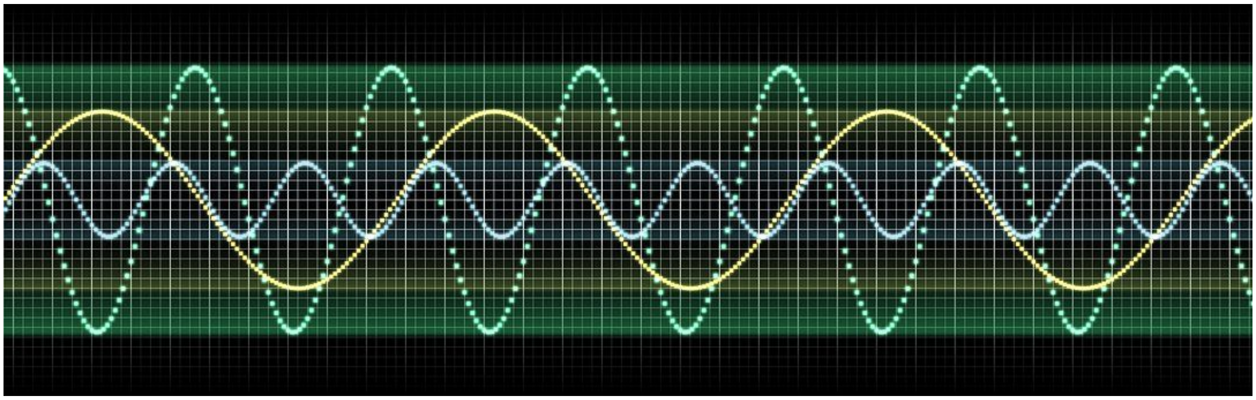

LoudProof

CSE 440 - Final Report

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PROBLEM AND SOLUTION OVERVIEW

People with Autism Spectrum Disorder (ASD) are often troubled with sensory sensitivities which make it hard for them to interact with their surroundings in sensory rich environments. Mostly due to loud sounds at places like airports and other travel stations, long distance travel becomes a barrier for these people. Our goal is to design a device that fits into the ear and will reduce sound coming in from the environment so that the user can effectively travel from one location to another without becoming overstimulated by sensory information. The device will be paired with a phone application which allows the user to customize how sound will be filtered and where he or she can go to get refuge from sensory rich environments.

Design Research Goals, Stakeholders, and Participants

Design Research Goals

During our design research, our goal was to figure out more about the situations which cause sensory overload, the current solutions that these individuals will use, and where those solutions fail. We wanted to gain an overall increase of knowledge and perception about what these individuals will feel, so that we could design a product that met their needs.

Stakeholders

People who are close to those who have ASD and experience sensory hypersensitivity, such as friends and family, can benefit from something that enables travel for these individuals. Another group of stakeholders are travel attendants who might wish to speak with people from our target group, therefore enabling communication. One of the current solutions is to block sound completely, which makes it difficult for people with ASD and sensory hypersensitivity issues to ask for help when necessary, and difficult for attendants to help if they see one of these individuals in distress.

Participants

Our first participant was an ABA therapist who had experience working with children who had ASD and suffered from sensory hypersensitivity issues. She described what it looks like when one of these individuals experiences sensory overload, and strategies to overcome impairment. Her current student reacts negatively to all loud noises, and has a hard time in social situations because of it. Because he is not able to handle sounds that so many of us are used to hearing every day, he uses noise cancelling headphones to block sound. This solution is not optimal, since he cannot communicate well with others, and brings unwanted attention to the child's friends and family.

Our second participant was an adult with ASD who has experience with short and long distance travel. Although this individual did not state any difficulties with auditory sensitivities, he mentioned that having ASD has affected how he travels by making social interactions tiresome and daunting. He does not travel alone, and does not plan to.

Our third participant was another adult with ASD and also suffers from sensory hypersensitivity. He travels, and frequently uses devices to cope with his sensory hypersensitivity struggles. He described some of his experiences of excessive sensory overload being like a panic attack. It is common for him to get to the point of yelling and screaming. ASD is something that is best dealt with at an early age, and he was not afforded that opportunity as his problems were not diagnosed or acknowledged as a legitimate concern. His sensory sensitivities have gotten worse in the recent years. His current solutions are to use ear plugs or noise cancelling headphones if he is able to put them in before overload occurs. Sharp, sudden, loud noises send him into overload very quickly, as his tolerance for such sounds has decreased over time. If he is unable to prepare for these situations by putting in earplugs or wearing his headphones, his other solutions are to retreat, self medicate, or both.

<u>Design Research Results and Themes</u>

Attention

A major disadvantage to many of the devices currently used to reduce auditory overload is that they cause unwanted attention from strangers. These devices tend to be large, obtuse, and to many people outside of this population, they appear inappropriate for many common social settings. This unwanted attention heightens anxiety for some individuals (such as our third participant) and in other cases, the stress is placed on the family and friends of the individual with ASD (like with the student that our first participant works with). An ideal solution “normalizes” the user, at least aesthetically, in order to avoid unwanted stares and comments from strangers.

Dependent Travel.

Our interviews confirmed that people in this target population often don’t travel independently; a personal aid, whether it be behavior therapist or family member, is desired, if not necessary, to avoid some sort of behavioral shut down. This is often in addition to some sort of auditory device. The desire for independent travel is, however, very prominent.

Sound Quality.

Current solutions mentioned in our interviews, such as noise canceling headphones (that can connect to a phone), noise muting headphones (that can’t connect to a phone), and earplugs all aim to block out sound for the user. While this does solve the issue of overwhelming auditory information, it does not facilitate social interactions that are necessary when wearing a device for long periods of time every day. By blocking all sound, these current solutions decrease voice clarity and muffle information that might be important, like an attendant giving you directions or a PA system listing the next train stop. Our first interviewee noted that she is not always sure if her student does not respond to her because he can’t hear her, or because having everything muffled makes it easier to tune someone out deliberately. Ideally, a device would be able to reduce background sound while localizing and enhancing nearby necessary auditory information.

<u>Task Analysis</u>

1. ***Who is going to use the design?***

The primary usage of this design will be among individuals on the autism spectrum experiencing auditory sensitivities and difficulty filtering sound, specifically those with travel desires. It should be noted that ASD is a sufficient, but not necessary condition for auditory hypersensitivities. As a result the potential user base extends beyond individuals with autism. In general these are individuals who have social difficulties, and are rendered incapable of communication in sensory rich environments.

2. ***What tasks do they now perform?***

Currently, activities like planning for travel and traveling small distances are reasonable tasks to be performed by our potential users. This is a result of the comfort of personal travel in a car and home. In addition to this, they also are able to communicate and gather critical information in environments that do not overwhelm their auditory senses.

3. ***What tasks are desired?***

These individuals would like to be able to travel long distances independently. The ability to communicate with attendants when necessary and maneuver the traffic and cacophony that are inherent in travel hubs, airports, subways, and vehicles is a necessity for modern day long-distance travel. Auditory sensitivities make this exceptionally difficult.

4. ***How are the tasks learned?***

Many of these people avoid independent long-distance travel entirely, as the prospect of auditory overload is too frightening. Others may choose to work with an ABA therapist for an extended amount of time in an effort to proactively prepare themselves.

5. ***Where are the tasks performed?***

The primary environment in which such tasks will be performed are large travel hubs, airports, trains, airplanes, and subway systems. We can generally reduce this to loud “checkpoints” or portions of travel.

6. ***What is the relationship between the person and data?***

In general, quantitative data is hard to come by when examining individual responses to sensory-rich environments. As a result we can consider data that may not be as easily quantifiable or detectable. Audio, particularly loud audio, can be thought of as the primary data that is being received and in many cases overloading the person. Data regarding a person’s auditory preferences and previous behavior in cases of auditory overload may also be of interest.

7. ***What other tools does the person have?***

The most popular current solutions for the reduction of auditory overload are noise-cancelling headphones. Discussions with an ABA therapist have pointed out several different flaws. Other possible “tools” include medications to dull senses, and assistive voice devices.

8. ***How do people communicate with each other?***

In the case of most of our potential users, communication is a large hurdle that can be near impossible to achieve. In fact, the issue of feasible communication is exactly the problem our design attempts to solve. There are no methods in place to facilitate communication in sensory-rich environments for our user group.

9. ***How often are the tasks performed?***

Long-distance travel is not a very common occurrence, and resultingly our estimates range from once to twice a year. However, our design can easily be extended to shorter distance day to day travel and to arenas like schools, cafeterias, and sporting/entertainment events.

10. ***What are the time constraints on the tasks?***

Retroactive approaches to the elimination of auditory overload during travel need to be in place and ready before travel. Reactive approaches, on the other hand, require solutions to be fully functional within seconds of interaction with high decibel range environments, as the onset of auditory overload is quite quick. Communication with attendants and gathering of information have time constraints on the granularity of minutes. Travel, especially in airports and subways, is time-sensitive, thus potential solutions must be designed accordingly.

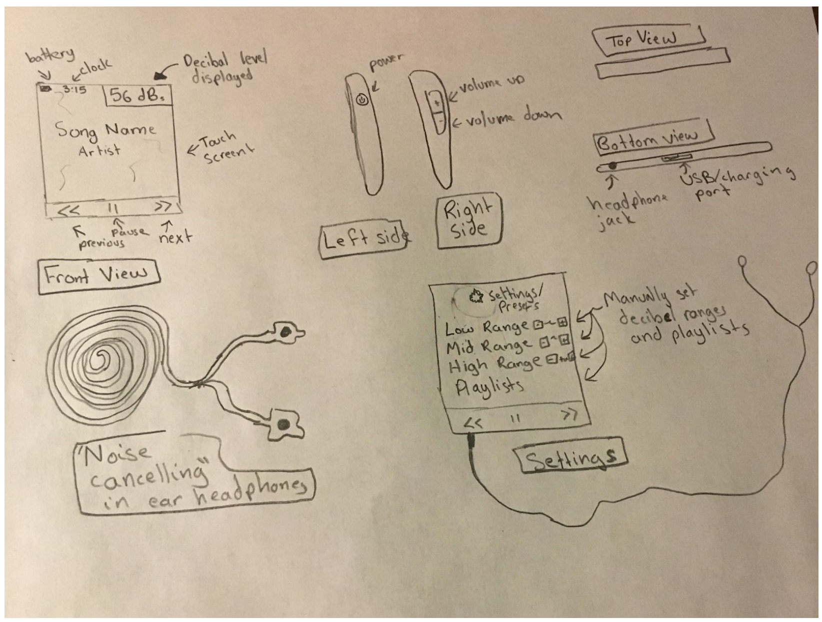
11. ***What happens when things go wrong?***

When sensory overload occurs for individuals with ASD and hypersensitivity, the typical response is to remove themselves from the environment, or use sound blocking devices such as earplugs, or noise cancelling headphones. The second option is only available if the individual is able to withstand the temporary disturbance. Some who experience sensory overload get to a point where they cannot calm themselves down without removing themselves from the situation, or using medicine as an option, which may impair them and prevent them from driving or functioning well in public. This can cause major complications in social situations, and inhibit them from accomplishing day to day tasks such as being at the grocery store, or participating in events they would like to go to such as concerts or traveling.

Proposed Design Sketches

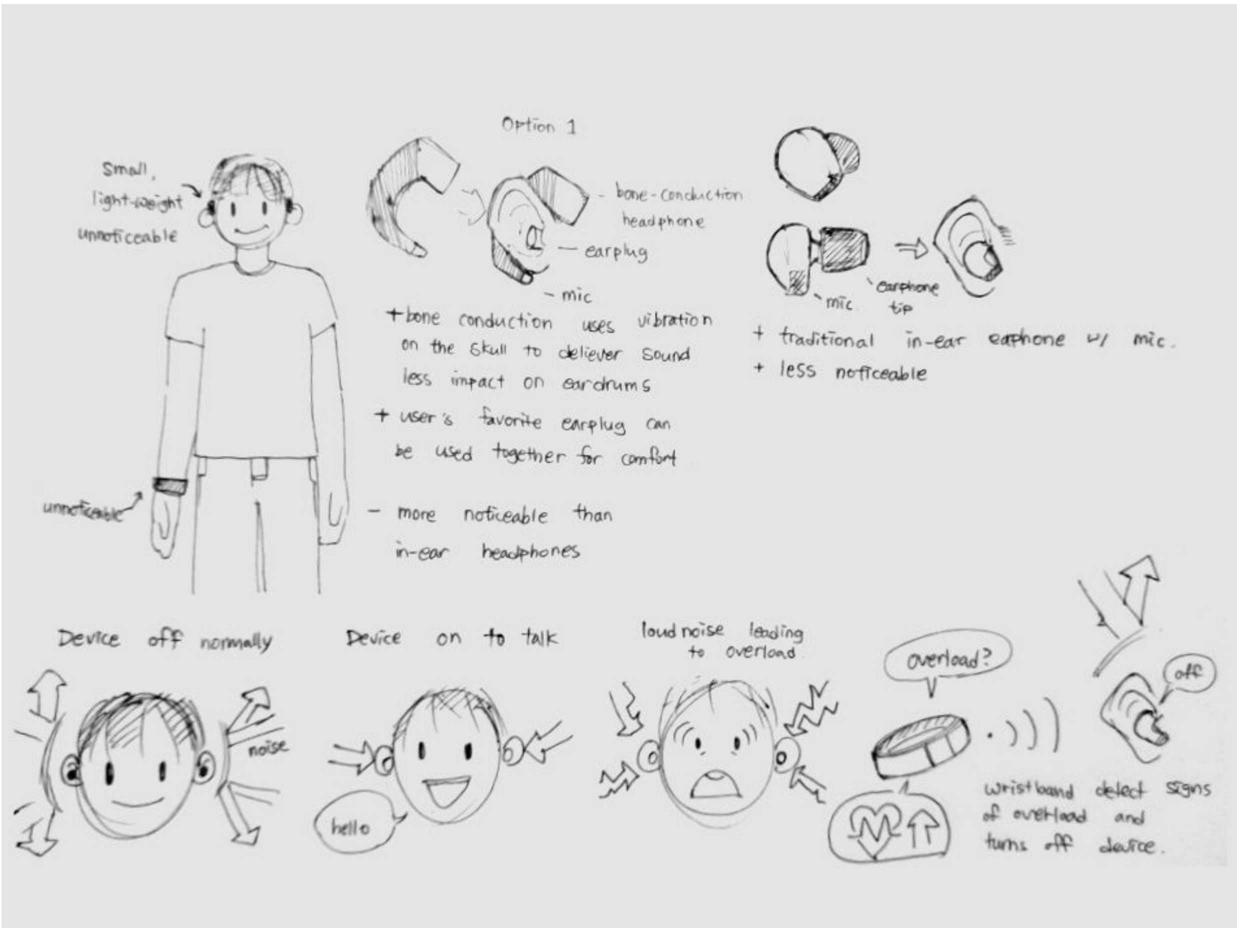
The Disguised Decibel Meter and Gradual Noise Reduction Headphones

In addition to detecting volume levels around the user, this decibel meter functions as a smart device/ mp3 player. Through tracking volume levels via user-defined presets, the meter can function as a messenger to the accompanying noise-reduction headphones to moderate peripheral sound and gradually enhance the volume of music as necessary in different environments. User research has shown that melodies at high volumes can be of aid to users who are on the verge of experiencing sensory overloads. This design acts as more of a pre-emptive solution by detecting surrounding noise characteristics, then increasing or decreasing music accordingly in order to prevent sensory overload. This design was able to address 4 tasks. First, by adding so little functionality, the process of setting up this device is incredibly quick and simple, *accommodating frequent travel*. Second, depending on the severity of the users conditions (modulated by user presets) and the volume of noises in the environment, the headphones *filter and drown out loud and high pitched noises* in exchange for soothing, self-curated melodies and songs picked by the user. Third, by disguising the decibel meter as a smart device similar to an ipod or mp3 player, the user does not have to worry about *unneeded attention*. Lastly, this proactive, gradual reduction of noise in exchange for slowly enhancing melodic tunes allows the user to *react to potential auditory overload quickly in order to continue travel comfortably.*



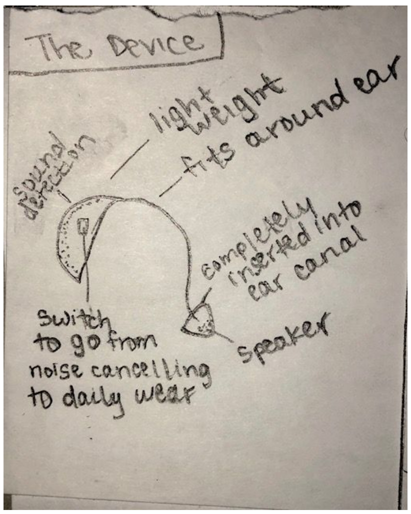
Bone conduction headphones and a wearable

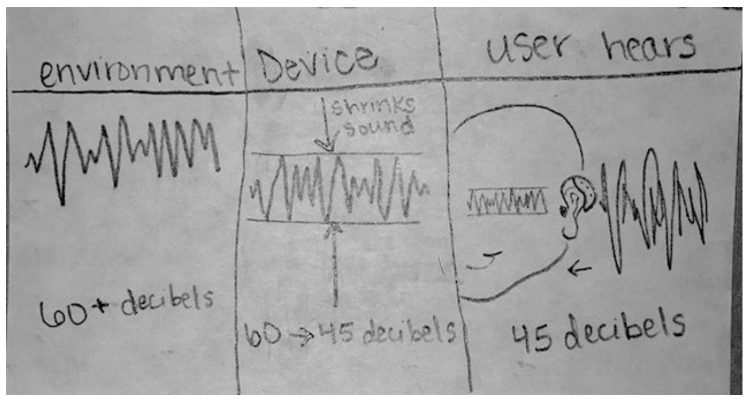
This design consists of a wristband and a bone-conduction headphone used with earplugs. By default, the headphone is on standby and sound is blocked by the earplug. When the user wants to speak to someone or listen to the surrounding, he or she can turn on the headphone to start listening, which simply repeats the sound it receives. Meanwhile, the wristband monitors the user's heart rate and movement, and shuts off sound transmission when it senses sudden changes that might indicate physiological dysregulation. This design works as a fail-safe mechanism to prevent unpleasant experiences of sensory overload, *enabling independent travel.* Wristbands and earphones are commonly used in everyday situations and are small enough to be hidden away, affording the user to be *indistinguishable from the crowd*. Wired headphones could easily get tangled and yanked and become very bothersome in crowded areas such as an airport, and big headphones can be feel heavy after a long time of use. This design tried to minimize the device so that users could *avoid other sensitivities (such as tactile) in exchange for a reduction in auditory stimuli.* This design allows the user to *react to* *potential auditory overload quickly in order to continue travel comfortably* in two ways: blocking all sounds by default and only allows sounds when the user desires, and monitoring the user's physiological state for signs of potential overload (like increase in heart-rate and hyperactivity) and shuts off the sound before auditory overload can happen.

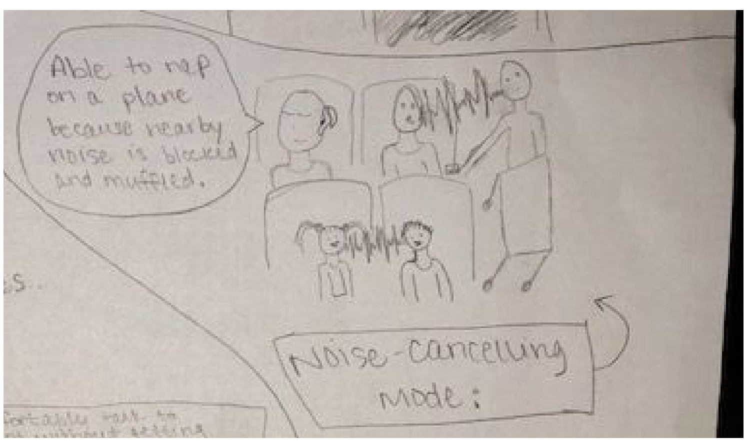


The Volume reduction hearing aid and accompanying app

This hearing aid reduces the volume of incoming sound without sacrificing sound quality or clarity, and has two settings that the user can toggle between by pushing a switch on the device itself. When in Daily Mode, the user can hear all sound in the environment up until a certain decibel cap, ensuring that auditory information does not become unbearable. Alternately, the noise-cancelling mode can be used when the user wants to completely block out incoming sound in order to relax, focus, or simply zone during travel (i.e. on a long train or plane ride). If a user starts to feel uncomfortable in their environment (due to sensory issues or to social anxiety) and desires to retreat to a quieter, less crowded area, this device's app component will scan the auditory environment to determine the closest sensory depleted area. When the user pulls up this feature, it will appear somewhat like a heat map, and guide the user to a new location by sensing where the lowest decibel area is. Daily Mode lowers the volume of incoming sounds without blocking or muffling sound, allowing the user to *hear important information and* *facilitates easy communication with attendants* without getting overstimulated by nearby sounds in the environment. By design, this device aims to *filter and reduce sound volume* at a certain decibel level so that commonly loud sounds do not impact the user in a negative way. This minimalistic design contains a small insert that goes into the ear canal and is attached to the sound detection (which rests gently behind the ear) device by a small, clear wire, allowing the user to have a *discrete outer appearance.* The accompanying app guides the user in the direction of a more desirable (less crowded and noisy) area with the hopes that the user can *intercept a sensory overload before it completely impedes his or her travel plans*.







Written Scenarios

Scenario 1: Filter and Reduce noises

Franklin is a 35 year-old evolutionary biologist at the University of Alaska Anchorage. He was invited to speak at a conference in Florida. His ASD and auditory hypersensitivity make it very difficult for him to go through airports, but he has no other options but to travel in flight. He puts the LoudProof earphone to mute mode as he enters the airport. He navigates his way through the airport to his flight, and finds that he has an hour until the departure. He feels a little overwhelmed by the crowd at the airport, and wants to find some quiet place to rest while he waits for his flight. He brings out the LoudProof app on his phone to find the quietest spot nearby.

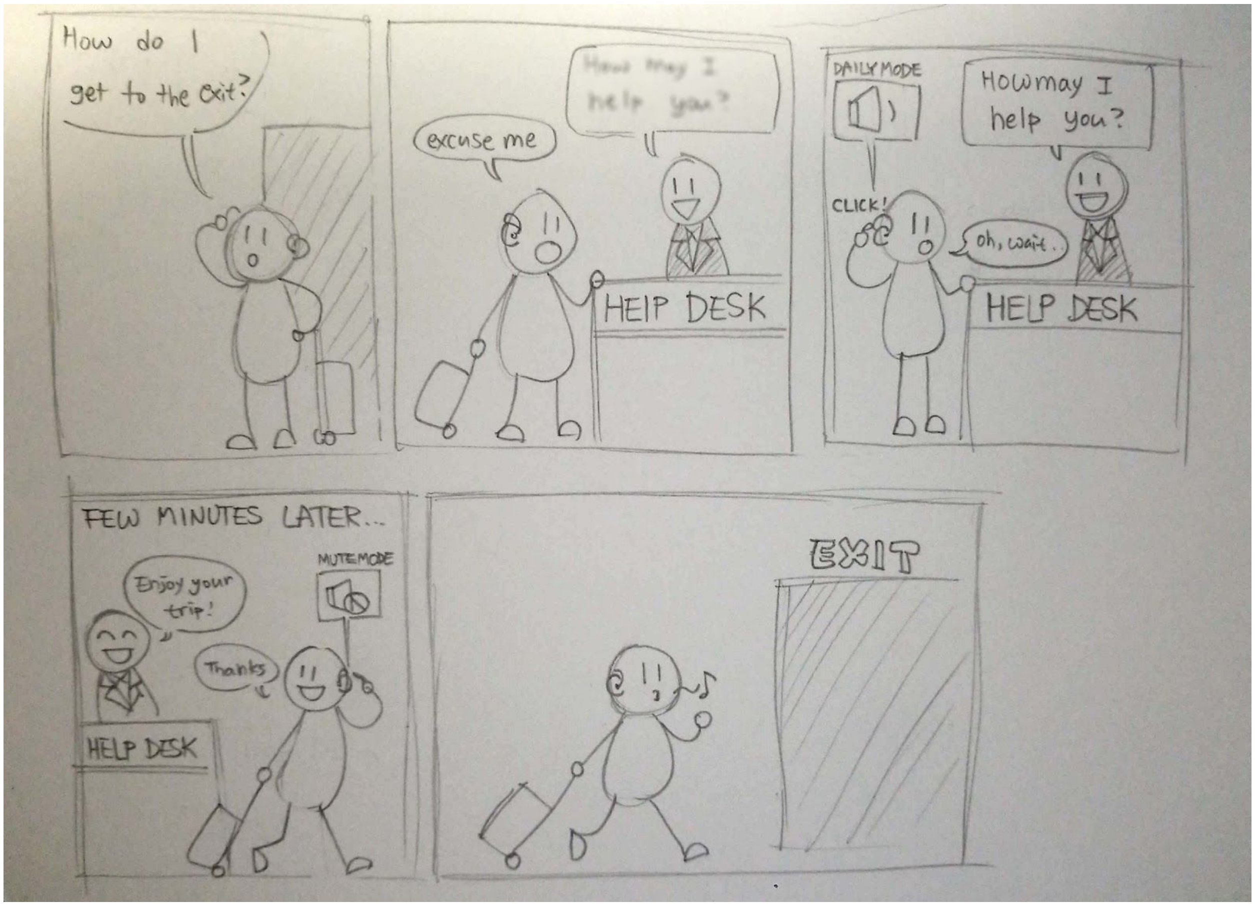
Scenario 2: Enable two-way communication

Franklin arrives at the airport in Florida and he is confused which way he needs to go to pick up his luggage and exit the airport. He walks up to the help desk to ask the attendant for the directions. He asks the attendant for the direction, but he cannot hear the attendant. He realizes that he forgot to switch his LoudProof earphone from mute mode to daily mode. He switches the mode and can now hear the attendant. After the conversation, he turns mute mode back on and finds his way out of the airport.

Storyboards of the Selected Design

Scenario 1:

Scenario 2:


How do I get to the exit?
excuse me
How may I help you?
DAILY MODE
CLICK!
How may I help you?
oh, wait.
HELP DESK
FEW MINUTES LATER...
Enjoy your trip!
MUTE MODE
Thanks
HELP DESK
EXIT