app for communication, are the reasons they choose to use Facebook Messenger over other apps. A common reason includes the ease of transition from using it in the Facebook interface to its own, as well as the opportunity to have broad connections through Facebook. Other reasons focus on functionality, specifically it's interface design, with opinions like, *"it's not overwhelming"* – P3 to the more specific, *"I prefer messenger because then I can send stickers"* – P6. Users valued ease; ease of connection to people and ease of use in the interface.

This design consideration was also developed from the results of Snippets and Diary Entries Theme 1: In-Situ Sound Comprehension. During the diary entry portion of the study, participants were more aware of the sounds they were hearing while using Facebook Messenger, as opposed to the pre-interview phase. Here, participants discussed their interactions with sound daily, sometimes sharing general observances, *"the subtle sounds are not distracting because they're almost like background noise - extra confirmation/feedback that I did an action"* – P2 on Day 6, sometimes discussing more specific sounds, *"I don't mind the dings back and forth if you're messaging one or two people; I do like the 'mention' sound when my phone is on because I can click on the specific message intended for me."* – P3 on Day 5. This elevated awareness allowed participants to hypothesize about the purpose of these notification sounds, and the general consensus was that their purpose is to give feedback and provide a more interactive experience. The researcher agrees with this perspective; sound as a design element can add functionality to the interface in which users don't have to see in order to understand the actions being taken, but Facebook Messenger also has many sounds that do not seem to have a functional purpose. These sounds, such as the 'emoji react sound,' or the 'sticker send sound,' give a degree of feedback as

the user hears a sound when the action is sent, but Facebook assigns them different tones, which in the researcher's perspective, seems much more experiential. Participants also discussed this duality between function and sounds that seem more likely to elicit an emotional reaction.

This was also brought up by participants in Post-Interview Theme 2: Sound as a Design Element; as discussed in the previous phases of data collection and analysis, participants place importance on the functionality of Facebook Messenger. Within this functionality, sound is viewed as additional feedback and a factor to improve interactivity and supplement conversation. Feedback is helpful to confirm basic interactions, like sending and delivering a message, as well as receiving a new message, and even more useful as an isolated element when the user is not looking at their screen. However, sound does not have to be fully functional; some participants discussed their responses to hedonic aspects of sound design, previous examples include Participant 2's joy when using the "customizable emoji sound" and Participant 5's enjoyment of the ASMR-type feeling when listening to the sounds in their headphones. Participant 7 said, *"I think it's just kind of cool when I'm having a light conversation with a friend and like we send stickers and it'll be like, like that sound will come up, the 'pop' sound. And so like having it go like back and forth… five minutes where we were just like joking around."* – P7

5.1.2   Design Consideration 2: User Control

Consider the users' agency and ability to control the volume and use of sound. For example, when designing a new alert message, the user may want the option to change the volume, or turn off, the sound of the new alert message.

In this study, the idea of user control is most relevant as it relates to the contexts and environments in which participants are hearing sounds, as is further elaborated on in Pre-Interview Theme 2: The Role of Sound for the Individual. Participants identified that their conversation habits aligned with passive and active communication styles, which the researcher refers to as asynchronous and synchronous communication. Sound plays a role in both of these styles of communication, most likely as an alert system for passive conversations, or an experiential feature in active conversations. Participants discussed sound in passive conversations with more neutral feelings, which changed to negative feelings if the user was receiving rapid notifications from Facebook Messenger. Active conversations were described more positively, potentially due to the participants' direct involvement and motivation to

continue a conversation of interest, but supplemental sounds were described as helpful in these situations as well. *"If I'm like actively having a conversation with my partner, I'll probably leave sound on just so I like know when he responds."* – P5.

Sound was also discussed across different contexts and environments, with a focus on how participants relate to audio without the influence of others' judgement of sound emitted from their phones. Most participants felt comfortable leaving their sound on when they were alone, with the most common environment being their home, and another being a car or a private room. In these spaces, any sounds from Facebook Messenger only impacted themselves, so they were more likely to leave it on. Another environment that most participants felt comfortable leaving sound on was in public where a level of noise was expected, again, an environment in which users could employ sound without fear of judgment, or fear of a reaction, from others. However, participants discussed that if the message was urgent enough, they would prioritize hearing a notification sound despite their environment. In conclusion, sound is used mostly when there is low risk of it being heard by other people, except in the case of an important message, in which users prioritize their ability to hear sound above their surroundings.

In addition, from Pre-Interview Theme 3: The Role of Sound for the Public, participants discussed their tendencies to ignore the sound aspect of the design, mitigating any negative responses others may have to sound by controlling it's volume. Participants routinely kept sound on their phones turned off, and did not want to hear sounds from Facebook Messenger in different environments, with the most common environment being work or class. Instead of a helpful sound to engage them in their messages, participants felt it was inappropriate, and made them self-conscious. Reasons for these feelings include social expectations to remain quiet, and generally revolved around a fear of disturbing others in the area. *"I don't want to bother other people."* – P4. In these cases, participants reported wearing headphones to hear sound, or turn it off to avoid impacting people around them.

5.2   Specific Design Considerations

In addition to more general design considerations, this study includes themes generated from data collection that align with more specific design considerations as they apply to a mobile messaging space. These design considerations provide insight on more specific audio user

experiences from communication on Facebook Messenger, and may be of use when designing similar messaging apps.

5.2.1 Design Consideration 3: Sound Experience

Consider the changing role of sounds in different experiences. For example, when a user is receiving multiple messages in succession, it may be beneficial to elicit one sound instead of multiple. Users may be unaware of their responses to sounds in an overall experience.

The post-interview established that most participants were unaware of certain messaging behaviors before the diary study, especially when gauging their frequency of use and their awareness of sounds. This design consideration comes from Post-Interview Theme 1: Reflection on Messaging Interactions. The participants' relationships to sounds varied, some thought they were more involved with audio notifications, while one participant said, *"I didn't realize how much I actually used the sound."* – P4. Many participants shared their interactions with sound as a way to physically be away from their phone, but still be able to hear notifications. In this case, sound is not blended with visual cues, and exists more as its own design element of the interface. These conclusions about their messaging habits are far from revolutionary; they exist as expected typical use cases of phones in general, but participants were unaware of these habits until the reflection stage of the research.

Beyond a new awareness of their messaging habits and relationship to sounds, they reflected upon their experience regarding sounds as well. This differs from the emotional responses discussed in-situ during the diary study, because at this stage, participants reflected upon their generalized responses and hypothesize as to why they feel this way. The most "annoying" use case was the scenario in which the participant received multiple messages in quick succession; regardless of the context or environment, their natural instinct was to turn off sound. Although reactions to specific sounds varied, negative feelings were attached to sounds that were considered too loud, or the tone to be too "jarring," not matching the purpose of the action made. Participant 1 expressed this in regards to the "message anticipation sound," which in their opinion, was too loud, and the volume and tone of the sound gave an importance to the sound that they felt undeserved and unnecessary. Participant 6 didn't necessarily dislike the sounds, but rather wished they were more subtle. This information regarding participant awareness and

emotional reaction to the sounds sets up an understanding of sound as a design element, and how it relates to functionality.

5.2.2 Design Consideration 4: Emotional Response

Consider that sounds may elicit an emotional response from the user, potentially both positive and negative depending on the context of the message, or social expectations. When designing for a communication context, including a feature like sound muting during typical work hours may mitigate a user's negative emotional response.

This design consideration was formulated based on Snippets and Diary Entries Theme 2: In-Situ Sound Reactions, as participants discussed their emotional responses to sounds within their daily habits. Emotional responses to audio notifications varied, which was expected by the researcher; with the multiple sound options, and changing contexts and environments the participants communicated in, a change in emotional responses to different sounds aligns. Negative descriptors were more prevalent than positive descriptors; sounds were described as sounds as "annoying," (P2, P3, P6, P8) "distracting," (P2, P3, P6) "surprising," (P2, P8) and "jarring," (P1) but also "delightful," (P2) "fun/calm," (P3) "pleasing," (P5) and "enjoying" (P8). Emotional responses were reported to change based on the frequency of messages (and their corresponding sounds), and the connotation of the message, for example feeling, *"irritation cuz i [sic] want to [be] lazy and sound is [telling] me to go back to work."* – P4. However, sounds were also discussed positively, for example, *"they are pleasing to me and usually make my head tingle; sometimes like ASMR."* – P5. From the researcher's perspective, it is unlikely that adding or removing sound from message notifications can change annoyance or stress as it is connected to the annoyance or stress of receiving a message in general; if the participant is already not in the space in which they are welcoming a message, they will most likely not enjoy the sound attached to this action. However, the tone of the sounds themselves may be able to limit a negative reaction, if they are more subtle.

Their reactions to audio notifications were also contingent on social expectations to remain quiet in public, as previously discussed. However, in this section, they were reacting to these sounds in real-time, rather than hypothesizing during the pre-interview stage. Negative reactions are more likely to occur when audio from their phone has the chance to interrupt someone else's focus, and the fear of others' judgement if it does.

5.2.3   Design Consideration 5: Customization

Consider customizable audio options in which the user can choose their preferred experience. In communication apps, users may want to hear sounds from multiple people in which they are messaging, or just one; the option of customization may impact experience.

This was brought up by participants in Post-Interview Theme 2: Sound as a Design Element. Participants were asked to imagine their ideal design of Facebook Messenger, and their responses focused on the ability to manipulate their experiences with sound. One participant mentioned a delay between the sending and delivering sounds (P1), and two participants (P4, P5) desired a way to associate different sounds to different people, like a customizable ringtone. Two participants (P7, P8) also wanted tones of sounds to match the emotional content of stickers they sent, which could be further transferred to the "emoji reaction sound" which is a standard "pop" no matter which emoji (a face with heart eyes, a laughing face, a crying face, a thumbs up, a thumbs down, etc.) is selected.

5.2.4   Design Consideration 6: Communication Immersion

Consider sound as a tool for immersion within a conversation and interface. For example, sounds could align with the connotation of a message's content within a communication app. This may mimic a person's subtle language cues that are not well translated across a screen, and further immerse a user in the interface.

During the post-interview stage of the study, participants could identify specific sounds throughout their experience, and their opinions of them. These specific sounds give insight into what sounds potentially impact interactivity and immersion within a messaging interface, and are developed through Post-Interview Theme 2: Sound as a Design Element. There were a few sounds that the participants considered the most important as they messaged back and forth; the most popular being the "notification sound," (P2, P4, P6, P7) referring to the out-of-app alert of a new message, the "sent" and "received" sounds (P1, P5), "typing anticipation bubble," (P1, P6, P8). These sounds are more functional in their design, and although many participants could identify experiential supplemental sounds, they did not name them as the most important to their experience. There were many sounds within the interface that the participants did not mention, whether that was due to not using those functions of the app, or the sounds going unnoticed, it is unclear. Even if participants enjoyed the sounds, they acknowledged that they were not

completely necessary, one participant said, *"I think the notifications [are the most important], more than anything, because I can definitely like, interact without the sticker sound."* – P7.

In addition, participants generally agreed that sounds were a factor in their usage of the app, whether it was prompting them to return to Facebook Messenger with an alert of a new message, or it was hearing something that encouraged them to stay within the app. *"When I receive messages, you know, [it is] kind of drawing me to use the app."* – P1, or *"maybe it's knowing somebody is typing… and I can just wait for [their message]. I don't need to turn off the app and do other things."* – P8. This factor encourages interactivity and immersion within Facebook Messenger, perhaps more so than standard SMS texting, and perhaps more so than when using Facebook Messenger with the sound turned off. Some participants viewed this as a positive feature, "*it just makes it like a more active experience and it almost feels more social to me for some reason."* – P5, whereas some felt negatively, *"I feel like I have a lot less control over like what I can look at. But the sound like brings me back immediately to the app."* – P6. Whether or not participants enjoyed this relationship, sound can be used as a design tool to keep users invested in an interface. This is powerful when tech companies like Facebook want users to continue using their product, and want users to keep their eyes on their product for as long as they can. However, users may not have the same goals; in this case, the sound design should be limited to minimize interaction and immersion.

5.3   Significance and Connection to Literature

As discussed in the literature review, audio applications to technology have been researched since early GUIs and computer interfaces. Historically, audio has been explored in contexts of information presentation and cognitive load (Bly,1982; Brown, Newsome, & Glinert,1989), as well as usability and instruction (Nyshadham, 1998; Koroghlanian & Sullivan, 2000; Carter, 2012). Within the last 20 years, audio has been explored as more of an experiential element in gaming and complex technologies (Nacke, Grimshaw, & Lindley, 2010; Ren et. al, 2018; Vazquez-Alvarez et. al, 2012). This study focused on audio notifications as they exist within the Facebook Messenger mobile app, fitting within this larger discussion of audio as it applies to an experience, rather than its' more traditional practical qualities. This research also frames audio notifications as a part of user experience, rather than usability, focusing on hedonistic values that apply to messaging specifically (van der Heijden, 2004; Zhou & Lou,

2011). This research frames audio notifications through the users' perceptions of their mobile phone habits in relationship to sound as well as their emotional responses to sounds in Facebook Messenger. These perceptions and emotional responses add another layer to the research done in regards to audio within interfaces, by including a user experience perspective.

It also provides a perspective regarding mobile interfaces. Mobile interfaces include specific characteristics as a technology, but also afford a specific user type. Mobile users can be distracted from their devices, but also have consistent opportunities to be reached by other people (Ballard, 2007). This specific use case creates opportunities for sound design, because users can experience sounds in asynchronous and synchronous communication styles. Mobile devices also provide a range of contexts and environments in which the user is situated, that impacts their perceptions and emotional responses to sound. Mobility as a concept diverts from a more static interaction between technology and human, and includes a more fluid, changing experience. This study capitalizes on this aspect by not only interviewing users about their habits and emotional responses to sound, but by also attempting to discover their perceived feelings in-situ through the daily diary study responses. This research aims to build upon audio notification research by offering a user's perspective and diving deeper into a hedonistic user experience through mobile communication on Facebook Messenger.

5.4   Chapter Summary

Overall, interfaces, especially within a communication space, can use sounds as design elements to provide additional functionality and enhance the user experience. Sound design vary across interfaces, and can potentially be guided with the input of users across multiple contexts and environments, as their reactions to sounds will inevitably change according to their use cases. Even if perceived negatively, sounds may draw users to an interface, and this factor should be considered carefully when designing – who is benefitting most from these sounds? The different implementation of sounds can potentially answer this question in many ways. This chapter discussed how design considerations were built off of the themes generated from all three phases of data collection, as well as this study's significance and relationship to previous literature. The next section will conclude the documentation.

CHAPTER 6.   CONCLUSION

This chapter provides a conclusion to the research study, beginning with a recognition of the limitations of the study, and ending with a discussion of future work.

6.1   Limitations

This study involved two data collection methods, interviews and a daily diary study for one week. These methods provided valuable insights into user's relationship with audio notifications in a mobile messaging experience. However, the researcher acknowledges limitations that exist within this study. The first limitation is the time frame of the study; the researcher's initial plan was to conduct a two-week diary study with each participant, in addition to pre- and post-interviews, however the data collection time was limited and the diary study was changed to one week. The timeframe to collect, analyze, and report on the data was also limited to a few weeks.

Second, the study relies on the participation of users, and their willingness to share their opinions and habits regarding Facebook Messenger use. The researcher attempted to lower the barrier to entry of the study by conducting interviews with participants remotely, to use Facebook Messenger as the method of collecting snippets and introducing diary entries, as well as adjusting the schedule of reminders through Facebook Messenger to reflect different time zones. However, some participants did not provide snippets of their daily experiences, and a few participants did not complete every diary entry.

6.2   Future Work

This research studied users' Facebook Messenger habits and their relationship to audio notifications and supplemental sounds within the interface. Despite encouragement from industry professionals, there is a lack of resources to understand how to effectively use sound as a design element in interfaces, especially within the context of mobile communication. This study provides relevant literature to establish a foundation of understanding sound as it relates to technology, as well as understanding mobile phones as specific devices. Eight participants within the age range of 18-29 years old, from across the United States, completed a pre-interview, a one-week diary study, and post-interview in an attempt to understand how sound shapes a mobile

messaging experience, and how sound plays a role in a primarily visual interface. The results show that sound plays a role in design and varies in its reception across different contexts and environments, but overall encourages interactivity and immersion into an interface.

In the future, more research is needed to fully understand the role of sound as it applies to user experience design and specific technologies or interfaces. Different age populations could also be incorporated into the study, to see if the results from this study are applicable to a wider range of mobile phone or Facebook Messenger users. Research could be collected over a longer period of time, as the user's preferences or attitudes toward sounds may change in different situations. Research from both the pilot study and the current study show similar results, and the current study provides design guidelines for consideration of future design implications, and these guidelines should be tested with alternate Facebook Messenger users, or potentially with a different communication application.

This research aimed to understand if the sound design elements of Facebook Messenger contributed to an overall positive user experience. Although there is not a definitive conclusion on whether or not the sounds contributed to a positive experience, participants' experiences were impacted by audio notifications, which they attributed to sound encouraging interactivity and immersion within the interface. Participants cited a few key sounds that they recognized as integral to their experience, such as the "new message sound," the "send" and "delivered" sounds, and the "typing anticipation sound." Emotional responses to hearing and interacting with Facebook Messenger sound notifications were both positive and negative, and changed based on the context and environment of the interactions. Participants were more likely to enjoy sounds in active conversations, or passive conversations in which they were expecting information. Participants had strong negative feelings towards sounds when they were in a quiet public space, and had neutral to positive feelings when using sounds at home, or in a space in which they were alone or a level of noise was expected. Social expectations of sounds emitted from phones contributed to the emotional responses associated with different sounds, and mostly involved a fear of judgement in a public space. Overall, sound is a design element, that if used in conjunction with the results and guidelines of this study, could impact a user's experience of an interface.

REFERENCES

Ahva, T. (n.d.). Please design notifications responsibly (+ free sounds). Retrieved from
https://www.futurice.com/blog/designing-notification-sounds/

Ballard, B. (2007). *Designing the mobile user experience. Springs*.
https://doi.org/10.1145/1453805.1453841

Barkhuus, L., & Polichar, V. E. (2011). Empowerment through seamfulness: Smart phones in
everyday life. *Personal and Ubiquitous Computing*, *15*(6), 629–639.
https://doi.org/10.1007/s00779-010-0342-4

Beckerman, J., & Gray, T. (2015). *The sonic boom: How sound transforms the way we think,
feel, and buy*. Boston: Mariner Books.

Bernhaupt, R., Ijsselsteijn, W., Mueller, F. "Floyd," Tscheligi, M., & Wixon, D. (2008).
Evaluating user experiences in games. *Proceeding of the Twenty-Sixth Annual CHI
Conference Extended Abstracts on Human Factors in Computing Systems - CHI '08*,
(January), 3905. https://doi.org/10.1145/1358628.1358953

Bly, S. (1982). Presenting information in sound. *Proceedings of the 1st Conference on Human
Factors in Computing Systems (CHI '82)*, 371–375. https://doi.org/10.1145/800049.801814

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in
psychology, 3(2), 77-101.

Brown, M. L., Newsome, S. L., & Glinert, E. P. (1989). An experiment into the use of auditory
cues to reduce visual workload. *ACM SIGCHI Bulletin*, *20*(SI), 339–346.
https://doi.org/10.1145/67450.67515

Carter, C. W. (2012). Instructional Audio Guidelines: Four Design Principles to Consider for
Every Instructional Audio Design Effort. *TechTrends*, *56*(6), 54–58.
https://doi.org/10.1007/s11528-012-0615-z

Cohen, M. H., Giangola, J. P., & Balogh, J. (2004). *Voice user interface design*. Boston: Addison-Wesley.

Context. (n.d.) In *Oxford's living dictionaries*. Retrieved from: https://en.oxforddictionaries.com/definition/context

Creswell, J. W. & Miller, D. L. (2000). Determining Validity in Qualitative Inquiry. *Theory Into Practice, 39*(3), 124-130. https://doi.org/10.1207/s15430421tip3903_2

Edwards, A. (1989). Soundtrack: An Auditory Interface for Blind Users. *Human–Computer Interaction*, *4*(1), 45–66.

Ekman, I. (2007). *Sound-based Gaming for Sighted Audiences – Experiences from a Mobile Multiplayer Location Aware Game. In Proceedings of the 2nd audio mostly conference*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.89.9421&rep=rep1&type=pdf#pa pa=152

Emotional Response. (n.d.) In *The Free Dictionary.* Retrieved from: https://medical-dictionary.thefreedictionary.com/emotional+response

Environment. (n.d.) In *Oxford's living dictionaries*. Retrieved from: https://en.oxforddictionaries.com/definition/environment

Ericsson, K. A., & Simon, H. A. (1998). How to study thinking in everyday life: Contrasting thinkaloud protocols with descriptions and explanations of thinking. *Mind, Culture, and Activity*, 5(3), 178-186. https://doi.org/10.1207/s15327884mca0503_3

Gaver, W. (1997). Multimedia, Video and Voice. In M. Helander, T. K. Landauer, & P. V. Prabhu (Eds.), *Handbook of Human-Computer Interaction* (pp. 1003–1042). Elsevier Science & Technology.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *Bdj*, *204*, 291. Retrieved from http://dx.doi.org/10.1038/bdj.2008.192

Goodman, E., Kuniavsky, M., & Moed, A. (2012). Universal Tools. *Observing the User Experience*, 95–139. https://doi.org/10.1016/B978-0-12-384869-7.00006-1

Harrison, S., Phoebe, S., & Tatar, D. (2007). The Three Paradigms of HCI, 1–18. Retrieved from http://www.citeulike.org/user/Yuancheng/article/4293792

Hussain, I., Chen, L., Mirza, H. T., Chen, G., & Hassan, S. U. (2015). Right mix of speech and non-speech: hybrid auditory feedback in mobility assistance of the visually impaired. *Universal Access in the Information Society*, *14*(4), 527–536. https://doi.org/10.1007/s10209-014-0350-7

IJsselsteijn, W., van Baren, J., & van Lanen, F. (2003). Staying in touch: Social presence and connectedness through synchronous and asynchronous communication media. *Human-Computer Interaction: Theory and Practice (Part II), 2*(924), e928.

International Standard. (2009). *International Standard Organization*, *2010*, 1–11. https://doi.org/10.1021/es0620181

Kim, J. (2015). The Three Threads of Experience (pp. 23–38). *Design for Experience: Where Technology Meets Design and Strategy*. Switzerland: Springer International Publishing. https://doi.org/10.1007/978-1-84996-272-8

Korhonen, H., Holm, J., & Heikkinen, M. (2007). Utilizing Sound Effects in Mobile User Interface Design. *Ifip International Federation For Information Processing*, 283–296.

Koroghlanian, C. M., & Sullivan, H. J. (2000). Audio and Text Density in Computer-Based Instruction. *J. Educational Computing Research*, *22*(2), 217–230.

Kvale, Steinar, and Svend Brinkmann. *Interviews: Learning the Craft of Qualitative Research Interviewing*. Sage Publications, 2007. [Ch. 7]

Lachman, O. (2018, January 06). Designing with Sounds – UX Collective. Retrieved from
https://uxdesign.cc/designing-with-sounds-98a4003e2133

Lazar, J., Feng, J. H., & Hochheiser, H. (2017). Diaries. *Research Methods in Human Computer Interaction*, 135–152. https://doi.org/10.1016/B978-0-12-805390-4.00006-6

Leading mobile messengers in the U.S. 2018, by users | Statista. (2018, September). Retrieved from https://www.statista.com/statistics/350461/mobile-messenger-app-usage-usa/

Nacke, L. E., Grimshaw, M. N., & Lindley, C. A. (2010). More than a feeling: Measurement of sonic user experience and psychophysiology in a first-person shooter game. *Interacting with Computers*, *22*(5), 336–343. https://doi.org/10.1016/j.intcom.2010.04.005

Nyshadham, E. A. (1998). The impact of auditory enhancement of a user interface on decision making: An experimental study. *The Journal of Computer Information Systems*, *38*(4), 100–107.

Maxwell, J. (2012). *Qualitative research design: An interactive approach: An interactive approach.*

McCarthy, J., & Wright, P. (2004). *Technology as experience*. *Interactions* (Vol. 11). https://doi.org/10.1145/1015530.1015549

Mynatt, E. D. (1990). Auditory Presentation of Graphical User Interfaces. *Interface*, 1–18.

Patton, M. Q. (2001). Qualitative research and evaluation methods (3rd ed.). Thousand Oaks, CA: Sage.

Patton, M. Q. (2014). Qualitative research and evaluation methods (4th ed.). Thousand Oaks, CA: Sage.

Pielot, M., Church, K., & de Oliveira, R. (2014). An in-situ study of mobile phone notifications. *Proceedings of the 16th International Conference on Human-Computer Interaction with Mobile Devices & Services - MobileHCI '14*, 233–242. https://doi.org/10.1145/2628363.2628364

Pirhonen, A., Tuuri, K., Mustonen, M.-S., & Murphy, E. (2007). Beyond Clicks and Beeps: In Pursuit of an Effective Sound Design Methodology. In I. Oakley & S. Brewster (Eds.), *Haptic and Audio Interaction Design* (pp. 133–144). Berlin, Heidelberg: Springer Berlin Heidelberg.

Rainie, Lee, and Andrew Perrin. "10 Facts about Smartphones." Pew Research Center, Pew Research Center, 28 June 2017, www.pewresearch.org/fact-tank/2017/06/28/10-facts-about-smartphones/.

Ren, G., Wei, S., O'Neill, E., & Chen, F. (2018). Towards the Design of Effective Haptic and Audio Displays for Augmented Reality and Mixed Reality Applications. *Advances in Multimedia*, *2018*. https://doi.org/10.1155/2018/4517150

Rickert, T. (2010). Music@Microsoft.Windows: Composing Ambience. *Writing Instructor*, 58–72. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&AuthType=cookie,ip,uid&db=eric&AN=EJ890602&site=ehost-live

Rogers, Y. (2011). *HCI Theory: Classical, Modern, and Contemporary*. London: Morgan & Claypool.

Sahami Shirazi, A., Henze, N., Dingler, T., Pielot, M., Weber, D., & Schmidt, A. (2014). Large-scale assessment of mobile notifications. *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems - CHI '14*, 3055–3064. https://doi.org/10.1145/2556288.2557189

Saldaña, J. (2016). *The coding manual for qualitative researchers*. Los Angeles, CA: SAGE.

Sohn, T., Li, K., Griswold, W., & Hollan, J. (2008). A Diary Study of Mobile Information Needs. *Computer Human Interaction*, 433–442. https://doi.org/10.1145/1357054.1357125

van der Heijden, H. (2004). User Acceptance of Hedonic Information Systems. *MIS Quarterly*, *28*(4), 695–704. https://doi.org/10.2307/25148660

Vazquez-Alvarez, Y., Oakley, I., & Brewster, S. A. (2012). Auditory display design for exploration in mobile audio-augmented reality. *Personal and Ubiquitous Computing*, *16*(8), 987–999. https://doi.org/10.1007/s00779-011-0459-0

Zimarev, R. (2017, August 28). UI Sounds: Everything about user interface sounds. Retrieved from https://icons8.com/articles/ui-sounds/

Zhou, T., & Lu, Y. (2011). Examining mobile instant messaging user loyalty from the perspectives of network externalities and flow experience. *Computers in Human Behavior*, *27*(2), 883–889. https://doi.org/10.1016/j.chb.2010.11.013

APPENDIX A. RECRUITMENT SURVEY

1. Are you a student, staff, or faculty at Purdue University?
   a. Student
   b. Staff
   c. Faculty
   d. None

2. What is your age?
   a. – 17
   b. 18 – 29
   c. 30 – 49
   d. 50 – 64
   e. 65+

3. How regularly do you use Facebook Messenger on your phone as a method of communication?
   a. Never
   b. Rarely
   c. Weekly
   d. Daily
   e. Frequency of use changes for specific people
      i. Please elaborate:_____

4. How often do you keep your sound volume up on your phone to hear audio notifications?
   a. Never
   b. Rarely
   c. Sometimes (depends on environment or context)
   d. Often
   e. Always

5. Are you willing to participate in a study that involves making short diary entries daily online for a two-week time period?
   a. Yes
   b. No

APPENDIX B. PRE-INTERVIEW PROTOCOL

1. BUILDING RAPPORT: Walk me through a typical day in which you use Facebook Messenger to communicate with other people. For example, you can share who you communicate with, what you talk about, or how often you use it – just a general overview. (Share one with them)

2. Topic Domain: Facebook Messenger as an app
    a. Lead-off Question: Why do you use Facebook Messenger?
    b. Back-up Question: Are there certain reasons you use messaging applications?
    c. Follow-up Questions:
        i. How often do you think you use instant messaging to communicate with people on a daily basis?
        ii. Why do you use instant messaging, compared other methods of communication? i.e. phone calls, face-to-face
    d. Covert Categories:
        i. Role of their personal network and how that changes communication
        ii. Unawareness of messaging habits

3. Topic Domain: Awareness of Audio Notifications
    a. Lead-off Question: How often do you keep your sound volume up on your phone to hear audio notifications?
    b. Back-up Question: When are you aware of supplemental sounds as you send and receive messages on Facebook Messenger?
    c. Follow-up Questions:
        i. Are there any audio notifications that you can identify distinctly in the Facebook Messenger interface?
    d. Covert Categories:
        i. Unawareness of audio notifications within the Facebook Messenger app interface
        ii. Not keeping sound volume up on their phone

4. Topic Domain: Messaging and Environment

    a. Lead-Off Question: In what environments do you find yourself muting or lowering the sound volume on your phone?

    b. Back-up Question: Does your involvement with audio notifications change based on your environment?

    c. Follow-up Questions:

        i. In what environments do you feel that sound emitted from your phone is not appropriate?

        ii. In what environments do you feel that sound emitted from your phone is appropriate?

        iii. In general, in what situations do you make hearing audio notifications a priority?

    d. Covert Categories:

        i. Unsure of the different environments that they use their smartphone to message other people

        ii. Unable to identify specific situations that their behavior regarding audio notifications changes

        iii. Embarrassment regarding environments or contexts in which the participant was messaging

APPENDIX C. DIARY ENTRY QUESTIONS

Each diary entry included three of the same questions to establish the frequency, awareness of sound, and environment of the users' messaging experience. These questions are as follows:

Q1: Describe your Facebook Messaging frequency today

- o Frequent: messaging throughout the day, and with multiple people
- o Moderate: pockets of messaging throughout the day
- o Limited: some messaging, but nothing significant
- o No messaging
- o Other (describe):_____

Q2: In what environments did you leave your sound on/notice sounds within the design of Facebook Messenger today?

- o Home
- o Work
- o Common public space (coffee shop, university studying area, etc.)
- o Other (describe):_____
- o None

Q3: Were you aware of the sounds within Facebook messenger while messaging today?

- o Yes
- o Sometimes
- o No
- o Other (describe):_____

Days 1 - 4 of the weeklong diary study included the same questions in addition to the previous three. These questions are as follows:

Q4: Describe in what contexts you were using Facebook Messenger today. This can include who you were talking with, what headspace/emotional state you were in, the content of messages, etc. For example: I was messaging with my friends group chat, mostly just sending memes, or I was mostly messaging my best friend about this work problem, ranting.

Q5: Were there any instances in your messaging experience throughout the day in which stood out?

Q6: Reflect upon any other aspects of your experience in relationship to messaging and it's supplemental sounds below.

Days 5, 6, and 7 of the weeklong diary added more questions.
The Day 5 questions are as follows:
Q7: What do you think the purpose of different sounds within the interface are?

Q8: Does your interaction with the app fulfill that purpose mentioned above?

Q9: If there was one sound feature that you would add to Facebook Messenger what would it be?

Q10: If there was one sound feature that you would take away from Facebook Messenger what would it be?

The Day 6 questions are as follows:
Q11: What is your emotional response to sounds in Facebook messenger? (For example: irritation, enjoyment, neutral) If you need to experiment with different sound functionalities, feel free to send some messages to the Res Owczarzak account.

The Day 7 questions are as follows:
Q12: What do you think your motivations are behind changing your sound volume in public?

Q13: Why do you think Facebook Messenger includes all of these sounds in their interface?

APPENDIX D. POST-INTERVIEW PROTOCOL

1. BUILDING RAPPORT: Are there any behaviors that you can reflect upon that you were unaware of before the diary entry process? For example, you can share about your messaging habits in general, or a specific instance that stood out in your experience.

2. Topic Domain: Snippet and Diary Entry Clarification
   a. Lead-off Question: Can you explain what you meant by (snippet or diary entry reference)?
   b. Back-up Question: What does (snippet or diary entry reference) refer to, and in what context was this (snippet or entry) made?
   c. Follow-up Questions:
      i. Can you confirm that I am interpreting this (snippet or diary entry reference) correctly?
      ii. Can you elaborate on this (snippet or diary entry), perhaps by explaining the language or providing context to this insight?
   d. Covert Categories:
      i. Unable to remember what the snippet or diary entry refers to
      ii. Unable to remember what context the snippet or diary entry was made in
      iii. Now unwilling to elaborate upon a specific point

3. Topic Domain: Facebook Messenger Experience
   a. Lead-off Question: When interacting with Facebook Messenger, especially over the last week, how did its sounds shape your experience?
   b. Back-up Question: How do sounds in Facebook Messenger contribute to the overall experience of using the app?
   c. Follow up Questions:
      i. Are there any sounds that are most important to your experience?
      ii. How is your experience using Facebook Messenger when your sound is off?
   d. Covert Categories:

      i.   Participant's experience didn't change much with sound on

     ii.   Lack of awareness of sound

4.   Topic Domain: Emotional Responses to Sound

    a.   Lead-off Question: What are your emotional responses to hearing sounds from Facebook Messenger?

    b.   Back-up Question: How would you describe your feelings toward hearing sounds from Facebook Messenger?

    c.   Follow-up Questions:

        i.   How, if at all, do these emotional responses change in different environments and contexts?

       ii.   What underlying social rules effect your habits and responses to sound emitted from your phone?

    d.   Covert categories:

        i.   Lack of introspection as to opinions or feelings regarding sound

       ii.   Embarrassment regarding environments or contexts in which the participant was messaging

5.   Topic Domain: Redesigning Facebook Messenger's Sounds

    a.   Lead-Off Question: How would you change the sound design of Facebook Messenger?

    b.   Backup Question: How would you improve the sound design of Facebook Messenger to better suit your needs?

    c.   Follow-up Questions:

        i.   What sound functionality would you add to the interface?

       ii.   What sound functionality would you take away from the interface?

      iii.   What does your ideal messaging interaction look like?

            1.   Public vs. Home

    d.   Covert categories:

        i.   Apathy to redesign

       ii.   Unsure of redesign purpose

      iii.   Content with the design of Facebook Messenger