DESIGN FOR MIGRAINE MANAGEMENT: PRODUCT PROPOSAL TO MITIGATE SOCIAL-EMOTIONAL BURDENS OF MIGRAINE

by

CHARLIE F. HOLDEN

A THESIS

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Title: Design for Migraine Management: Product Proposal to Mitigate Social-Emotional Burdens of Migraine

Approved: _____*Professor Kiersten Muenchinger*______
Primary Thesis Advisor

Migraine is a common and debilitating neurological illness. Effective migraine treatment often relies on pharmaceutical interventions, though this strategy alone is insufficient in allowing migraineurs, or people who experience migraine headaches, to manage their condition because it does not address social and emotional burdens.

My work aims to provide migraineurs with tools to build healthy habits and increase their understanding of individual triggers and treatments, thereby decreasing attack frequency and intensity. My motivation is to lessen the social and emotional burdens of migraine by reducing feelings of helplessness, isolation, frustration, and guilt among migraineurs.

I propose that I may increase migraineurs' actual and perceived control over their condition by providing them with tools to build positive migraine prevention habits. This solution is Pagno, a system by which to record attacks and personal metrics and synthesize these data to gain insights into appropriate treatment plans. By providing migraineurs with a system that optimizes the formation of migraine tracking as a habit, I propose that migraineurs will be empowered to adopt strategies that will improve short-term migraine incidence and long-term condition management.

Acknowledgements

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I extend my gratitude to those who took the time to respond to my user survey and those who sat down with me to share their experiences with migraine. Your input is as appreciated as it is invaluable, as there is no user-centered design without users.

I would like to thank my family for their support and advice on this and all projects. Thank you to my father, Tobin, and my sister, Audrey, for their willingness to listen to my ideas and push me towards greater ones. I am and will forever be grateful for my mother, Lisa, whose tenacity and strength inspires me to push through the bad days and to celebrate the good ones. I am fortunate to have someone with her wealth of migraine knowledge and experience in my life, so that I may have an easier path towards understanding and caring for myself. I wish for all migraineurs to have a friend and advocate in their lives who is as kind, supportive, and understanding as her.

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Chapter 1: Design Challenge Context

1.1 Purpose of Study

I chose to research and design for migraineurs because my immediate family members and I experience migraine headaches. Though migraine was ranked second among the world's causes of disability,[1] it is still underdiagnosed, undertreated, and underestimated as a source of legitimate pain and disability (Steiner, et al., 2020). Migraine, like many chronic pain conditions, is isolating and takes a considerable amount of cognitive and emotional bandwidth to manage. This reality is not adequately addressed by existing treatment strategies, which is why I chose the social-emotional burdens of migraine as the focal point of my work. In addressing these burdens, it is my intention to provide a broader level of care that supports current treatment plans, resulting in an increase in one's actual and perceived control over this highly individualized condition.

In this paper, I outline my findings from research on migraine headaches and migraineurs. I explain how these findings translate into design insights. These insights inform the constraints and requirements of my design, the proposal of which is the culmination of my thesis work.

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[1] The overall burden of a disease can be assessed using disability-adjusted life year (DALY), which combined years of life lost due to premature mortality, years of life lost due to time lived in states less than full health, and years of healthy life lost due to disability. One DALY translates to the loss of one year of full health (World Health Organization).

1.2 What is Migraine?

1.2.1 Pathology

Migraine is a neurological disease. Though proper management can greatly reduce episodes, migraine has no cure and is therefore generally a lifelong condition. There is no single cause for migraine. It is known to be heritable, as the probability of migraine is 40% if one parent has migraine and 75% if both do (Peters, 2019). The exact pathology of migraine is not understood, though the currently accepted model is the neurovascular hypothesis (Peters, 2019; Chawla, 2021). The mechanisms of this hypothesis do not fall under the scope of my research. The significant takeaway is that migraine pathology is highly complex, individualized, and not fully understood even within medical communities.

1.2.2 Symptoms

The International Classification of Headache Disorders (ICHD) describes migraine as being distinguished by moderate to severe head pain lasting 4-72 hours, often characterized by a unilateral location and a pulsating quality (International Headache Society, 2018). There are four phases of a migraine: prodrome, aura, headache, and postdrome. The following chart (Figure 1) illustrates the severity, symptoms, and time frames typically associated with these stages.

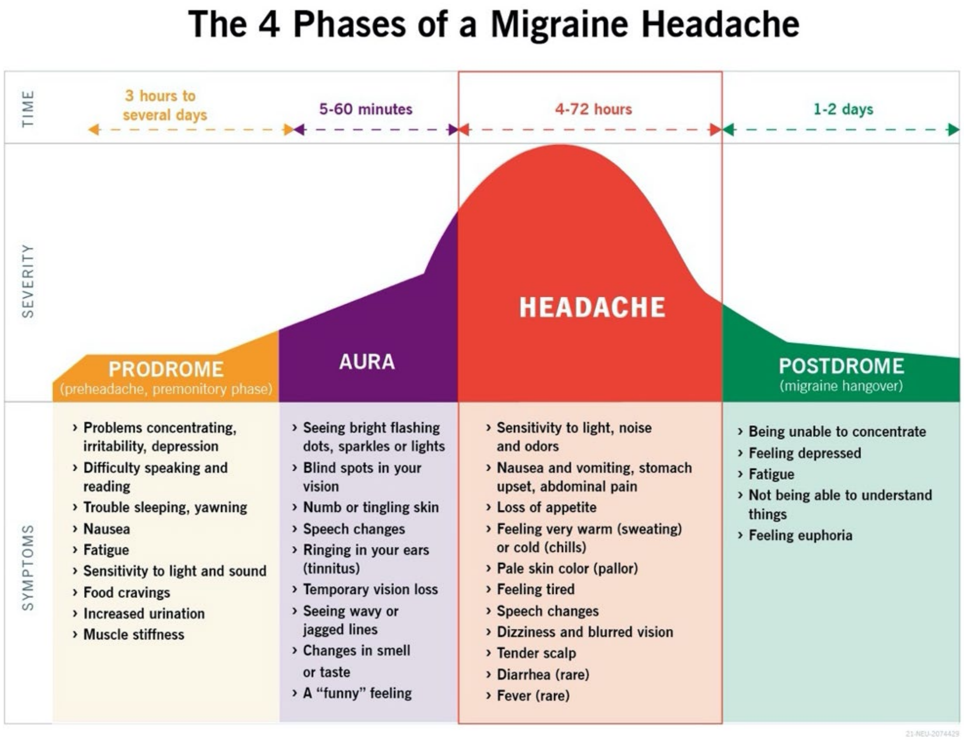

Figure 1: The Four Phases of a Migraine Headache

Migraine is often accompanied by secondary symptoms, the most common being nausea, vomiting, photophobia,[2] phonophobia,[3] and visual disturbances known as auras.[4] Symptoms can be highly individualized, with each migraineur having symptoms expressed in unique ways. Other symptoms include (but are not limited to) confusion, dizziness, fatigue, muscle weakness, tinnitus, eye pain, and cranial or sinus pressure.

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[2] Extreme sensitivity to light.

[3] Extreme sensitivity to sounds.

[4] Auras are temporary visual and/or sensory disturbances that occur before or during a migraine. 25 to 30 percent of migraineurs experience auras (American Migraine Foundation, 2017).

1.2.3 Demographics

Approximately 1 in 6 individuals in the United States are affected by migraine. Migraine is most common in individuals aged 18 to 44, though all ages can be affected (Peters, 2019). Women are three to four times more likely to experience migraine (Al-Hassany, 2020). As a result, it is often perceived as a women's illness, which negatively impacts migraineurs of all gender identities. Migraine severity in women is underestimated and migraine in men is underdiagnosed (Befus et al., 2018).

The effects of migraine vary between individuals in different social locations.[5] This is an example of a health inequity. Migraine prevalence is highest in those with an annual household income of less than $35,000 (Peters, 2019). This is likely due to "increased exposure to migraine triggers and decreased access to treatment and healthcare resources" (Peters, 2019, p. S24). People experiencing poverty, women, people of color, un- and underinsured individuals, and those with lower levels of education experience "significant disparities in migraine incidence, prevalence, migraine-related pain and disability, access to care, and quality of care" (Befus et al., 2018, p. 78). It is essential to recognize that migraine, like many medical conditions, is influenced by systems of inequity.

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[5] Social location is defined as "a position on the social hierarchy determined by the ways intersecting socially ascribed identities are valued within shifting social, political, and economic contexts" (Befus et al., 2019). One's social location determines their access to power and privilege. Race, ethnicity, class, gender, sexual orientation, and disability are factors in determining social location.

1.2.4 Types

Migraine may be episodic[6] or chronic.[7] Episodic migraines are far more common than chronic migraines, though suboptimal treatment of episodic migraines may cause a patient to progress into chronic migraine (Peters, 2019). Chronic migraine is often caused by the overuse of abortive[8] migraine medication. Such chronic migraines are known as medication overuse headaches.[9] The overuse of migraine medications can make sufferers more sensitive to future migraines, putting them at risk for developing chronic migraine (Felice et al., 2010). Therefore, there is a need for migraine management methods that aim to decrease medication reliance by reducing migraine frequency and intensity.

1.3 How is Migraine Treated?

1.3.1 Pharmaceutical Treatments

Pharmaceutical treatments for migraine include oral and injectable medications, which may be prophylactic (preventative) or abortive (taken at attack onset). Prescription migraine treatments can have side effects that patients do not find acceptable, such as nausea and brain fog. There are instances where medications may worsen migraine attacks or cause medication overuse headaches. Migraine is more

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[6] Patients with episodic migraine have 14 or less migraine days a month.

[7] Patients with chronic migraine have headaches on at least 15 days a month, at least eight of which meet the diagnostic criteria for a migraine. 2% of the population experience chronic migraines (Nierenburg et al., 2020).

[8] Medication taken at migraine attack onset.

[9] Medication overuse headaches are chronic migraines caused by acute migraine medication overdose. It is the most common secondary headache disorder (WHO, 2016).

common in un- and underinsured people, which means medications can be cost-prohibitive to many who need them (Befus et al., 2018). To be sure, migraine medications are helpful and necessary for many patients, but nonpharmacological treatments ought to become more widely studied and prescribed by healthcare professionals as a supplement or alternative to pharmaceutical options.

1.3.2 Nonpharmaceutical Treatments

A variety of nonpharmaceutical treatments have been shown to decrease migraine frequency and intensity. They include wearables,[10] behavioral modifications, nutritional supplements, and holistic medicine. Many migraineurs incorporate other strategies into their care routines, including sleep, hot or cold packs, massage, and drinking fluids. These miscellaneous coping strategies are among the most common courses of treatment for migraineurs, as they are the most intuitive and accessible.

1.3.3 Recording

Recording is an essential component of migraine management. Migraineurs may record pain onset and duration, pain level, pain location, secondary symptoms, medication administered, and other attempted relief methods such as sleeping or drinking water, along with their efficacy. These data help migraineurs and their healthcare providers understand migraine triggers[11] and identify helpful and unhelpful treatment methods.

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[10] Medical devices worn on the body to treat migraine. Such devices use external neuromodulation to interrupt pain signals. Nerivio and Cefaly are prominent examples currently on the market.

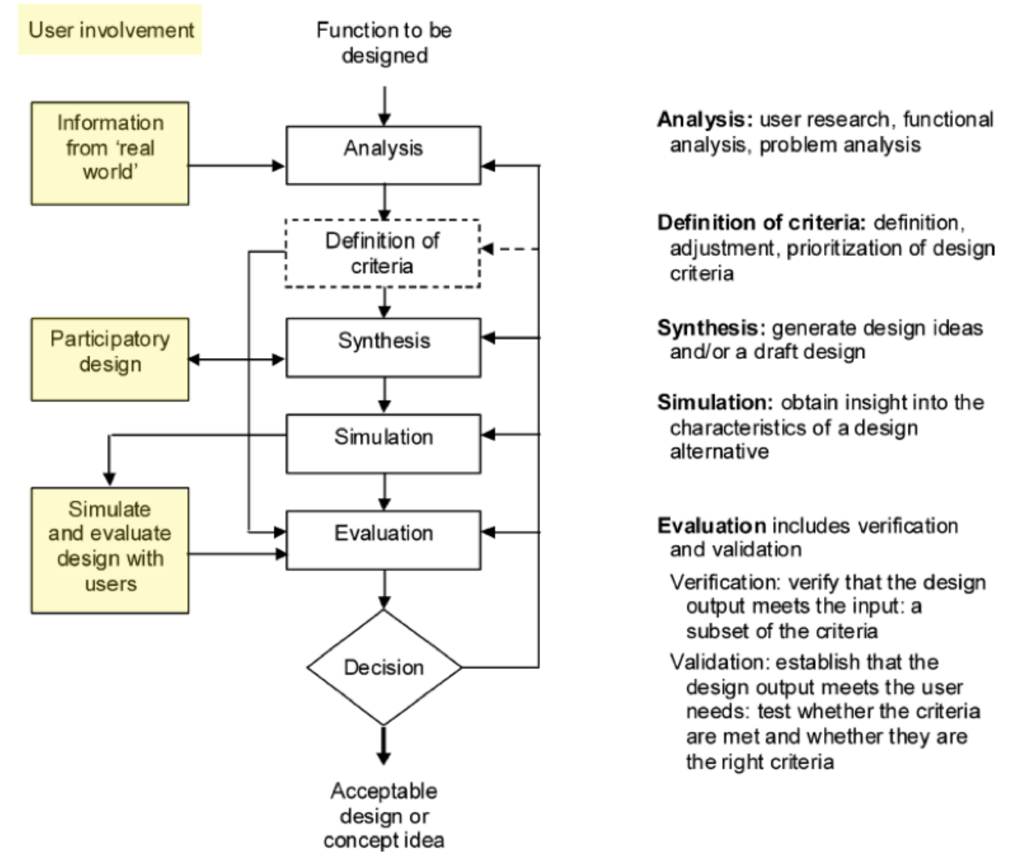
[11] Migraine triggers differ from one person to another, but stress, sleep changes, hormones, caffeine, alcohol, weather changes, and dehydration are common triggers.

Recording is primarily either physical (handwritten/journal format) or digital (mobile application format). Some apps organize these data into migraine impact reports or connect migraineurs with members of the community, discussed further in Section 2.2.1.

1.4 Why Design?

A design-focused solution is warranted for this challenge because it has the potential to empower migraineurs not only as passive patients but as active users.

This design challenge was executed by following the User-Centered Design Cycle (Figure 2) as a guide. User-centered design allows for the creation of solutions that address problems that users actually face rather than problems that the designer imagines the users are facing. In my research, understanding the mindsets of users was essential because “patients who did not believe they could influence their headache or felt that their headache was due to fate or chance are more likely to insufficiently manage their headaches, resulting in poorer overall disability” (Peters, 2019, p. S25). Therefore, I approached this design challenge from a holistic viewpoint because both short-term pain relief and long-term condition management are essential to empowering users.



This depiction of the User-Centered Design Cycle was originally published in "Design for Risk Control: The Role of Usability Engineering in the Management of Use-Related Risks" (Peijl, et al. 2012). Highlighted are points of user involvement within the cycle.

1.5 Methods

1.5.1 Research Focus & Methods

For the purposes of my research, I identified five categories of migraine burden: *medical*, *professional*, *financial*, *social*, and *emotional*. Each category is informed by the lived experience of migraineurs as well as secondary research on migraine, discussed in Section 2.1.1. The primary findings I used to define the categories of migraine burden are illustrated by Figures 3 and 4 and are compiled in Appendix 1.

I define the *medical burden* of migraine as the frequency and intensity of physical pain brought on by migraine attacks.[12] I define *professional burden* as lost wages, decreased productivity, and decreased chances of promotion due to migraine.[13] I define *financial burden* as lost wages due to migraine and cost of migraine treatment. These three categories may be addressed to an adequate degree by established pharmaceutical treatments for migraine. My final two categories of burden are not easily addressed by existing solutions. *Social burden* is defined by the negative impact migraine has on relationships with friends and family members (Figure 3). *Emotional burden* is defined by the negative impact migraine has on mental health, including feelings of depression, isolation, worthlessness, or brokenness (Figure 4).

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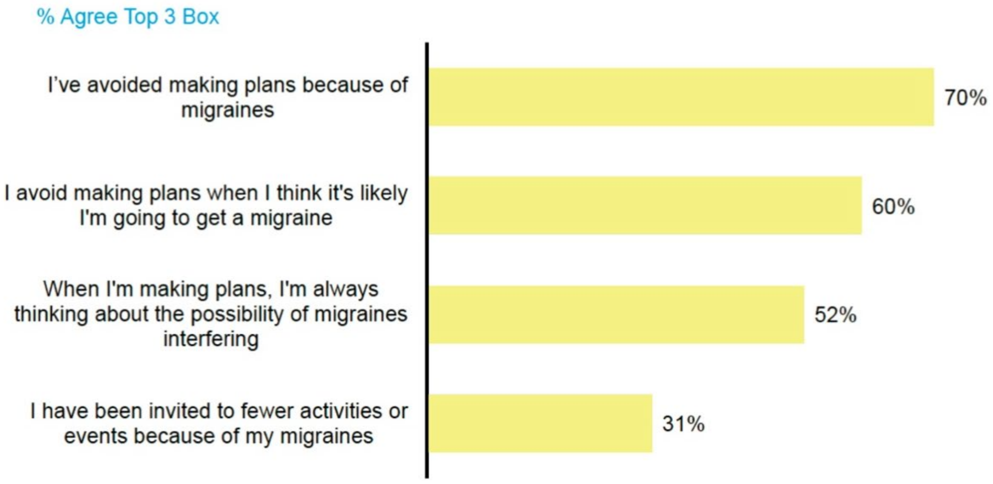
[12] Respondents to Nielsen's Migraine Impact Report survey (2018) on average rated their worst migraine pain similarly to the most painful thing they had ever experienced, on a ten-point scale.

[13] Nielsen's Migraine Impact report found that 39% of respondents missed out on work opportunities due to migraine, and 55% agreed that migraines have impacted their career goals.



Base: Migraine ; (n=518), agree is top 3 box on a 6 point scale
Q15. Using the scale shown below, please indicate how much you agree or disagree with the following statements.

Figure 3: The Social Burden of Migraine

Survey findings published in Neilsen's Migraine Impact Report (2018).

Base: Migraine (n=518); Top 3 box agreement on a 6 point scale
Q12. Using the scale shown below, please indicate how much you agree or disagree with the following statements. .

Figure 4: The Emotional Burden of Migraine

Survey findings published in Neilsen's Migraine Impact Report (2018).

I applied this framework of migraine burden to the User-Centered Design Cycle (Figure 2) to identify pain points, or areas that would benefit from a design approach. Broadly, my methods included general research on migraine (outlined in Sections 1.2 and 1.3) as well as secondary research on users and current markets and primary research in the form of a survey and six user interviews. The results of my secondary and primary research are outlined in Sections 2.1 and 2.2. After synthesizing the findings of this research, I began to develop solutions. I sought feedback on these solutions from interviewees before making further design edits and finalizing my design concept.

1.5.2 Constraints

My primary research was constrained by the respondents available to me. The respondents were largely representative in terms of gender, with a slight overrepresentation of female-identifying respondents. There was a strong underrepresentation of BIPOC respondents to my survey. This is a significant constraint, keeping in mind that migraine affects individuals with one or more marginalized identities more than individuals without. These skews were also present in my interviews, as I drew my interviewees from the pool of survey respondents.

My product development process was primarily constrained by a limited timeframe and manufacturing capabilities. Because of this, I relied on computer-aided design (CAD) models and renderings of my concepts for user feedback. Therefore, the result of this proposal is not a market-ready product, but rather the visual representation of a product concept requiring multiple more cycles of research, design, feedback, and revision. It is for this reason that the User-Centered Design Cycle (Figure 2) ends when an “acceptable” solution, rather than a finished solution, is reached. One may always find room for improvement, so product concepts can rarely, if ever, be considered truly finished.

Chapter 2: Design Problem Analysis

2.1 User Research

2.1.1 Secondary User Research

I began my research by examining studies compiling data on migraineur demographics, behaviors, and condition impacts. Using this research, I defined the five categories of migraine burden, as outlined in Section 1.5.1. The primary findings I used to define the categories of migraine burden are illustrated by Figure 3 and 4 and are compiled in Appendix 1.

In addition to examining migraine impact studies, I conducted a literature review on migraine treatments. Though my product proposal does not fall under the scope of a pharmaceutical treatment or device, it was important that I understood how users are currently treating their migraines. My goal is to decrease reliance on pharmaceutical treatments and therapies, as they can be cost prohibitive and confer negative side effects, though it must be acknowledged that they are the first line of defense against migraine pain and secondary symptoms. Therefore, I knew any solution I proposed should work in tandem with, not replace, pharmaceutical treatments.

At this point in the design process I was viewing migraine holistically and had not chosen a design focus beyond improving the social and emotional wellbeing of migraineurs. Starting with an issue and then broadening one's research (divergent thinking) and then narrowing in on areas of improvement (convergent thinking) characterizes the Double Diamond Design Model (Figure 5).

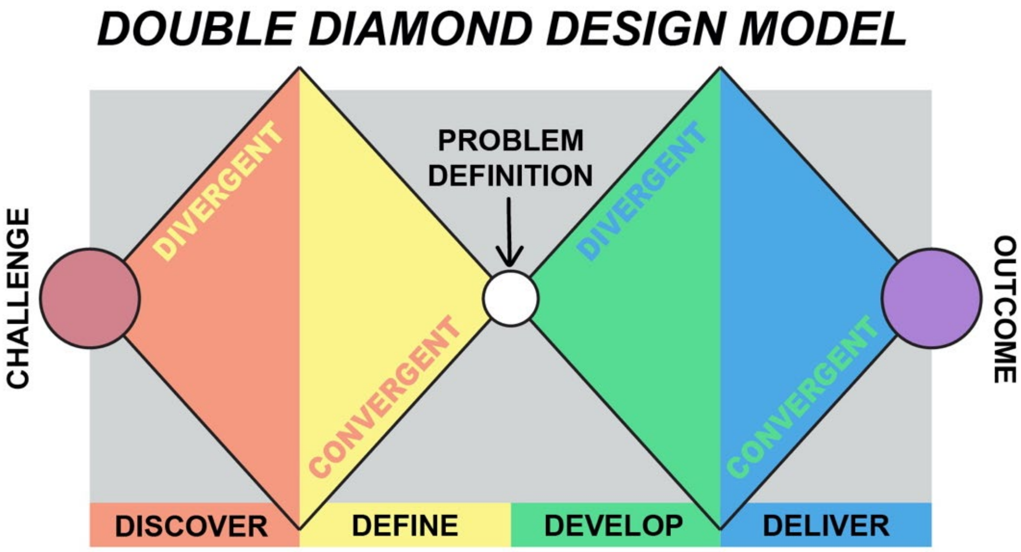


Figure 5: Double Diamond Design Model

The Double Diamond Design Model was popularized by the British Design Council in 2005 and adapted from the divergence-convergence theory proposed by linguist Béla H. Bánáthy in 1996. Graphic by Charlie Holden.

Using this method, I started with my overall challenge (to design a product to help migraineurs) and then worked through stages of divergent and convergent thinking to expand my knowledge base and refine my goals through problem definition. For an overview of my project goals, see Section 2.3. The Double Diamond Method moves through the product development process until the designer arrives at an acceptable outcome. The Double Diamond Method helps designers to look at problems and potential solutions from multiple focal lengths, allowing for outcomes that address issues that are the most pressing, though not necessarily the most obvious.

2.1.2 Primary User Research

To begin my primary user research, I created a 33-question survey for individuals who have experienced migraine or other significant head pain including cluster and tension headaches. I used insights from my secondary research to formulate questions for this study. See Appendix 2 for survey questions. I made the content of this survey very broad with the intention of understanding general trends among users. My survey accrued 45 responses.

The most significant takeaway from my questionnaire regarded the proportion of users that did not track or had stopped tracking their migraines. Almost one-third of respondents had trouble keeping up with recording their migraine attacks, while another 40% had never recorded their attacks (Figure 6). 75% of respondents had never used an app to track migraine, and half of the respondents who said they had used an app in the past no longer used it (Figure 7).

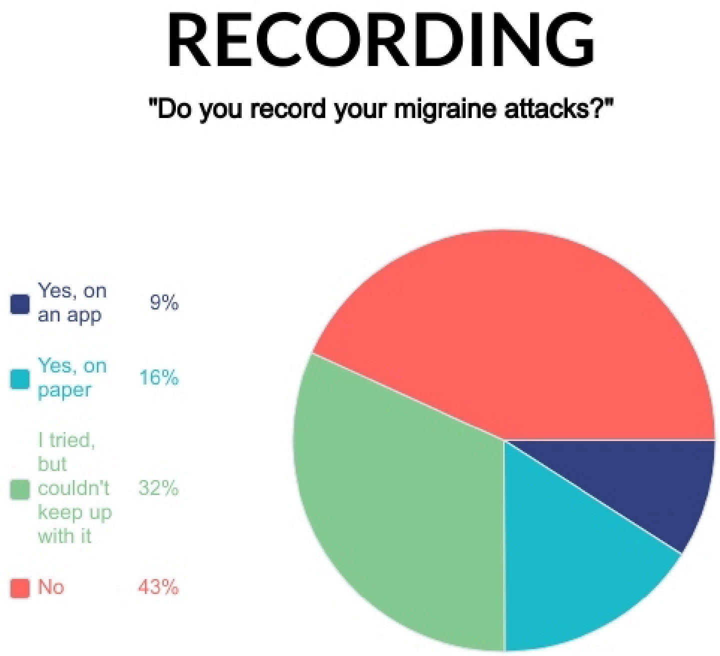


Figure 6: Survey: Recording

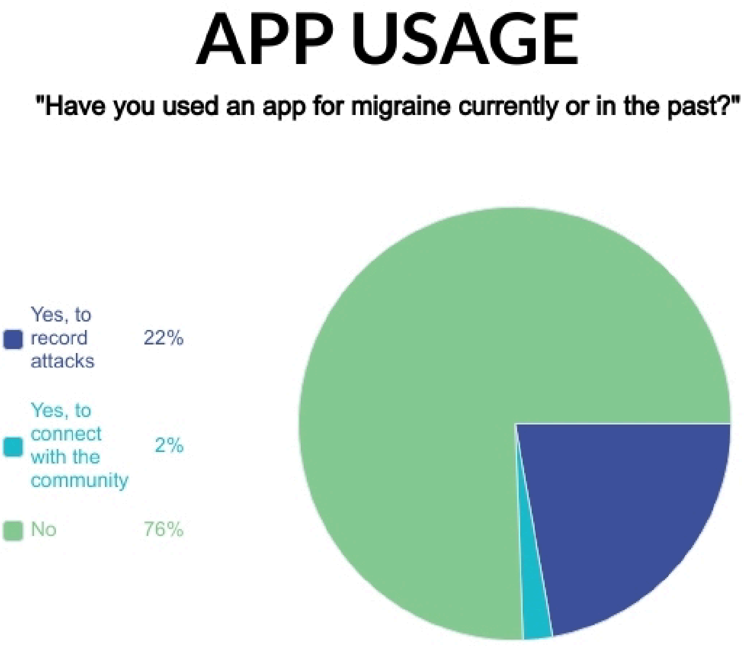


Figure 7: Survey: App Usage

Another significant takeaway from my questionnaire regarded the impacts that migraine had on migraineurs. According to respondents, the most common barriers posed by migraine were social ("I cannot remove or avoid the migraine triggers that exist in my life") and emotional ("I cannot find the energy or motivation to take measures to prevent or avoid migraine attacks") (Figure 8). This finding further justifies my focus on products that aim to improve the social and emotional wellbeing of migraineurs. For additional findings from this survey, see Appendix 3.

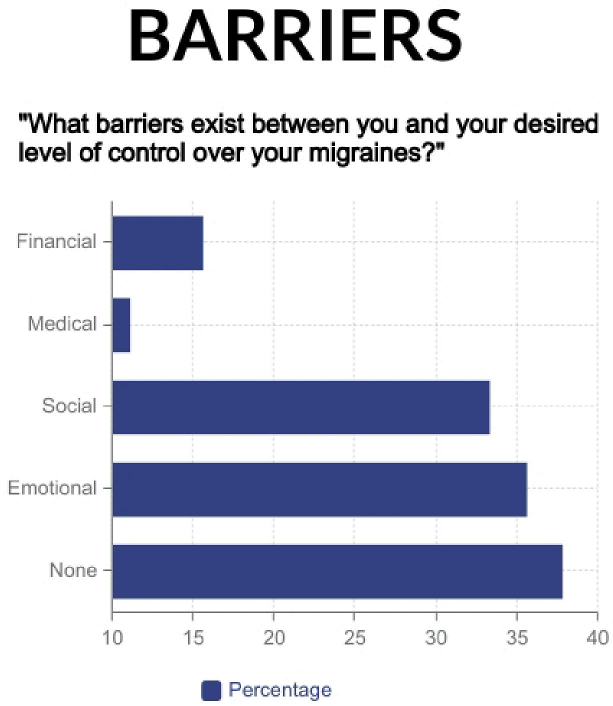


Figure 8: Survey: Barriers

After the survey results were in, I highlighted respondents with interesting, compelling, and unique answers as potential interviewees and I reached out to those who had opted to provide their contact information. From this pool, I interviewed six individuals using a version of the McGill Illness Narrative Interview that I modified to suit my needs. See Appendix 4 for the original and modified versions of these interview questions.

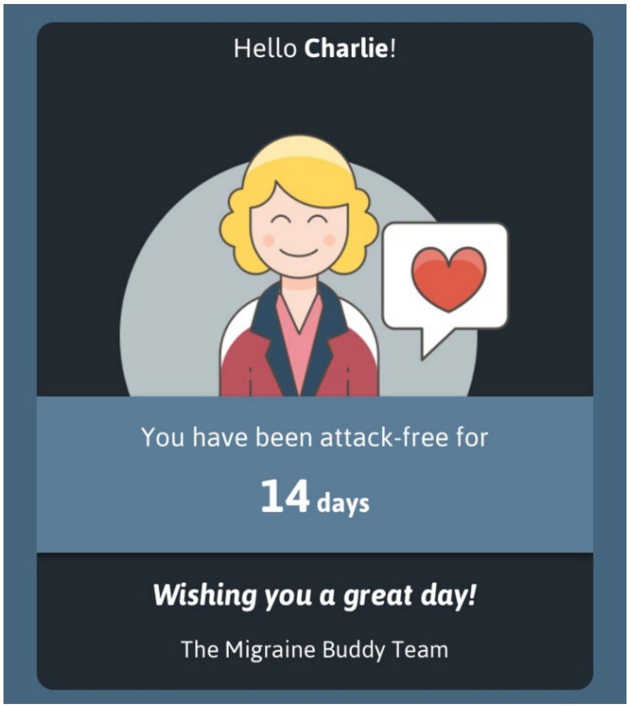
My interviewees each had different experiences with migraine, which was expected due to the highly individualized nature of the condition. See Appendix 5 for profiles on each interviewee. The significant takeaway from the interviews was that social and emotional burdens of migraine are a real issue for the majority of migraineurs. Some interviewees were not acutely aware of these issues in that they rated social and emotional impact as low on the survey. However, these respondents readily identified the negative impacts that migraine had on both categories when questioned further. In these instances, impacts like frustration, guilt, and social isolation had been normalized in the mind of the user as inevitable consequences of migraine attacks and were revealed only when they were asked to elucidate upon the specific ways in which migraine has impacted their lives. This finding supported my initial analysis of my migraine burden framework, which identified social and emotional burdens as the impact areas most in need of improvement.

2.2 Design Precedents

2.2.1 Mobile Applications

After examining migraine products currently on the market, it became clear that the vast majority did not address the social and emotional needs of their users. One exception are migraine tracking apps, which include features that allow users to make connections with other migraineurs or share data with their healthcare professionals.

One of the most popular mobile applications for migraine tracking and community building is Migraine Buddy, with over 2.8 million users worldwide. In addition to supporting intra-community connection, the Migraine Buddy App adopts a caretaking tone. Users are greeted by a ‘buddy’ avatar (Figure 9) and app notifications have a familiar tone.



Hello **Charlie**!

You have been attack-free for

14 days

Wishing you a great day!

The Migraine Buddy Team

Figure 9: Migraine Buddy Welcome Screen

Though Migraine Buddy includes features that begin to address the social and emotional needs of its users, the retention rate of users on migraine tracking apps in general leaves much to be desired (see Figures 6 and 7). Interactions must confer positive social and emotional connotations, but they must also encourage sustained use.

Habit building, and by extension, user adherence, requires a low cognitive load.[14] This means the number of physical actions and mental cycles it takes a user to complete a task should be as minimal as possible. In Migraine Buddy's case, users are required to page through nearly a dozen menus to record their attacks. Some menus such as symptom selection have over 20 options to choose from. As a result, the action (recording migraine attacks) becomes a burden. Consequently, the action is not performed with enough frequency to become habit and is then, in most cases, abandoned entirely. This sequence answers the question that arises from the findings in Figures 6 and 7: Why aren't migraineurs recording their attacks reliably, if at all? It is because tracking confers a cognitive load too high to allow the formation of habit. See Section 2.2.2 for further discussion of habit formation.

2.2.2 Ritualized Self-Care

In addition to migraine tracking apps, I chose to examine products that focus on ritualized self-care. Ritualized self-care consists of positive health and wellness behaviors that have been established as habits, such as brushing one's teeth or administering medication. To effectively establish self-care rituals, one must first build effective habits. There have been various studies in cognitive psychology that deconstruct habit-forming elements of products. According to the Fogg Behavior Model, there are three elements required to initiate all behaviors: motivation, ability, and triggers (Fogg, 2009). Habits are built upon repeated behaviors, meaning that to

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[14] Cognitive load is defined as the amount of information a person is trying to process in working memory at any one time. The Cognitive Load Theory proposed by John Sweller recognizes that there is a limited capacity to working memory.

create habits, users must have proper motivation to complete a task, have the ability to easily complete the task, and experience external or internal triggers or calls to complete the task. Of these three elements, ability was my largest concern. Effectively recording migraine means collecting a considerable amount of information, and I needed to make inputting that information as easy as possible, both physically and cognitively. This consideration factored heavily into my final design direction, as discussed in Sections 3.2 and 3.3.

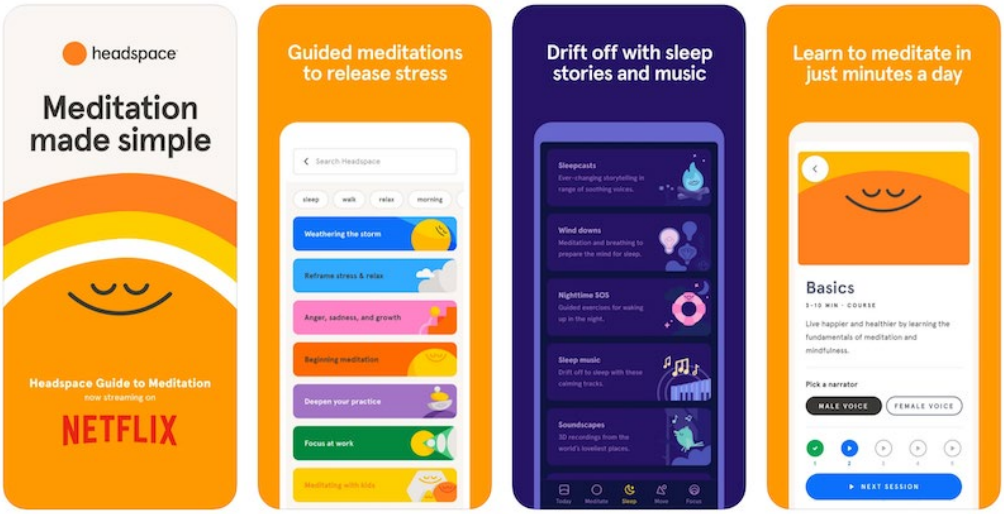

Figure 10: Headspace App

One product that effectively uses the power of habit to establish ritualized self-care is Headspace, a guided meditation mobile app (Figure 10). Headspace claims that through its service, users can “learn to manage feelings and thoughts with the lifelong skill of everyday mindfulness” (Headspace.com, 2022). Managing negative emotions like stress and anxiety can be an overwhelming task, but Headspace gives its users the tools to make emotional regulation via meditation a habit. By making difficult tasks more accessible, users can engage in behaviors that become habit. Once users see results from daily meditations (or in this case, consistent migraine tracking) the value of the action is reinforced, and habit is upheld.

2.2.3 Biometric Trackers

Survey results identified migraine recording as a design opportunity (Figures 6 and 7). Mobile applications require active recording, though data may also be collected passively via biometric tracking devices. Interest in tracking wearables has continued to increase in recent years, and consumers are interested now more than ever in devices that can use data to understand and improve their own health and wellbeing (Garter, 2021). Making this data as easy to collect and analyze as possible increases ability, one of the three essential components of habit formation discussed in Section 2.2.2. It is for this reason that I chose to include a wearable device as one component of my proposed product system (see Section 3.3).

2.3 Design Criteria & Objectives

To conclude the analysis stage of my research, I outlined the constraints, objectives, and directives (CODs) for my design. They are as follows:

Constraints:

- Must give migraineurs greater actual control of their condition
- Must give migraineurs greater perceived control of their condition
- Must be easy and intuitive to use
- Must avoid associations with negative feelings and blame

Objectives:

- Should decrease long-term reliance on pharmaceutical treatments
- Should serve migraineurs who cannot access healthcare services
- Should be easily incorporated into existing daily routines

Directives:

- Ought to be reasonably affordable and attainable
- Ought to work in tandem with, not replace, existing treatment plans
- Ought to facilitate a greater understanding of migraine and migraine treatment

These constraints, objectives, and directives culminate in the **following problem statement:** How might I increase migraineurs' actual and perceived control of their condition, thereby decreasing the overall social and emotional burden conferred by migraine?

Design solution statement: I may increase migraineurs' actual and perceived control of their condition by providing them with a system that optimizes the formation of migraine tracking as a habit, which will empower them to adopt strategies that will improve short term migraine incidence and long-term condition management.

Chapter 3: Ideation & Development

3.1 Synthesis

At this point in the design process, I synthesized what I had learned from my secondary and primary research into a task flow analysis, personas, and user experience maps. Each of these tools facilitate problem definition (see Double Diamond Model, Figure 5).

A task flow analysis is a tool that designers use to outline the steps that make up a task or behavior (see Appendix 6). In breaking down a behavior to its components, actions, and corresponding emotions, opportunities for improvement through design may be identified. In my task flow analysis, I identified four areas of design opportunities within the migraine attack cycle: migraine recording, identification of migraine attacks, precautionary measures for migraine attacks, and long-term migraine management.

Personas (see Appendix 7) are tools that designers create to represent the expected or intended users of a product. Characteristics of actual users are aggregated into archetypes, or personas. This allows designers to apply insights about particular users to a broader base. Using this tool, I identified my target user as migraineurs who require additional support to form the sustained lifestyle habits required to improve migraine incidence. This may include users who do not fully understand their attacks, feel that there is more they could do to manage their attacks, or who are overwhelmed by the effort required to manage their attacks. In this case mindset, rather than age, race, gender, or other such demographics, was most central to the formation of my target user group.

Designers create user experience maps (see Appendix 8) by applying the information contained in user personas to an expected or desired use case scenario for a product. Anticipating how different user archetypes might act in different scenarios allows designers to anticipate the efficacy of a design choice and identify room for improvement. The main takeaways from my user experience maps were that it can be difficult to begin and maintain recordings during an attack and that users must understand they are experiencing migraine in order to take precautionary measures.

3.2 Simulation

It is during the simulation stage that designers obtain insights into the characteristics of design alternatives and generate design concepts. This is where I took my initial concept and pushed it to discover areas of improvement.

As discussed in Section 2.1.2., my primary research revealed migraine recording as an area for improvement. Recording is an essential component of migraine management, yet the majority of migraineurs do not record their attacks consistently. This may be because people are unaware of the benefits of tracking or feel that it is not something that they could keep up with. Nearly half of respondents who said they had used an app in the past no longer used it. Why would users stop doing something that would benefit them? It is because migraine tracking apps require users to put in a large amount of mental energy over a sustained period before they can experience a comparable reward. Inconsistent tracking cannot provide a user with enough information to glean helpful insights. Consistent tracking, however, is difficult because it requires the user to overcome a high cognitive load, as discussed in Sections 2.2.1 and 2.2.2. This cognitive load presents itself as a barrier to habit building, as it decreases a user’s ability to perform a task. To address this issue, I chose to focus on a product to help users establish tracking as a habit. It is in this intersection of tracking and habit that I found an opportunity to create a product that has the potential to be as impactful as possible; tracking itself is not enough, it must become habit to have a positive effect on the long-term condition of the migraineur. The question then becomes, how could one get to the point where migraine tracking is ritualized self-care? My proposed answer to this question is the Pagno System, outlined in Section 3.3.

3.3 Final Proposal

My work aims to provide migraineurs with tools to build healthy habits and increase their understanding of individual triggers and treatments, thereby decreasing attack frequency and intensity, which then reduces the social and emotional burdens of migraine. I propose that the Pagno System will meet this need. See Appendix 9 for the full visual presentation of the Pagno System.

I created the Pagno System out of a need to remove barriers to migraine tracking. There is a cognitive load associated with any task, and tasks with greater cognitive loads are less likely to be completed on time or at all. Effective recording carries a large cognitive load, and if a user is already feeling pain and discomfort, the likelihood that they will complete this task is close to none. The Pagno System (Figure 11) is a product pair designed to help migraineurs understand and record their attacks so they can build healthy, sustained, and impactful habits.

Figure 11: The Pagno System

The system begins with the wearable tracking device, or Eto. Eto allows the user to start recording a migraine attack with the smallest cognitive input possible. Users may only input only the most essential and immediate information using Eto, including pain onset, intensity, and medication administration.

Eto is to be worn on the wrist, allowing the user to carry with them the ability to record *as soon as they start feeling bad*. This immediacy is what allows users to overcome the most difficult part of the recording process, which is to begin recording at all. Eto eliminates all possible steps between cognition (“I don’t feel well”) and action (recording). Even recording on an app requires the user to find their phone, unlock it, find their app, and open it to get to where they can begin recording, and once they start recording, they may be taken through up to a dozen pages before they can exit. With Eto, a migraineur can start recording with a single button press. Below (Figure 12) is the application flow for Eto.

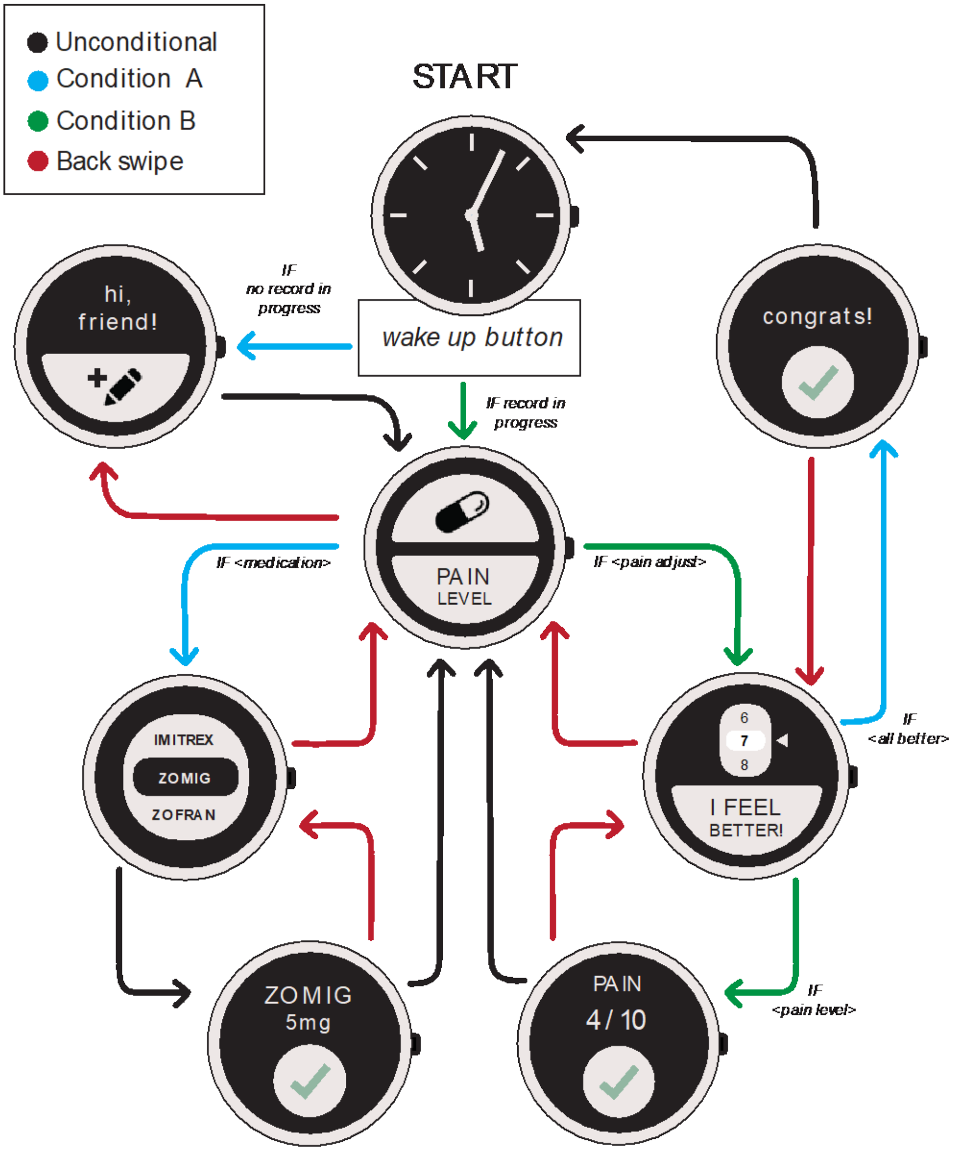

Figure 12: Eto Application Flow

When Eto is in sleep mode, a clock is displayed on its face. Its watch-like appearance makes Eto blend into existing expectations of wrist wearables, so unwanted attention is not drawn towards migraineurs. When the user presses the side button, the recording menu appears. Each menu screen offers as few options as possible to reduce cognitive load. An essential component of establishing actions as habits is the ease of the action, as the fewer physical movements and mental cycles it takes to perform a task, the more likely that the task will be repeated and solidified as habit.

Figure 13: Umo Features

The second element of Pagno is a stationary recording device which acts as a home base for the system (Figure 13). This device, called Umo, allows the user to conduct all essential recording on one interface. Its physical presence serves as a reminder and touchpoint in habit formation, giving migraineurs the visual feedback necessary to build up to making migraine tracking ritualized self-care. Umo is meant to be kept on the user's nightstand where it can be incorporated into existing routines.

Additionally, migraineurs often spend the duration of their attacks resting or sleeping in bed, so a nightstand location allows for easy access to Umo during attacks.

Umo's interface (Figure 14) is where all additional (but necessary) information can be added to recordings, including pain onset and duration, pain level, pain location, secondary symptoms, medication administered, and other attempted relief methods. Voice activation allows users to input information independent of the touchscreen interface. Adjustable volume and brightness accommodate photo- and phonophobia. Both Eto and Umo have e-reader screens[15] and were designed to be in "dark mode" to be easy on the eyes, because migraineurs frequently experience eye fatigue or pain during a migraine attack.

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[15] In the past year, improved color e-reader displays have come to market. The E Ink Kaleido™ display offers 16 levels of grayscale and is capable of displaying 4,096 colors (Eink, 2021). A color display is essential, as color is a crucial component in creating the visual hierarchies necessary to optimize the usability of interfaces.

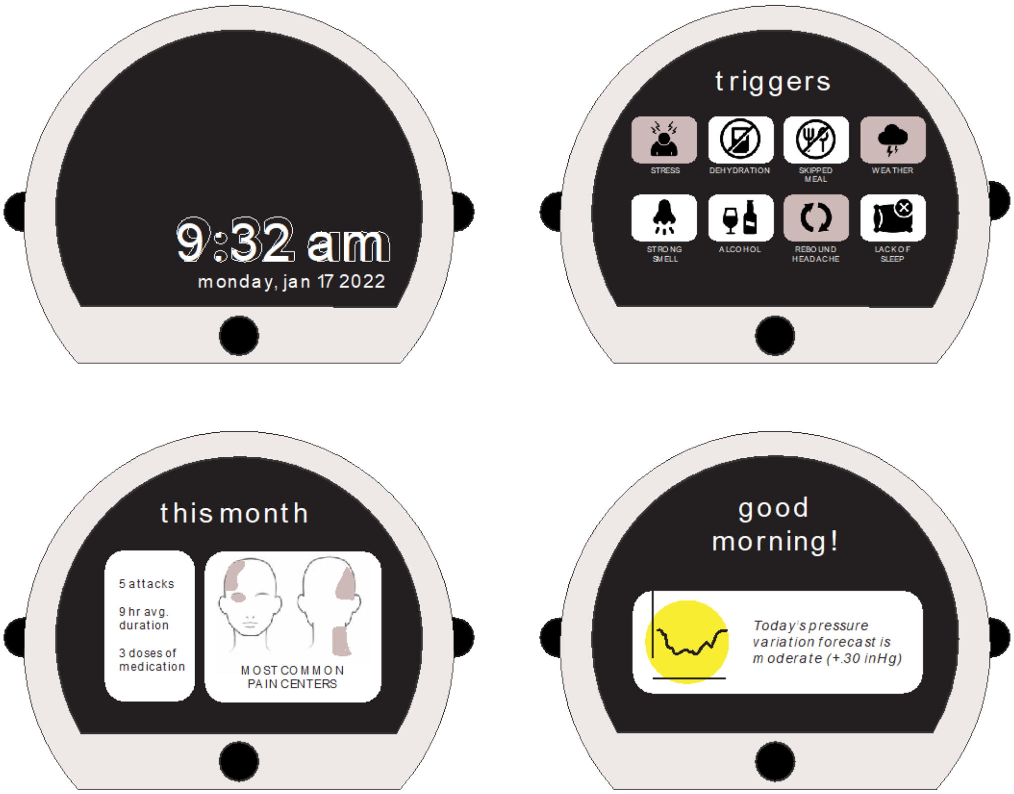

Figure 14: Umo Interfaces

Umo is also designed to allow users to record daily habits and metrics. Recording and monitoring the change over time in water intake, barometric pressure changes, stress, and more can help determine which conditions trigger a migraine. The system aggregates the data it collects on both migraine attacks and user habits and uses it to generate impact reports. These reports show migraineurs trends in their migraine attacks that may be used to alter treatment plans or lifestyle habits to reduce and improve future migraine incidences.

Eto and Umo use a Bluetooth connection to communicate. Because of this, they do not require Wi-Fi or Internet connection to function. Umo has the option of connecting to Wi-Fi so that the user may receive weather updates. Umo can also use Wi-Fi to connect with the user's cell phone to place calls[16] when prompted by voice activation.

The Pagno system can be managed and customized using the Pagno mobile app (Figure 15). Because migraine is a highly individualized condition, the management strategies that migraineurs employ ought to be individualized as well. For example, users can choose which Umo tracking pages they would like to interact with as well as in what situations they would like to be notified. Personalized voice shortcuts can be programmed using the app to allow users to input information quickly and with ease. Each feature is included with the intention of making the experience as customizable, but also as streamlined, as possible. I put the settings in the app, away from Eto and Umo, with the intention that if ancillary functions take up a different physical location, they will also preside in a distinct cognitive location. As a result, the user is able to set and forget their customization settings and focus on interacting with the recording devices.

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[16] It is important to have the ability to place calls during a migraine attack for reasons of safety, comfort, and emotional support. Migraineurs may call loved ones for company or for assistance, such as to request water or medicine. Additionally, severe migraine may be treated at hospitals or minor emergency clinics. Migraineurs require assistance in traveling to receive treatment at these locations and may need to call to request such assistance.

●	ZOMIG	5 mg
●	IMITREX	6 mg
●	EXCEDRIN	250 mg
○	ZOFRAN	8 mg

script	last fill	remaining
ZOMIG	12/31/21	4
IMITREX	06/27/20	1
ZOFRAN	01/17/22	0

● Pain intensity
● Pain location
● Prodrome
● Symptoms
○ Relief methods
● Medication
○ Menstruation

○ Attack type
● Affected activities
● Mood

Figure 15: Pagno Mobile Application

The Pagno System was created with the acknowledgement that managing migraine is difficult and highly nuanced. The system aims to alleviate some of this burden. Though my target user requires additional support in achieving an optimal level of migraine management, I do not assume that they are helpless or lazy in their current level of condition management. Those migraineurs with suboptimal migraine management should not be made to feel that they have done anything wrong, because they have not. When you have a chronic condition, it may come with the assumption, whether externally or internally, that you are not already doing everything you can. Individuals may internalize cultural messages on sickness and health, believing that if they are unwell, there must be something they can do to make it better, and if they are still unwell, it must mean they have done something wrong or not enough. This mindset can create a negative feedback loop that further damages the social and emotional health of the user.

Leveraging negative emotions for the purpose of habit formation is a powerful tool, but I have made the decision to exclude this strategy in my work. Those migraineurs who manage their condition sub-optimally need assistance that lifts them up rather than puts them down, and that is the driving force behind my product proposal.

3.4 Evaluation

One way to evaluate design concepts is through user validation. In order to determine if my early concepts were going in the right direction, I returned to some of the migraineurs I had interviewed during my primary research and showed them renderings of my concepts. Their confusion towards elements of my design let me know which parts of my system were not specific enough or were too complicated. They suggested various design edits and offered ideas on opportunities for further exploration, discussed in Section 4.1.

Figure 16: Umo Form Exploration

Various side views of Umo. These forms tested how Eto would fit into the wireless charger in a way that would ensure proper connection with the charger as well as allow for ease of accessibility by the user and protection from falls.

Another way to evaluate the success of designs is to compare design concepts against the CODs outlined at the beginning of the design process. The majority of my constraints, objectives, and directives were adequately addressed by Pagno, though I did fall short of my directive "ought to be reasonably affordable and attainable." Realistically, Pagno would be expensive considering its complexity. Looking at current health and wellness recording products on the market, Pagno would likely be out of the price range of many low-income individuals experiencing migraine. This shortcoming should not be accepted as inevitable, and further work should investigate how biometric and habit tracking can be made more economically sustainable.

Chapter 4: Design Retrospective

4.1 Further Study

To push this study further, I would put Pagno into production and create a works-like model. This would allow for hands-on user testing and would reveal additional design insights, allowing for more cycles of design edits and feedback.

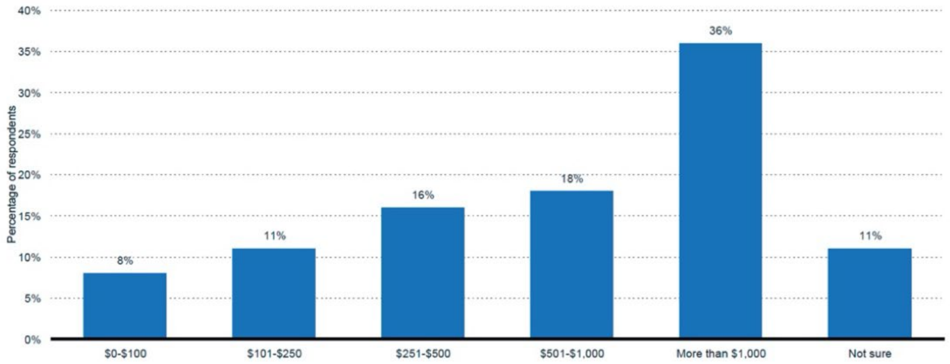
It is significant to note that during each of my follow-up interviews, my interviewees remarked that Pagno could be used to track other medical conditions and habits. One interviewee was interested in tracking mental health and mindfulness practices, while another proposed that this system would be applicable for most any chronic medical condition. The forms of the Eto and Umo would need to be altered very minimally, if at all, for these applications. Reframing Pagno as a universal tracking station that would allow users to install different condition- or goal-specific software is intriguing and merits further exploration.

Appendix 1: Secondary User Research

The financial burden of migraine

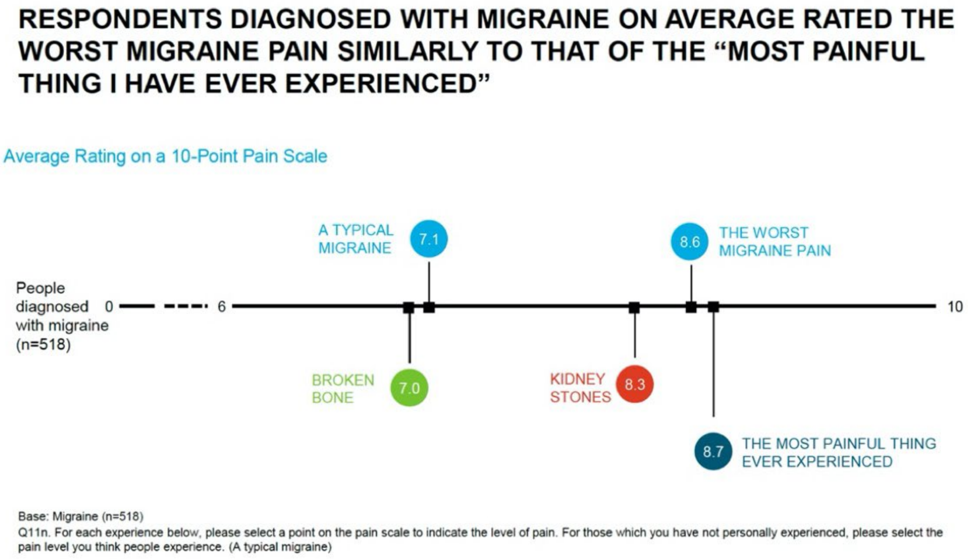
Annual out-of-pocket spending on migraine-related treatments by migraine patients in the U.S. as of 2016*

Migraine treatment out-of-pocket spending among U.S. patients 2016



Note(s): United States; May to June 2016; 18 years and older; 3,923 respondents; Patients suffering from migraines
Further information regarding this statistic can be found on page 74.
Source(s): Migraine.com; ID 615824

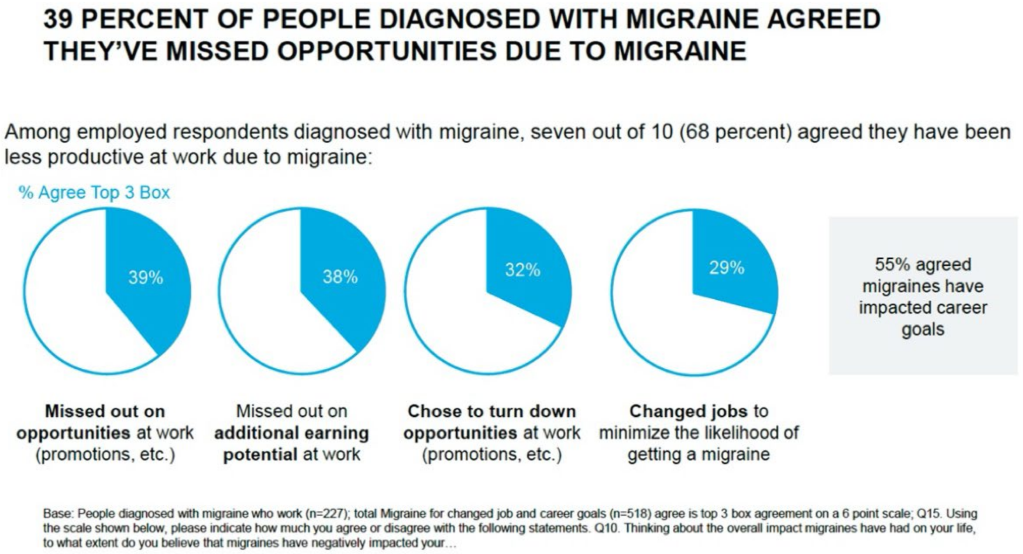
The medical burden of migraine



RESPONDENTS DIAGNOSED WITH MIGRAINE ON AVERAGE RATED THE WORST MIGRAINE PAIN SIMILARLY TO THAT OF THE "MOST PAINFUL THING I HAVE EVER EXPERIENCED"

Base: Migraine (n=518)
Q11n. For each experience below, please select a point on the pain scale to indicate the level of pain. For those which you have not personally experienced, please select the pain level you think people experience. (A typical migraine)

The professional burden of migraine



39 PERCENT OF PEOPLE DIAGNOSED WITH MIGRAINE AGREED THEY'VE MISSED OPPORTUNITIES DUE TO MIGRAINE

Among employed respondents diagnosed with migraine, seven out of 10 (68 percent) agreed they have been less productive at work due to migraine:

Missed out on opportunities at work (promotions, etc.)

Missed out on **additional earning potential** at work

Chose to turn down opportunities at work (promotions, etc.)

Changed jobs to minimize the likelihood of getting a migraine

55% agreed migraines have impacted career goals

Base: People diagnosed with migraine who work (n=227); total Migraine for changed job and career goals (n=518) agree is top 3 box agreement on a 6 point scale; Q15. Using the scale shown below, please indicate how much you agree or disagree with the following statements. Q10. Thinking about the overall impact migraines have had on your life, to what extent do you believe that migraines have negatively impacted your…

Appendix 2: Primary User Research (Survey)

Q1: Which of the following do you experience, or have experienced in the past? Select all that apply.

- Migraine without aura
- Migraine with aura
- Tension headaches
- Cluster headaches
- Other (please specify)

Q2: What is your gender identity?

- Female
- Male
- Non-binary
- Prefer not to say
- Other (please specify)

Q3: What is your age?

- Under 18
- 18 – 30
- 31 – 45
- 46 – 60
- 61+
- Prefer not to say

Q4: What is your ethnicity? Select all that apply.

- White
- Black or African American
- Hispanic or Latino
- Asian
- Native Hawaiian or Pacific Islander
- Native American or Alaskan Native
- Prefer not to say

Q5: Which socioeconomic class do you identify with most?

- Low income
- Lower-middle income
- Middle income
- Upper-middle income
- High income
- Prefer not to say

Q6: Do you have health insurance?

- Yes, and it covers my migraine expenses adequately
- Yes, but it does not cover my migraine expenses adequately
- No

Q7: Have you ever seen a doctor for migraine? Select all that apply.

- Yes, a general health provider or family doctor
- Yes, and emergency health provider
- Yes, a neurologist or headache specialist
- Yes, a chiropractor
- Yes, and alternative medicine practitioner
- No
- Other (please specify)

Q8: I see a doctor or medical provider for my migraines at least annually.

- True
- False
- Depends on my financial situation at the time
- Other (please specify)

Q9: I will only go to a doctor or medical provider for migraine in extreme circumstances.

- True
- False
- Depends on my financial situation at the time
- Other (please specify)

Q10: Have you ever used the following products to manage migraine pain? Select all that apply.

- Yes, OTC pain medication
- Yes, hot or cold packs
- Yes, essential oils/aromatherapy
- Yes, vitamins or nutritional supplements
- Yes, massage devices
- Yes, external neuromodulation (e.g. Cefaly)
- I have never used products for migraine
- Other (please specify)

Q11: Which of the following products have been helpful in relieving migraine pain? Select all that apply.

- OTC pain medication
- Hot or cold packs
- Essential oils/aromatherapy
- Vitamins or nutritional supplements
- Massage devices
- External neuromodulation (e.g. Cefaly)
- None of these have been helpful
- I have never used products for migraine
- Other (please specify)

Q12: Have you ever used the following treatments or prescription medicines for your migraines? Select all that apply.

- Prescription medicine (as needed)
- Prescription medicine (preventative)
- Acupuncture
- Botox
- Behavioral medicine (e.g. biofeedback training, cognitive behavioral therapy)
- I have never used treatments or prescriptions for migraine
- Other (please specify)

Q13: Which of the following treatments or prescriptions have been helpful in reliving migraine pain? Select all that apply.

- Prescription medicine (as needed)
- Prescription medicine (preventative)
- Acupuncture
- Botox
- Behavioral medicine (e.g. biofeedback training, cognitive behavioral therapy)
- None of these have been helpful
- I have never used treatments or prescriptions for migraine
- Other (please specify)

Q14: Which relief methods do you find effective during a migraine attack? Select all that apply.

- Dark room rest
- Sleep
- Food
- Caffeine
- Drinking fluids (water, electrolyte drink)
- Meditation/deep breathing
- Other (please specify)

Q15: I understand why I get migraine attacks.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q16: Which of the following are triggers for your migraines? Select all that apply.

- Lack of sleep
- Stress
- Dehydration
- Caffeine
- Caffeine withdraw
- Alcohol
- Odd/strong smells
- Weather
- Other (please specify)

Q17: Do you record your migraine attacks?

- ○ Yes, on an app
- ○ Yes, on paper
- ○ I tried, but didn't keep up with it
- ○ No
- ○ Other (please specify)

Q18: Have you used an app for migraine currently or in the past?

- ○ Yes, to record my attacks
- ○ Yes, to connect with the community
- ○ Yes, to record my attacks and connect with the community
- ○ No

Q19: There is more I could do to manage my migraine attacks.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q20: What barriers exist between you and your desired level of control over your migraines? Select all that apply.

- ○ Financial – I cannot afford the medications or treatments I desire
- ○ Medical – I cannot find a treatment that works for me
- ○ Social – I cannot remove or avoid the migraine triggers that exist in my life
- ○ Emotional – I cannot find the energy or motivation to take measures to prevent or avoid migraine attacks
- ○ No barriers exist for me
- ○ Other (please specify)

Q21: I'm interested in non-pharmaceutical options for treating migraine.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q22: I'm interested in a product that I can wear to treat migraine.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q23: I would wear a product to treat migraine pain …

- ○ Regardless of where I am
- ○ Only in my home
- ○ I would not wear a product to treat migraine pain

Q24: I would wear a product to treat migraine pain …

- ○ Anywhere on my body
- ○ Only on locations that are discreet/inconspicuous to others
- ○ I would not wear a product to treat migraine pain

Q25: Migraines have a significant negative impact on my emotional wellbeing.

[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q26: Migraines have a significant negative impact on my social life.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q27: When I have a migraine, I feel guilty.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q28: When I have a migraine, I feel frustrated.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q29: When I have a migraine, I feel depressed.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q30: When I have a migraine, I feel isolated.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

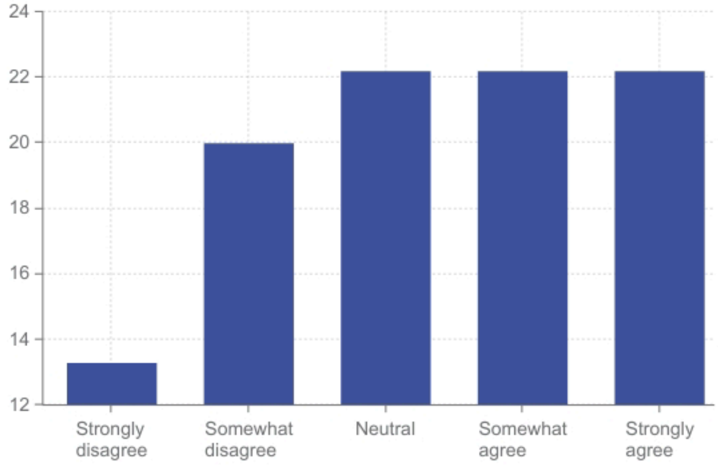
Q31: I have a strong network of people who are supportive of my condition and experience with migraine.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Q32: I would like to connect with other people who experience migraine, regardless of whether I know them in my personal life.
[Rate the degree to which you agree, on a scale from 1 to 5, 1 being strongly disagree and 5 being strongly agree.]

Appendix 3: Survey Results

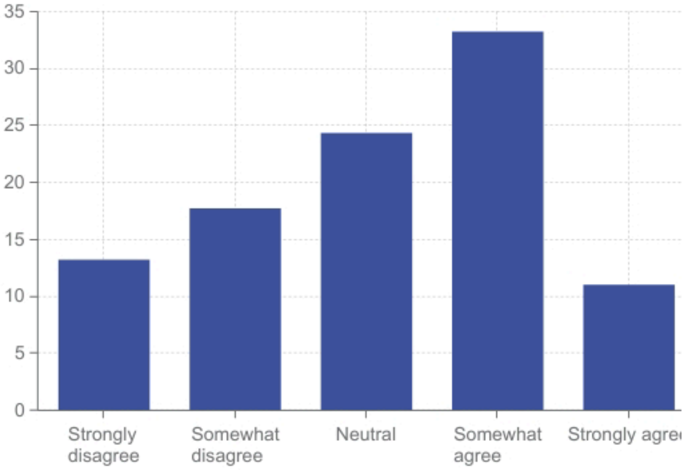
WEARABLE INTEREST

"I'm interested in a product that I can wear to treat migraine."

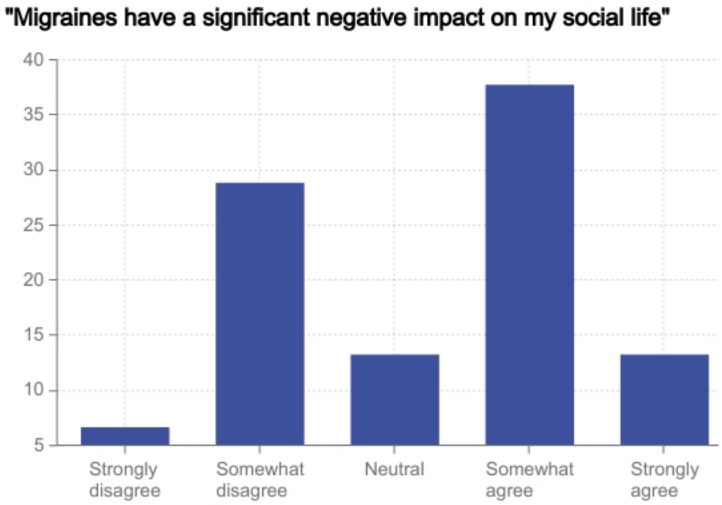


UNDERSTANDING

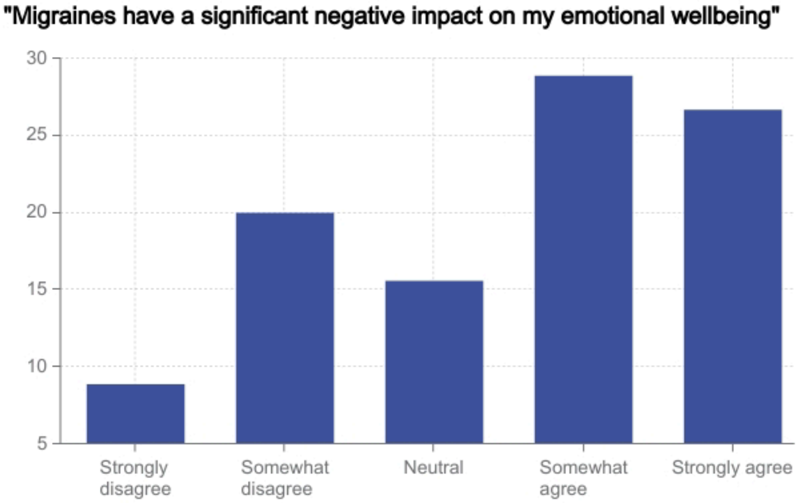
"I understand why I get migraine attacks"



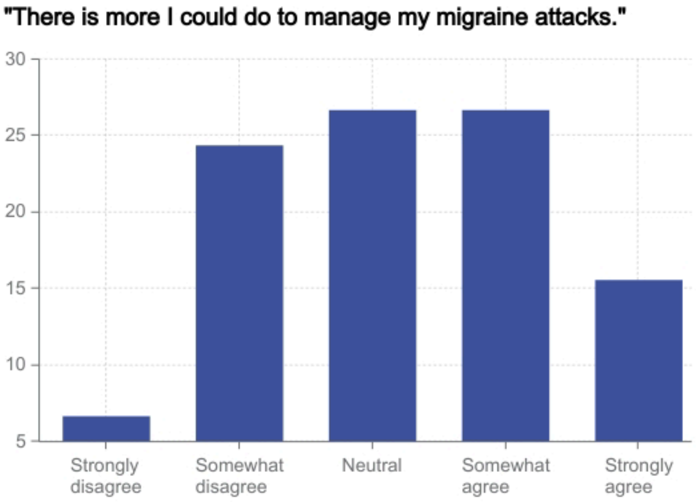
SOCIAL IMAPCT


"Migraines have a significant negative impact on my social life"

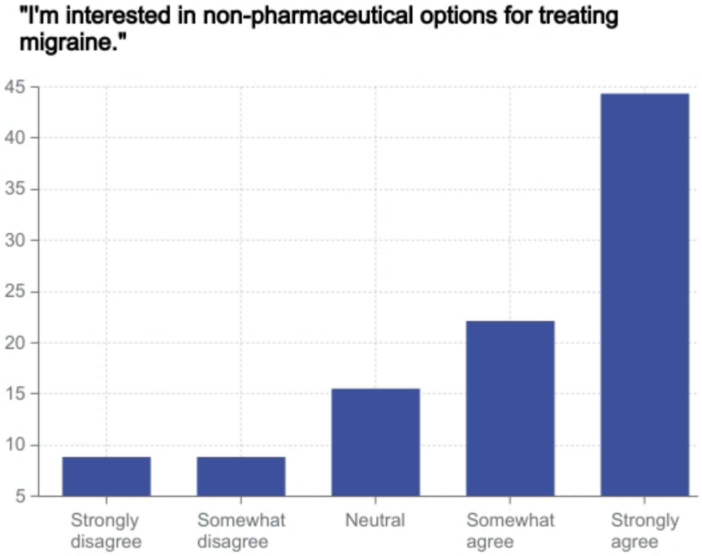
EMOTIONAL IMPACT


"Migraines have a significant negative impact on my emotional wellbeing"

MANAGEMENT



NON-PHARMACEUTICAL INTEREST



Appendix 4: Primary User Research (Interviews)

For my interviews I took the McGill Illness Narrative Questionnaire and modified it to fit my needs. I made the questions migraine-specific, taking out or adding questions as necessary. Additionally, I reordered the sections to optimize the flow of the interview. Here is the original:

McGill Illness Narrative Interview (MINI)

Generic Version for Disease, Illness or Symptom

Danielle Groleau, Allan Young, & Laurence J. Kirmayer C 2006

Section 1. INITIAL ILLNESS NARRATIVE

1. When did you experience your health problem or difficulties (HP) for the first time? *[Substitute respondent's terms for 'HP' in this and subsequent questions.] [Let the narrative go on as long as possible, with only simple prompting by asking,* 'What happened then? And then?']
2. We would like to know more about your experience. Could you tell us when you realized you had this (HP)?
3. Can you tell us what happened when you had your (HP)?
4. Did something else happen? *[Repeat as needed to draw out contiguous experiences and events.]*
5. If you went to see a helper or healer of any kind, tell us about your visit and what happened afterwards.
6. If you went to see a doctor, tell us about your visit to the doctor/hospitalization and about what happened afterwards.
7. Did you have any test of treatments for your (HP)? *[The relevance of this question depends on the type of health problem.]*

Section 2. PROTOTYPE NARRATIVE

1. In the past, have you ever had a health problem that you consider similar to your current (HP)? *[If the answer is Yes, then ask next question]*
2. In what way is that past health problem similar to or different from your current (HP)?
3. Did a person in your family ever experience a health problem similar to yours? *[If the answer is Yes, then ask next question.]*
4. In what ways do you consider your (HP) to be similar to or different from this other person's health problem?
5. Did a person in your social environment (friends or work) experience a health problem similar to yours? *[If the answer is Yes, then ask next question]*
6. In what ways do you consider your (HP) to be similar to or different from this other person's health problem?

7. Have you ever seen, read or heard on television, radio, in a magazine, a book or on the Internet of a person who had the same health problem as you? *[If the answer is Yes, then ask next question.]*
8. In what ways is that person's problem similar to or different from yours?

Section 3. EXPLANATORY MODEL NARRATIVE

1. Do you have another term or expression that describes your (HP)?
2. According to you, what caused your (HP)? *[List primary cause(s).]*
3. Are there any other causes that you think played a role? *[List secondary causes].*
4. Why di you (HP) start when it did?
5. What happened insdide your body that could explain your (HP)?
6. Is there something happening in your family, at work or in your social life that could explain your health problem? [If the answer is Yes, ask next question.]
7. Can you tell me how that explains your health problem?
8. Have you considered that you might have [INTRODUCE POPULAR SYMPTOM OR ILLNESS LABEL]?
9. What does [POPULAR LABEL] mean to you?
10. What usually happens to people who have [POPULAR LABEL]?
11. What is the best treatment for people who have [POPULAR LABEL]?
12. How do other people react to someone who has [POPULAR LABEL]?
13. Who do you know who has had [POPULAR LABEL]?
14. In what ways in your (HP) similar to or different from that person's health problem?
15. Is your (HP) somehow linked or related to specific events that occurred in your life?
16. Can you tell me more about those events and how they are linked your (HP)?

Section 4. SERVICES AND RESPONSE TO TREATMENT

1. During your visit to the doctor (healer) for your HP, what did you doctor (healer) tell you that your problem was?
2. Did your doctor (healer) give you any treatment, medicine, or recommendations to follow? *[List all]*
3. How are you dealing with each of these recommendations? *[Repeat this and the following three questions as needed for every recommendation, medicine and treatment listed.]*
4. Are you able to follow that treatment (or recommendation or medicine)?
5. What made that treatment work well?
   What made that treatment difficult to follow or work poorly?
6. What treatments did you expect to receive for your (HP) that you did not receive?
7. What other therapy, treatment, help or care have you sought out?
8. What other therapy, treatment, or help or care would you like to receive?

Section 5. IMPACT ON LIFE

1. How has your (HP) changed the way you live?
2. How has your (HP) changed the way you feel or think about yourself?

3. How has your (HP) changed the way you look at life in general?
4. How has your (HP) changed the way that others look at you?
5. What has helped you through this period in your life?
6. How have your family or friends helped you through this difficult period of your life?
7. How had your spiritual life, faith or religious practice helped you through this difficult period of your life?
8. Is there anything else you'd like to add?

And here is the modified version:

Modified McGill Illness Narrative Interview (MINI)

Section 1. INITIAL ILLNESS NARRATIVE

1. When did you first start having migraines, and how long have you been having them for?
2. Walk me through an average migraine attack for you – what do you think, feel, and do?
3. Have you ever gone to see a doctor of any kind for your migraines?
4. If you went to see a doctor, tell me about your visit.

Section 4. SERVICES AND RESPONSE TO TREATMENT

1. Did your doctor give you any treatment, medicine, or recommendations to follow?
2. Are you able to follow that treatment, medicine, or recommendation?
3. What made the treatment work well?
4. What made the treatment difficult to follow or work poorly?
5. Do you feel that there could be more that you could do to manage your migraines?
6. Do you believe there are any barriers between you and your desired level of migraine management? What are they?
7. Are there any other therapies or treatments you have sought out or would like to receive for your migraines?
8. Have you ever purchased a product to treat or manage your migraine pain?

Section 3. EXPLANATORY MODEL NARRATIVE

1. According to you, what causes your migraines?
2. Are there any other causes that you think play a role?
3. What is the best treatment for people who have migraine?
4. How do other people react to someone who has migraine?
5. Do you record your migraine attacks? If so, how?

Section 2. PROTOTYPE NARRATIVE

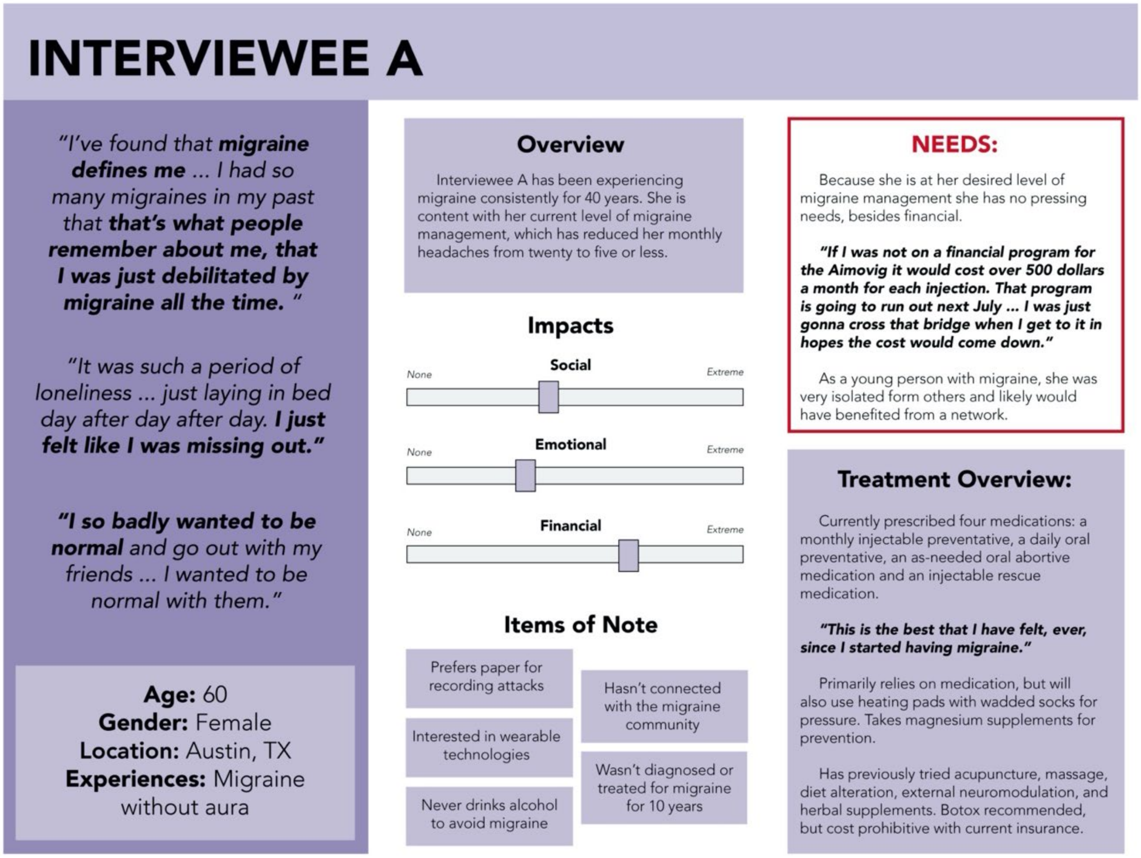
1. Has a person in your family or social circle ever experienced migraine?
2. Has this person or people impacted the ways in which you manage your migraines?

Section 5. IMPACT ON LIFE

1. How have your migraines impacted the way you live?
2. How have your migraines changed the way you feel or think about yourself?
3. How have your migraines changed the way you look at life in general?
4. How have your migraines changed the way others look at you?
5. What has helped you through periods in your life when you’ve had migraine attacks?
6. How have your friends or family helped you through this period in your life?
7. Is there anything else you would like to add?

Appendix 5: Interviewee Profiles

After conducting my six user interviews, I compiled the significant findings from each into anonymized interviewee profiles. This allowed me to more easily identify trends and important areas to address in my design solution.



INTERVIEWEE A

*"I've found that **migraine defines me** ... I had so many migraines in my past that **that's what people remember about me, that I was just debilitated by migraine all the time.** "*

*"It was such a period of loneliness ... just laying in bed day after day after day. **I just felt like I was missing out."***

***"I so badly wanted to be normal** and go out with my friends ... I wanted to be normal with them."*

Age: 60
Gender: Female
Location: Austin, TX
Experiences: Migraine without aura

Overview

Interviewee A has been experiencing migraine consistently for 40 years. She is content with her current level of migraine management, which has reduced her monthly headaches from twenty to five or less.

Impacts

Items of Note

- Prefers paper for recording attacks
- Interested in wearable technologies
- Never drinks alcohol to avoid migraine
- Hasn't connected with the migraine community
- Wasn't diagnosed or treated for migraine for 10 years

NEEDS:

Because she is at her desired level of migraine management she has no pressing needs, besides financial.

"If I was not on a financial program for the Aimovig it would cost over 500 dollars a month for each injection. That program is going to run out next July ... I was just gonna cross that bridge when I get to it in hopes the cost would come down."

As a young person with migraine, she was very isolated form others and likely would have benefited from a network.

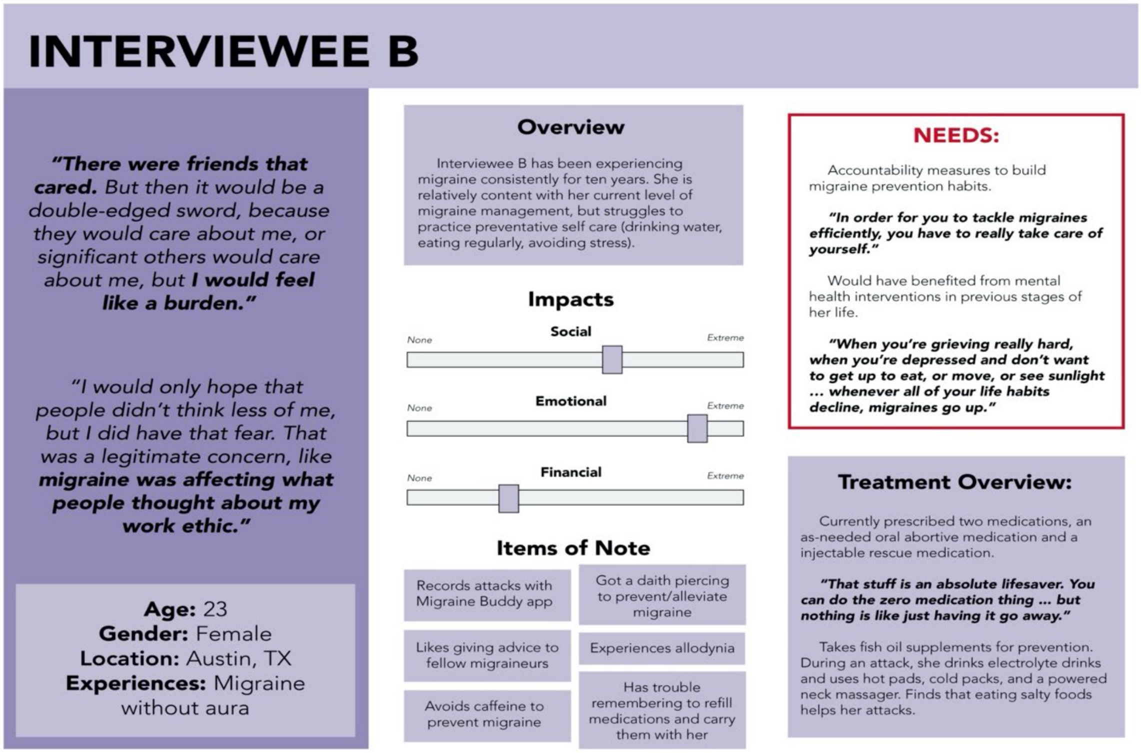
Treatment Overview:

Currently prescribed four medications: a monthly injectable preventative, a daily oral preventative, an as-needed oral abortive medication and an injectable rescue medication.

"This is the best that I have felt, ever, since I started having migraine."

Primarily relies on medication, but will also use heating pads with wadded socks for pressure. Takes magnesium supplements for prevention.

Has previously tried acupuncture, massage, diet alteration, external neuromodulation, and herbal supplements. Botox recommended, but cost prohibitive with current insurance.



INTERVIEWEE B

"There were friends that cared. *But then it would be a double-edged sword, because they would care about me, or significant others would care about me, but* ***I would feel like a burden."***

"I would only hope that people didn't think less of me, but I did have that fear. That was a legitimate concern, like ***migraine was affecting what people thought about my work ethic."***

Age: 23
Gender: Female
Location: Austin, TX
Experiences: Migraine without aura

Overview

Interviewee B has been experiencing migraine consistently for ten years. She is relatively content with her current level of migraine management, but struggles to practice preventative self care (drinking water, eating regularly, avoiding stress).

Impacts

Social

Emotional

Financial

Items of Note

Records attacks with Migraine Buddy app	Got a daith piercing to prevent/alleviate migraine
Likes giving advice to fellow migraineurs	Experiences allodynia
Avoids caffeine to prevent migraine	Has trouble remembering to refill medications and carry them with her

NEEDS:

Accountability measures to build migraine prevention habits.

"In order for you to tackle migraines efficiently, you have to really take care of yourself."

Would have benefited from mental health interventions in previous stages of her life.

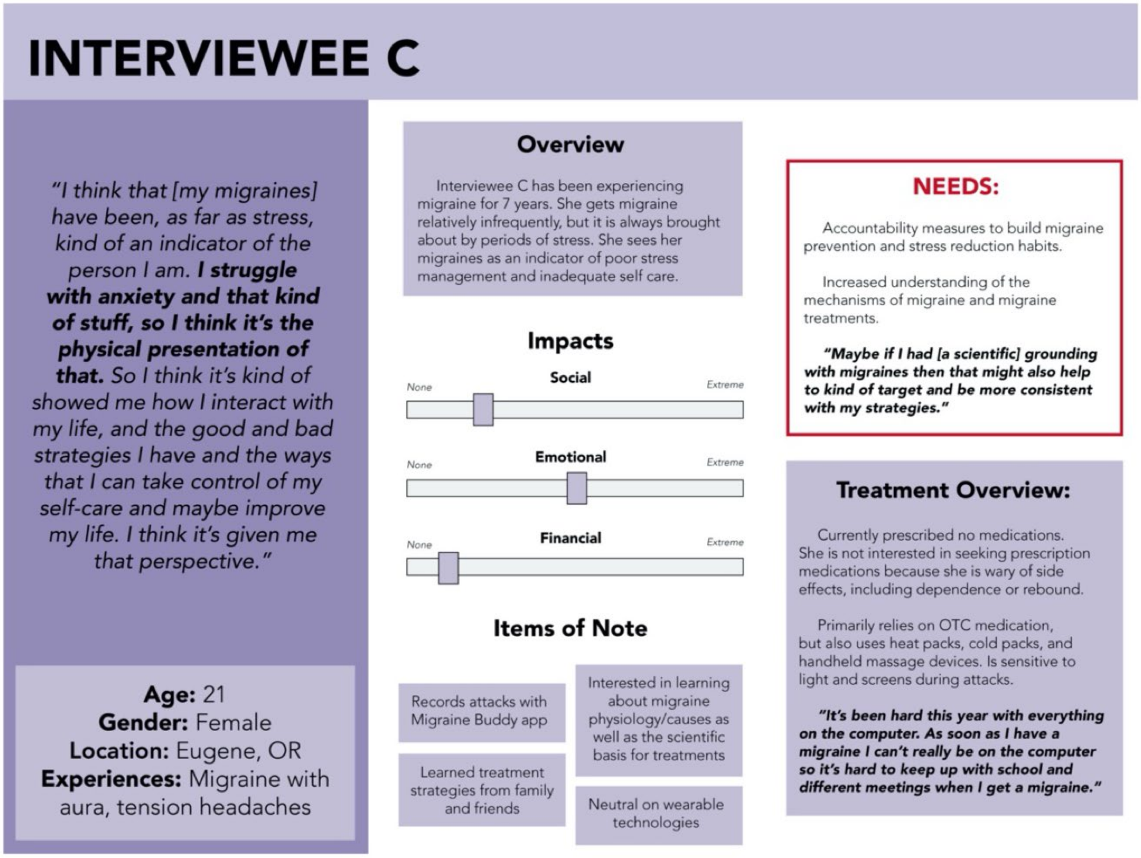
"When you're grieving really hard, when you're depressed and don't want to get up to eat, or move, or see sunlight … whenever all of your life habits decline, migraines go up."

Treatment Overview:

Currently prescribed two medications, an as-needed oral abortive medication and a injectable rescue medication.

"That stuff is an absolute lifesaver. You can do the zero medication thing … but nothing is like just having it go away."

Takes fish oil supplements for prevention. During an attack, she drinks electrolyte drinks and uses hot pads, cold packs, and a powered neck massager. Finds that eating salty foods helps her attacks.



INTERVIEWEE C

"I think that [my migraines] have been, as far as stress, kind of an indicator of the person I am. ***I struggle with anxiety and that kind of stuff, so I think it's the physical presentation of that.*** *So I think it's kind of showed me how I interact with my life, and the good and bad strategies I have and the ways that I can take control of my self-care and maybe improve my life. I think it's given me that perspective."*

Age: 21
Gender: Female
Location: Eugene, OR
Experiences: Migraine with aura, tension headaches

Overview

Interviewee C has been experiencing migraine for 7 years. She gets migraine relatively infrequently, but it is always brought about by periods of stress. She sees her migraines as an indicator of poor stress management and inadequate self care.

Impacts

Items of Note

- Records attacks with Migraine Buddy app
- Learned treatment strategies from family and friends
- Interested in learning about migraine physiology/causes as well as the scientific basis for treatments
- Neutral on wearable technologies

NEEDS:

Accountability measures to build migraine prevention and stress reduction habits.

Increased understanding of the mechanisms of migraine and migraine treatments.

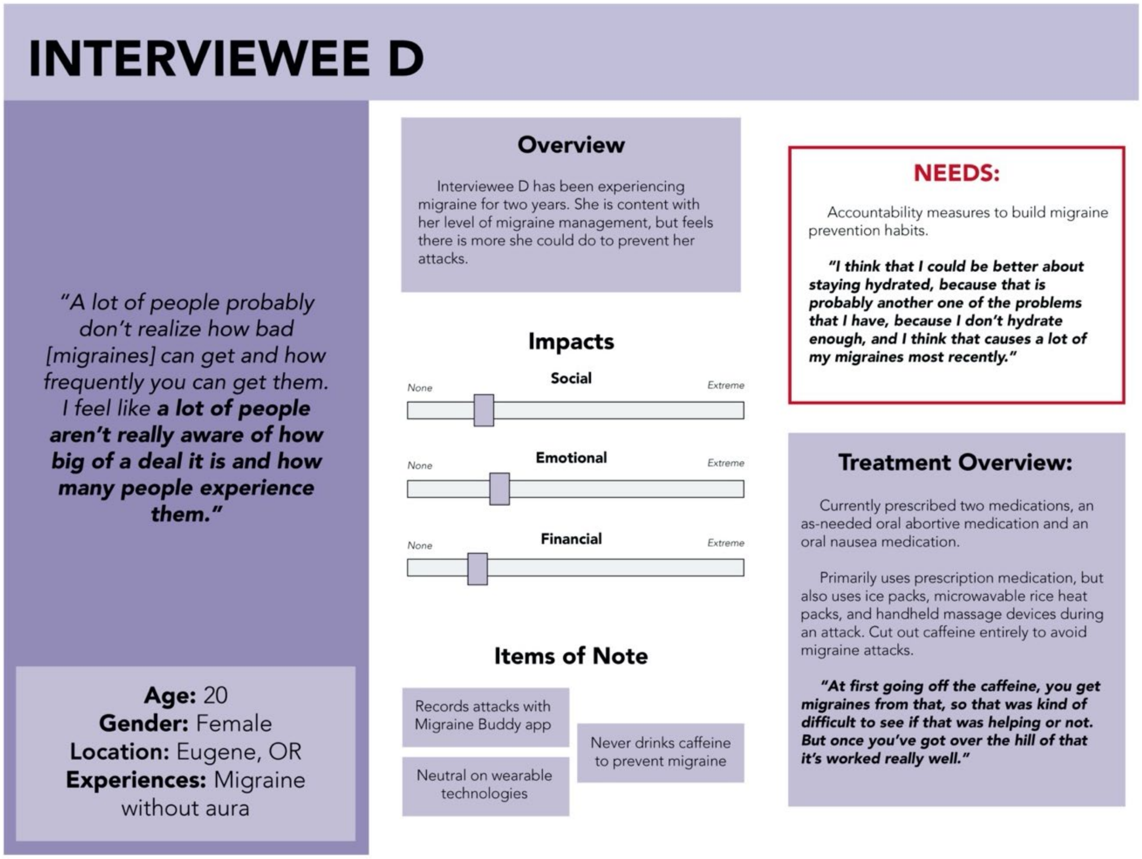
"Maybe if I had [a scientific] grounding with migraines then that might also help to kind of target and be more consistent with my strategies."

Treatment Overview:

Currently prescribed no medications. She is not interested in seeking prescription medications because she is wary of side effects, including dependence or rebound.

Primarily relies on OTC medication, but also uses heat packs, cold packs, and handheld massage devices. Is sensitive to light and screens during attacks.

"It's been hard this year with everything on the computer. As soon as I have a migraine I can't really be on the computer so it's hard to keep up with school and different meetings when I get a migraine."



INTERVIEWEE D

"A lot of people probably don't realize how bad [migraines] can get and how frequently you can get them. I feel like ***a lot of people aren't really aware of how big of a deal it is and how many people experience them."***

Age: 20
Gender: Female
Location: Eugene, OR
Experiences: Migraine without aura

Overview

Interviewee D has been experiencing migraine for two years. She is content with her level of migraine management, but feels there is more she could do to prevent her attacks.

Impacts

Items of Note

- Records attacks with Migraine Buddy app
- Neutral on wearable technologies
- Never drinks caffeine to prevent migraine

NEEDS:

Accountability measures to build migraine prevention habits.

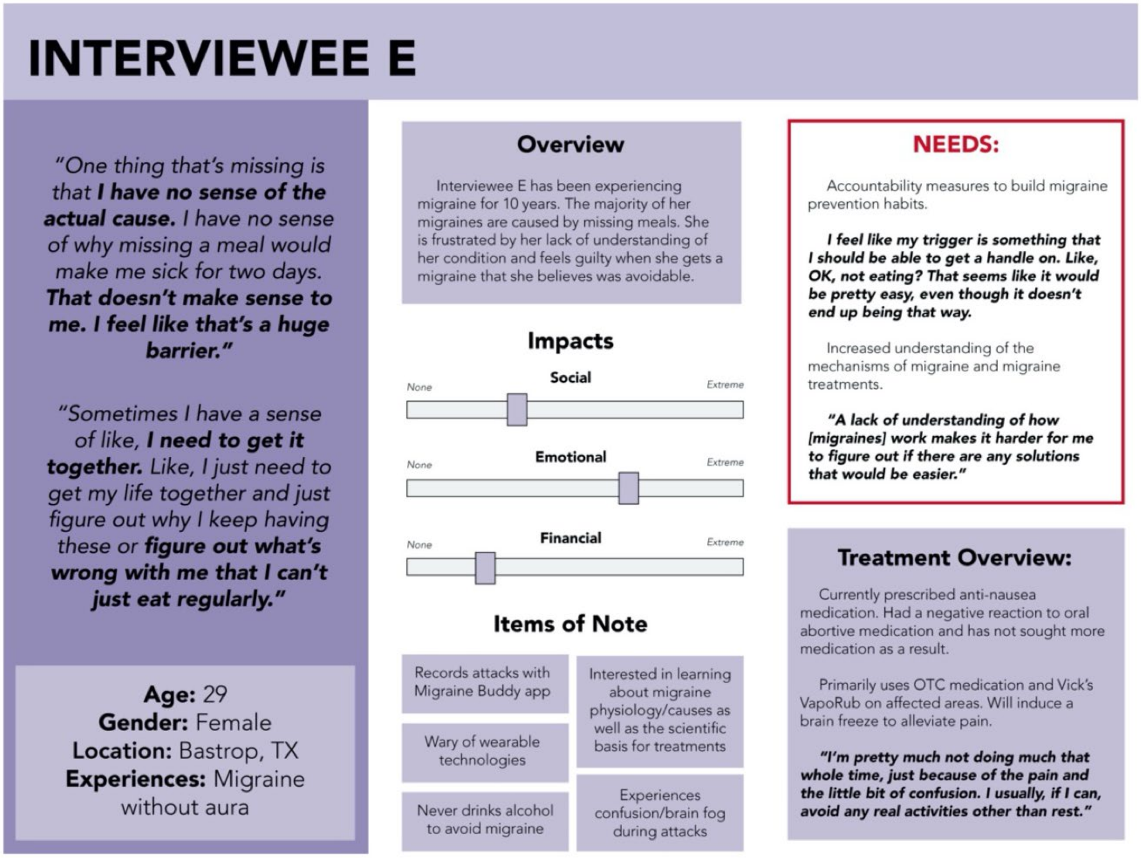
"I think that I could be better about staying hydrated, because that is probably another one of the problems that I have, because I don't hydrate enough, and I think that causes a lot of my migraines most recently."

Treatment Overview:

Currently prescribed two medications, an as-needed oral abortive medication and an oral nausea medication.

Primarily uses prescription medication, but also uses ice packs, microwavable rice heat packs, and handheld massage devices during an attack. Cut out caffeine entirely to avoid migraine attacks.

"At first going off the caffeine, you get migraines from that, so that was kind of difficult to see if that was helping or not. But once you've got over the hill of that it's worked really well."



INTERVIEWEE E

*"One thing that's missing is that **I have no sense of the actual cause.** I have no sense of why missing a meal would make me sick for two days. **That doesn't make sense to me. I feel like that's a huge barrier."***

*"Sometimes I have a sense of like, **I need to get it together.** Like, I just need to get my life together and just figure out why I keep having these or **figure out what's wrong with me that I can't just eat regularly."***

Age: 29
Gender: Female
Location: Bastrop, TX
Experiences: Migraine without aura

Overview

Interviewee E has been experiencing migraine for 10 years. The majority of her migraines are caused by missing meals. She is frustrated by her lack of understanding of her condition and feels guilty when she gets a migraine that she believes was avoidable.

Impacts

Items of Note

- Records attacks with Migraine Buddy app
- Wary of wearable technologies
- Never drinks alcohol to avoid migraine
- Interested in learning about migraine physiology/causes as well as the scientific basis for treatments
- Experiences confusion/brain fog during attacks

NEEDS:

Accountability measures to build migraine prevention habits.

I feel like my trigger is something that I should be able to get a handle on. Like, OK, not eating? That seems like it would be pretty easy, even though it doesn't end up being that way.

Increased understanding of the mechanisms of migraine and migraine treatments.

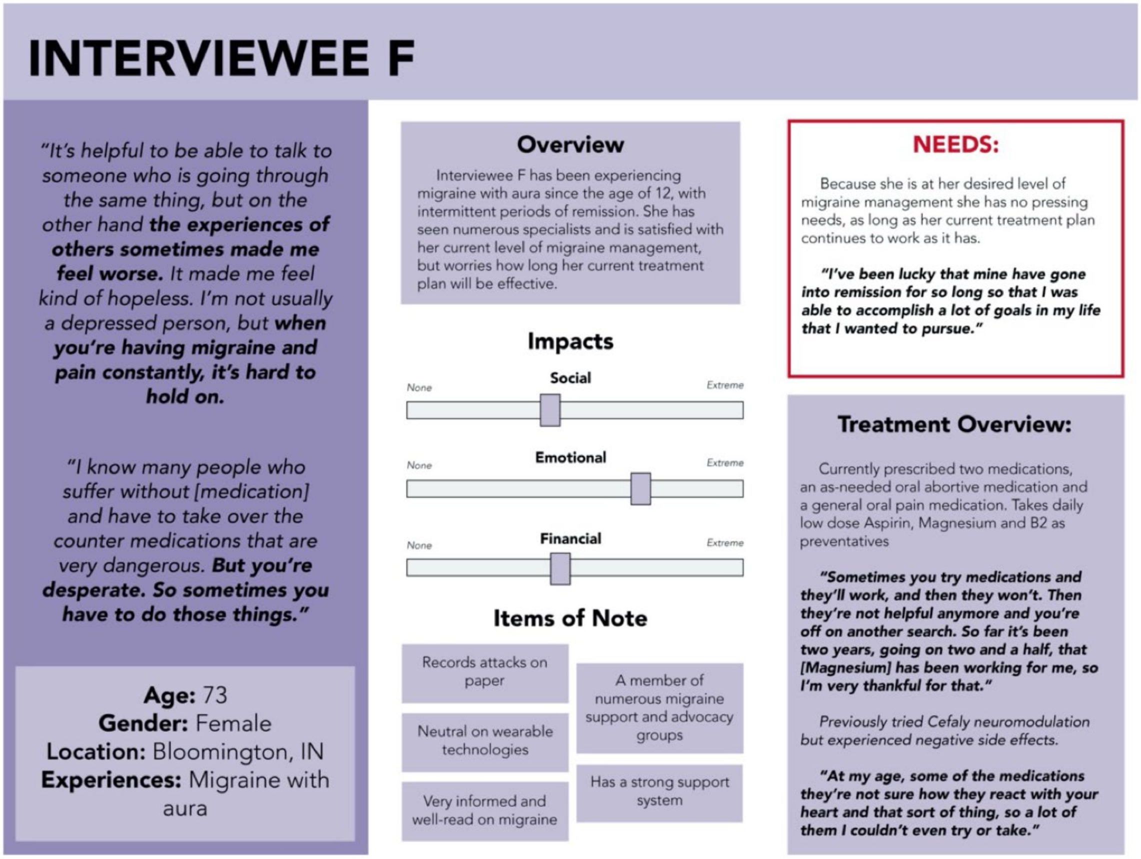
"A lack of understanding of how [migraines] work makes it harder for me to figure out if there are any solutions that would be easier."

Treatment Overview:

Currently prescribed anti-nausea medication. Had a negative reaction to oral abortive medication and has not sought more medication as a result.

Primarily uses OTC medication and Vick's VapoRub on affected areas. Will induce a brain freeze to alleviate pain.

"I'm pretty much not doing much that whole time, just because of the pain and the little bit of confusion. I usually, if I can, avoid any real activities other than rest."



INTERVIEWEE F

"It's helpful to be able to talk to someone who is going through the same thing, but on the other hand ***the experiences of others sometimes made me feel worse.*** *It made me feel kind of hopeless. I'm not usually a depressed person, but* ***when you're having migraine and pain constantly, it's hard to hold on.***

"I know many people who suffer without [medication] and have to take over the counter medications that are very dangerous. ***But you're desperate. So sometimes you have to do those things."***

Age: 73
Gender: Female
Location: Bloomington, IN
Experiences: Migraine with aura

Overview

Interviewee F has been experiencing migraine with aura since the age of 12, with intermittent periods of remission. She has seen numerous specialists and is satisfied with her current level of migraine management, but worries how long her current treatment plan will be effective.

Impacts

Items of Note

- Records attacks on paper
- Neutral on wearable technologies
- Very informed and well-read on migraine
- A member of numerous migraine support and advocacy groups
- Has a strong support system

NEEDS:

Because she is at her desired level of migraine management she has no pressing needs, as long as her current treatment plan continues to work as it has.

"I've been lucky that mine have gone into remission for so long so that I was able to accomplish a lot of goals in my life that I wanted to pursue."

Treatment Overview:

Currently prescribed two medications, an as-needed oral abortive medication and a general oral pain medication. Takes daily low dose Aspirin, Magnesium and B2 as preventatives

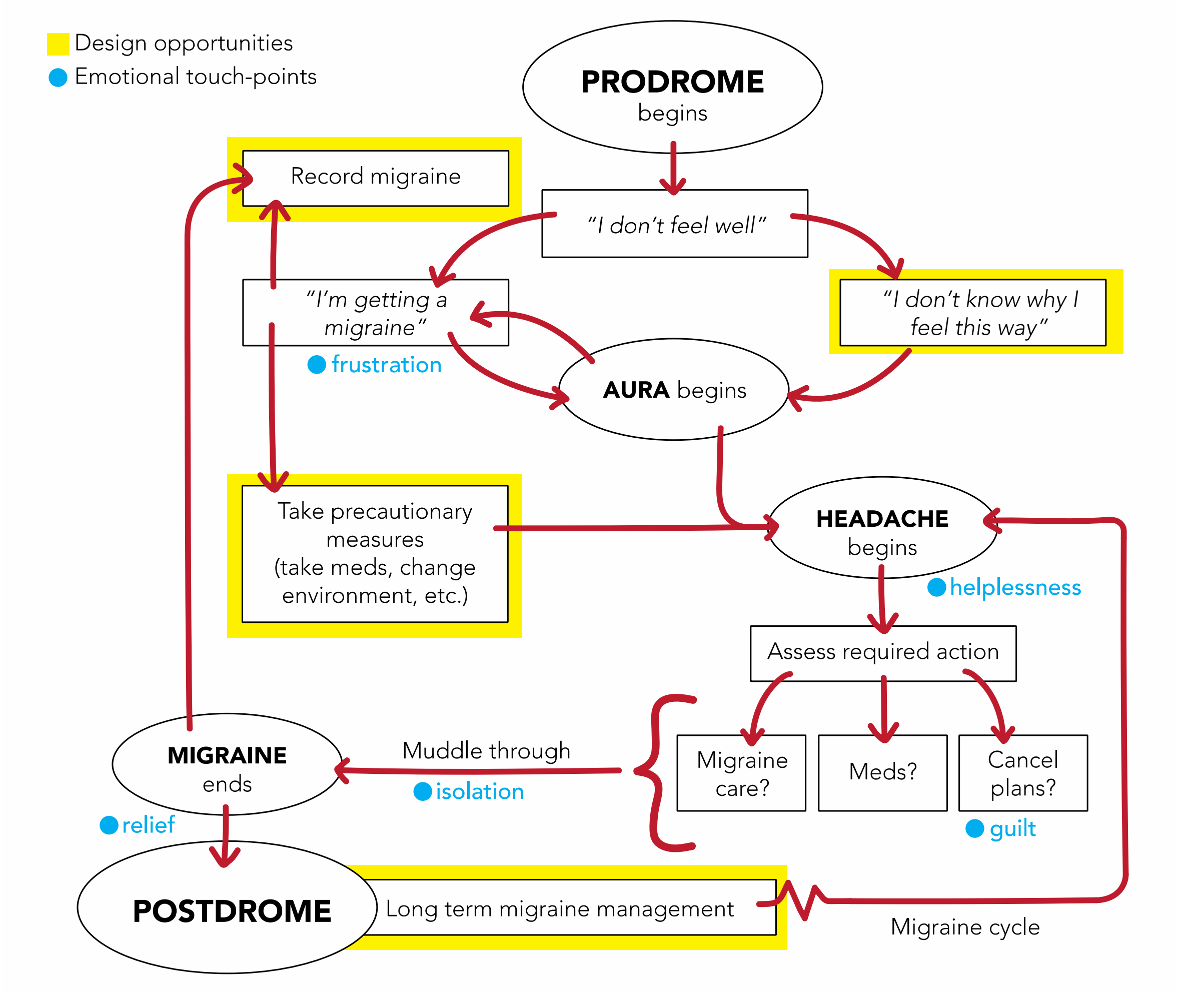
"Sometimes you try medications and they'll work, and then they won't. Then they're not helpful anymore and you're off on another search. So far it's been two years, going on two and a half, that [Magnesium] has been working for me, so I'm very thankful for that."

Previously tried Cefaly neuromodulation but experienced negative side effects.

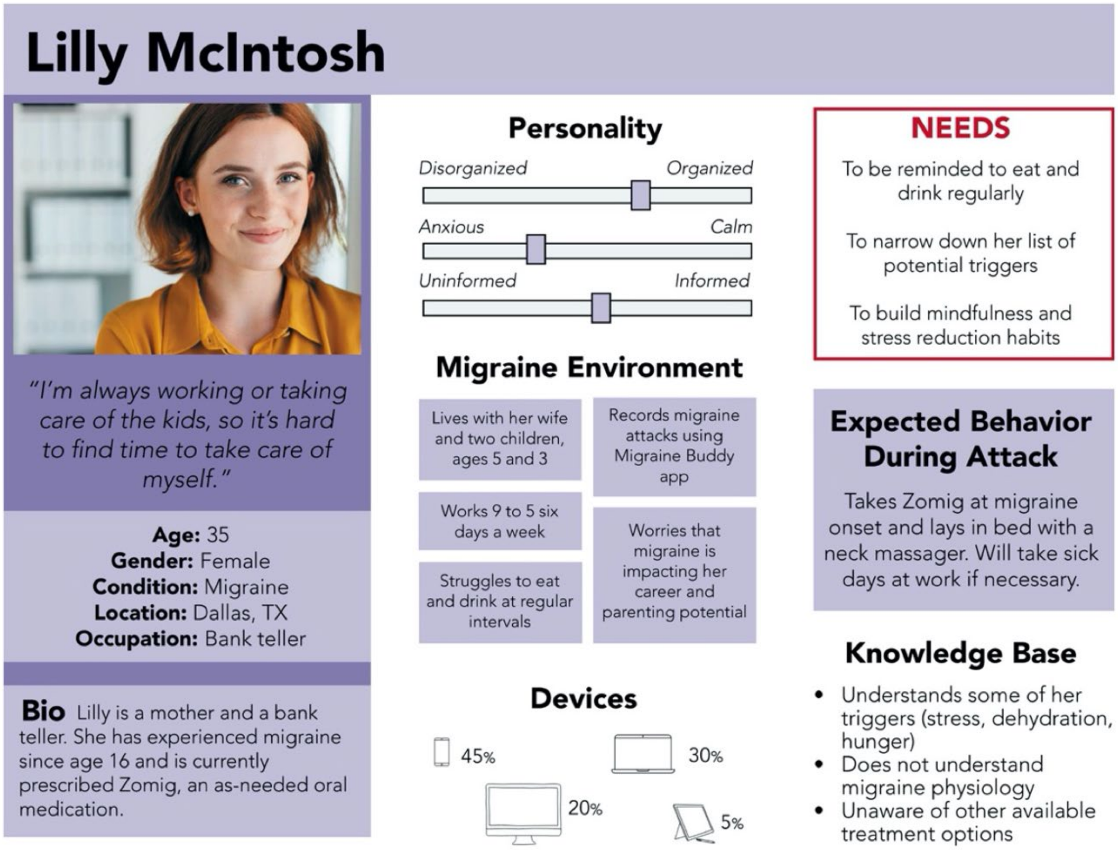
"At my age, some of the medications they're not sure how they react with your heart and that sort of thing, so a lot of them I couldn't even try or take."

Appendix 6: Task Flow Analysis

Below is the Task Flow Analysis for a migraine attack. Note that typically, attacks last between 4 and 72 hours, though there are outlying cases.



Appendix 7: Personas



Lilly McIntosh

"I'm always working or taking care of the kids, so it's hard to find time to take care of myself."

Age: 35
Gender: Female
Condition: Migraine
Location: Dallas, TX
Occupation: Bank teller

Bio Lilly is a mother and a bank teller. She has experienced migraine since age 16 and is currently prescribed Zomig, an as-needed oral medication.

Personality

Disorganized — *Organized*
Anxious — *Calm*
Uninformed — *Informed*

Migraine Environment

- Lives with her wife and two children, ages 5 and 3
- Works 9 to 5 six days a week
- Struggles to eat and drink at regular intervals
- Records migraine attacks using Migraine Buddy app
- Worries that migraine is impacting her career and parenting potential

Devices

45%
30%
20%
5%

NEEDS

To be reminded to eat and drink regularly

To narrow down her list of potential triggers

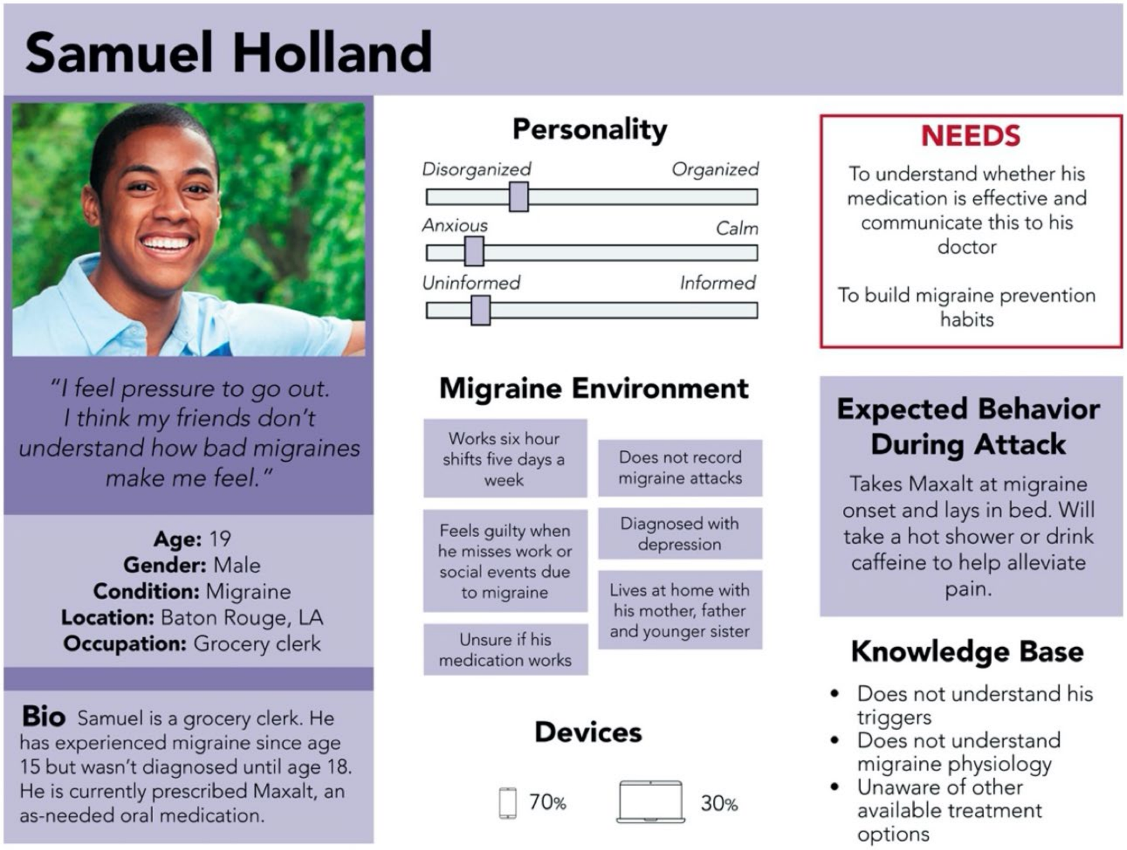
To build mindfulness and stress reduction habits

Expected Behavior During Attack

Takes Zomig at migraine onset and lays in bed with a neck massager. Will take sick days at work if necessary.

Knowledge Base

- Understands some of her triggers (stress, dehydration, hunger)
- Does not understand migraine physiology
- Unaware of other available treatment options



Samuel Holland

"I feel pressure to go out. I think my friends don't understand how bad migraines make me feel."

Age: 19
Gender: Male
Condition: Migraine
Location: Baton Rouge, LA
Occupation: Grocery clerk

Bio Samuel is a grocery clerk. He has experienced migraine since age 15 but wasn't diagnosed until age 18. He is currently prescribed Maxalt, an as-needed oral medication.

Personality

Migraine Environment

- Works six hour shifts five days a week
- Feels guilty when he misses work or social events due to migraine
- Unsure if his medication works
- Does not record migraine attacks
- Diagnosed with depression
- Lives at home with his mother, father and younger sister

Devices

📱 70%
💻 30%

NEEDS

To understand whether his medication is effective and communicate this to his doctor

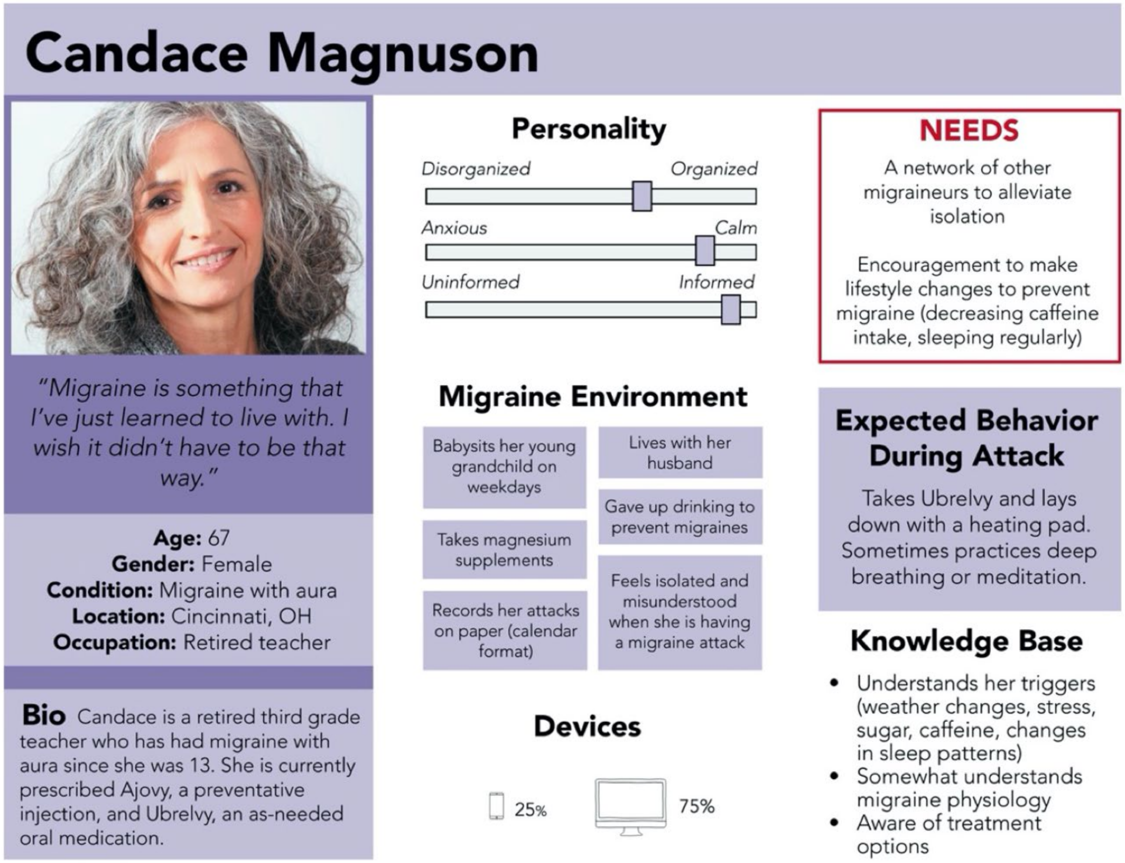
To build migraine prevention habits

Expected Behavior During Attack

Takes Maxalt at migraine onset and lays in bed. Will take a hot shower or drink caffeine to help alleviate pain.

Knowledge Base

- Does not understand his triggers
- Does not understand migraine physiology
- Unaware of other available treatment options



Candace Magnuson

"Migraine is something that I've just learned to live with. I wish it didn't have to be that way."

Age: 67
Gender: Female
Condition: Migraine with aura
Location: Cincinnati, OH
Occupation: Retired teacher

Bio Candace is a retired third grade teacher who has had migraine with aura since she was 13. She is currently prescribed Ajovy, a preventative injection, and Ubrelvy, an as-needed oral medication.

Personality

Migraine Environment

- Babysits her young grandchild on weekdays
- Takes magnesium supplements
- Records her attacks on paper (calendar format)
- Lives with her husband
- Gave up drinking to prevent migraines
- Feels isolated and misunderstood when she is having a migraine attack

Devices

NEEDS

A network of other migraineurs to alleviate isolation

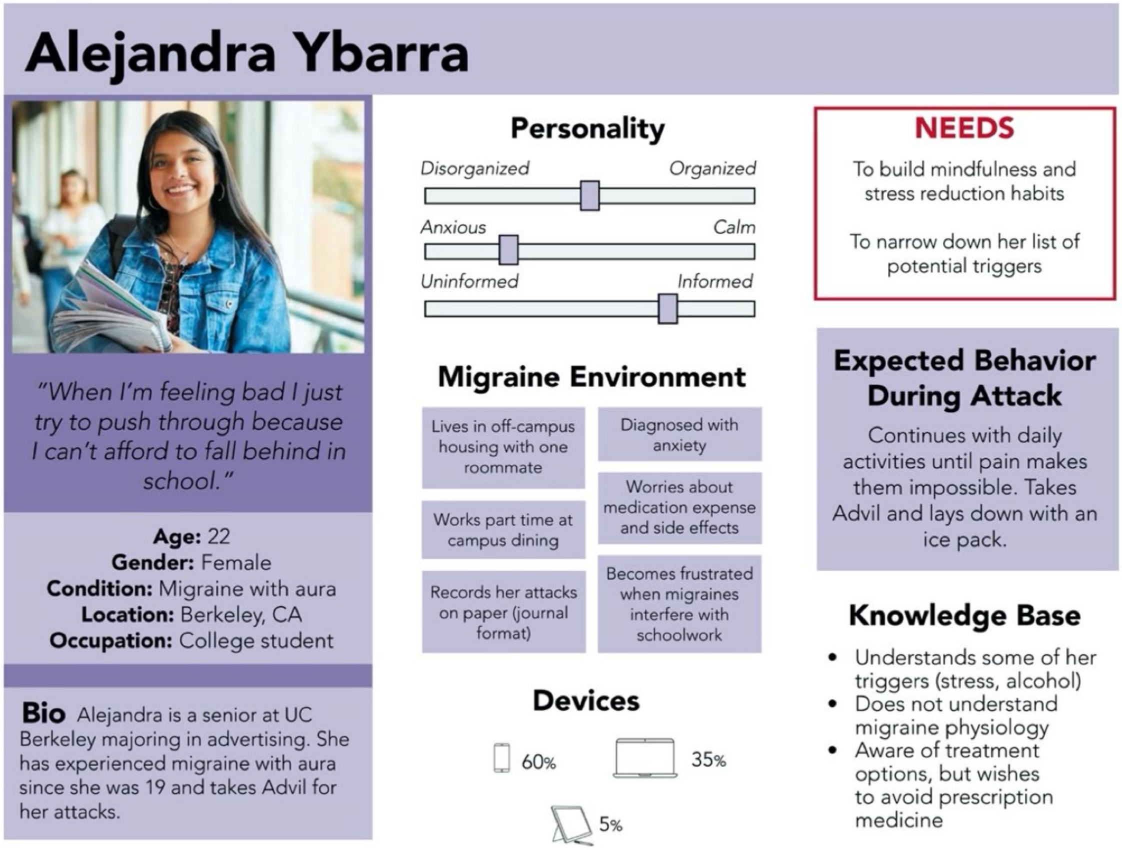
Encouragement to make lifestyle changes to prevent migraine (decreasing caffeine intake, sleeping regularly)

Expected Behavior During Attack

Takes Ubrelvy and lays down with a heating pad. Sometimes practices deep breathing or meditation.

Knowledge Base

- Understands her triggers (weather changes, stress, sugar, caffeine, changes in sleep patterns)
- Somewhat understands migraine physiology
- Aware of treatment options



Alejandra Ybarra

"When I'm feeling bad I just try to push through because I can't afford to fall behind in school."

Age: 22
Gender: Female
Condition: Migraine with aura
Location: Berkeley, CA
Occupation: College student

Bio Alejandra is a senior at UC Berkeley majoring in advertising. She has experienced migraine with aura since she was 19 and takes Advil for her attacks.

Personality

Migraine Environment

- Lives in off-campus housing with one roommate
- Works part time at campus dining
- Records her attacks on paper (journal format)
- Diagnosed with anxiety
- Worries about medication expense and side effects
- Becomes frustrated when migraines interfere with schoolwork

Devices

📱 60%
💻 35%
5%

NEEDS

To build mindfulness and stress reduction habits

To narrow down her list of potential triggers

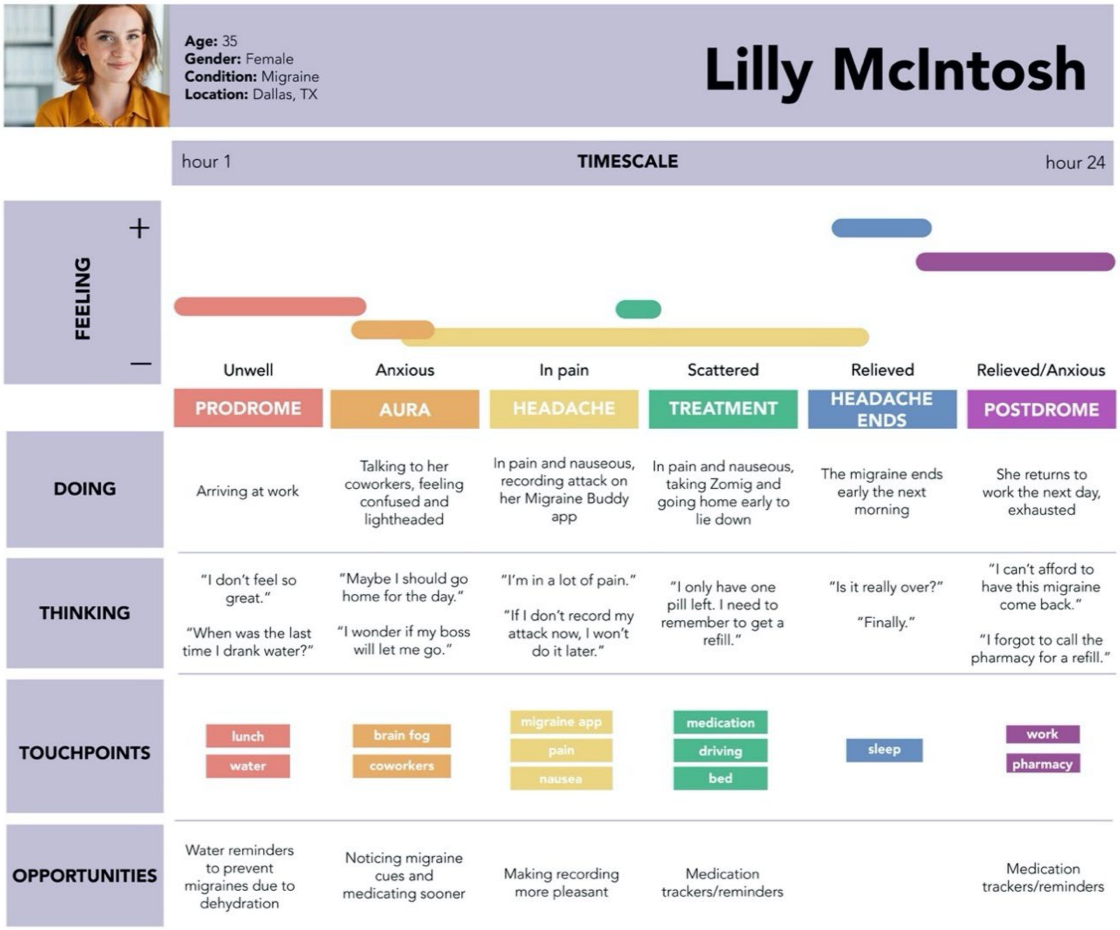
Expected Behavior During Attack

Continues with daily activities until pain makes them impossible. Takes Advil and lays down with an ice pack.

Knowledge Base

- Understands some of her triggers (stress, alcohol)
- Does not understand migraine physiology
- Aware of treatment options, but wishes to avoid prescription medicine

Appendix 8: User Experience Maps

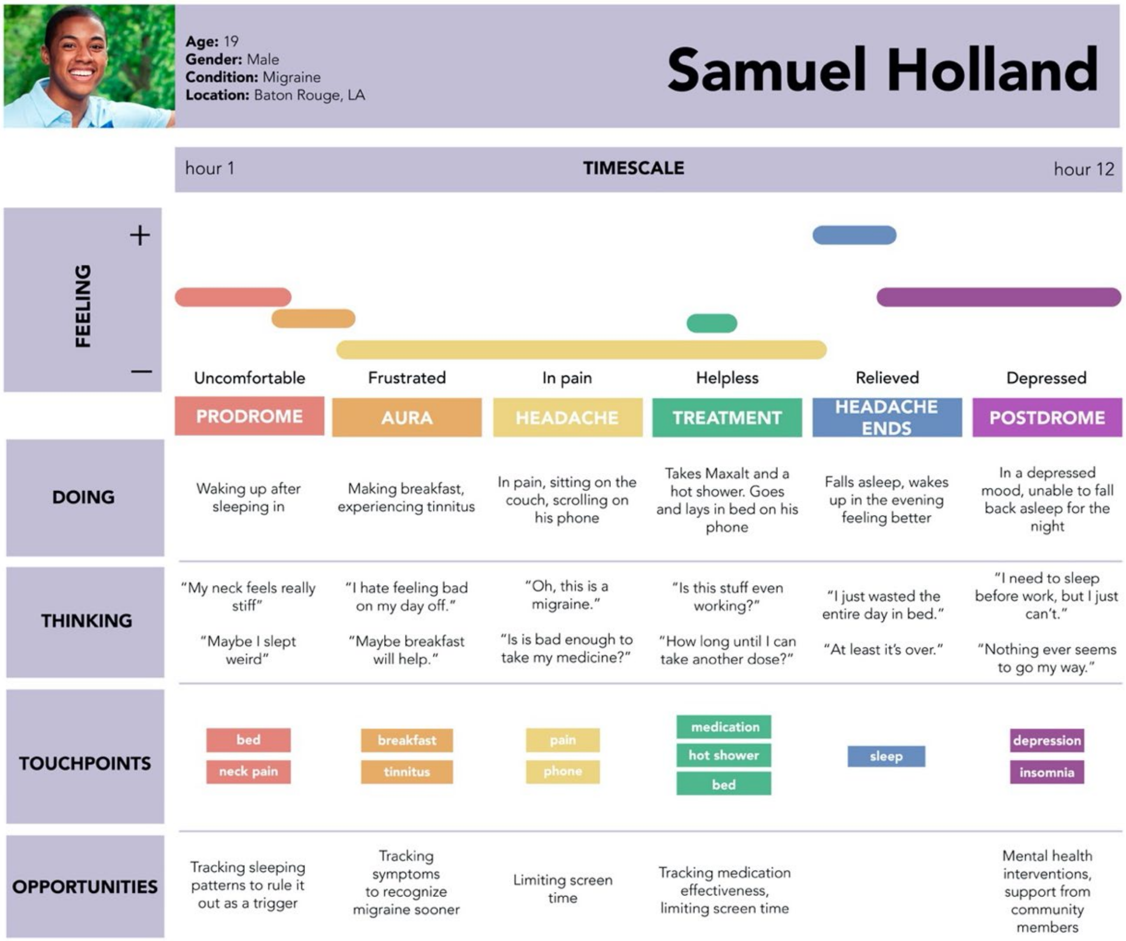


Age: 35
Gender: Female
Condition: Migraine
Location: Dallas, TX

Lilly McIntosh

hour 1 **TIMESCALE** hour 24

	PRODROME	**AURA**	**HEADACHE**	**TREATMENT**	**HEADACHE ENDS**	**POSTDROME**
FEELING + –	Unwell	Anxious	In pain	Scattered	Relieved	Relieved/Anxious
DOING	Arriving at work	Talking to her coworkers, feeling confused and lightheaded	In pain and nauseous, recording attack on her Migraine Buddy app	In pain and nauseous, taking Zomig and going home early to lie down	The migraine ends early the next morning	She returns to work the next day, exhausted
THINKING	"I don't feel so great." "When was the last time I drank water?"	"Maybe I should go home for the day." "I wonder if my boss will let me go."	"I'm in a lot of pain." "If I don't record my attack now, I won't do it later."	"I only have one pill left. I need to remember to get a refill."	"Is it really over?" "Finally."	"I can't afford to have this migraine come back." "I forgot to call the pharmacy for a refill."
TOUCHPOINTS	lunch water	brain fog coworkers	migraine app pain nausea	medication driving bed	sleep	work pharmacy
OPPORTUNITIES	Water reminders to prevent migraines due to dehydration	Noticing migraine cues and medicating sooner	Making recording more pleasant	Medication trackers/reminders		Medication trackers/reminders

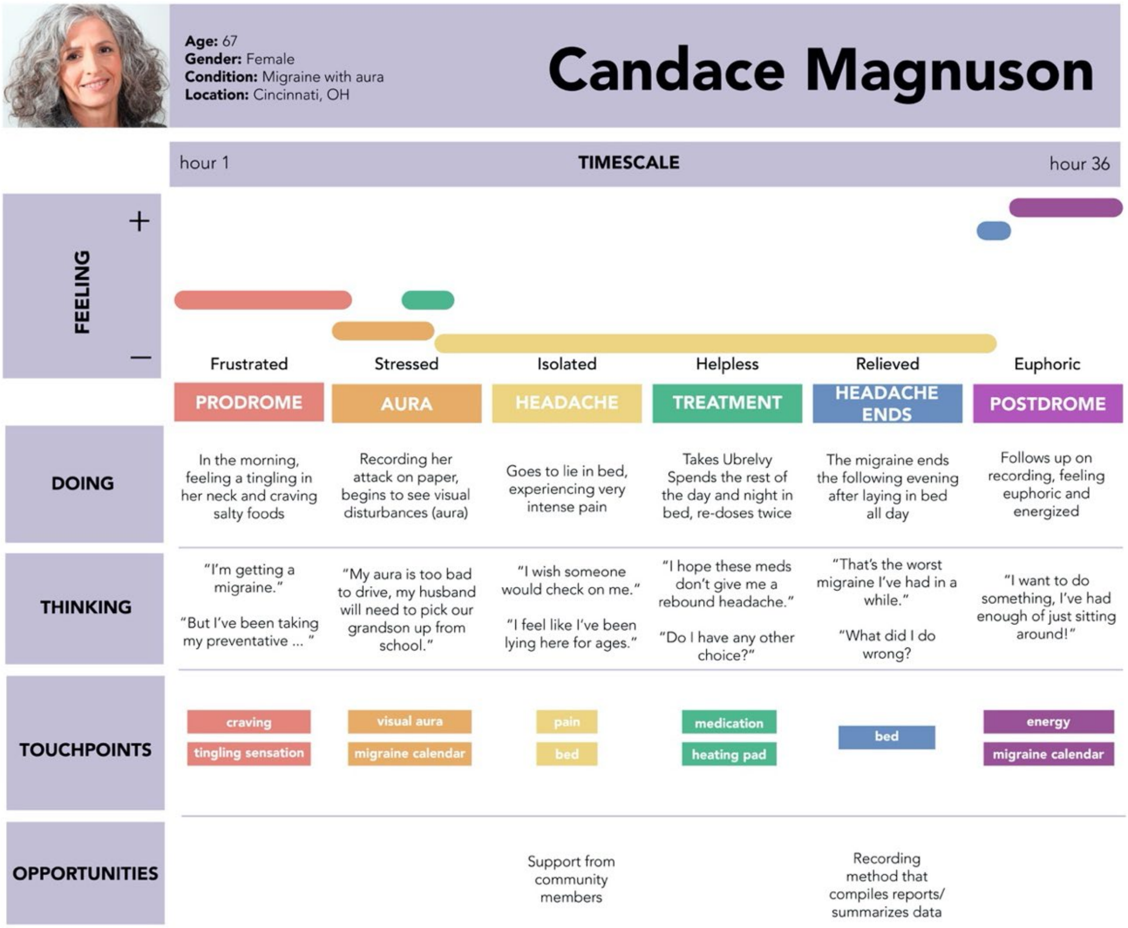


Age: 19
Gender: Male
Condition: Migraine
Location: Baton Rouge, LA

Samuel Holland

hour 1 — **TIMESCALE** — hour 12

FEELING	Uncomfortable	Frustrated	In pain	Helpless	Relieved	Depressed
	PRODROME	**AURA**	**HEADACHE**	**TREATMENT**	**HEADACHE ENDS**	**POSTDROME**
DOING	Waking up after sleeping in	Making breakfast, experiencing tinnitus	In pain, sitting on the couch, scrolling on his phone	Takes Maxalt and a hot shower. Goes and lays in bed on his phone	Falls asleep, wakes up in the evening feeling better	In a depressed mood, unable to fall back asleep for the night
THINKING	"My neck feels really stiff" "Maybe I slept weird"	"I hate feeling bad on my day off." "Maybe breakfast will help."	"Oh, this is a migraine." "Is is bad enough to take my medicine?"	"Is this stuff even working?" "How long until I can take another dose?"	"I just wasted the entire day in bed." "At least it's over."	"I need to sleep before work, but I just can't." "Nothing ever seems to go my way."
TOUCHPOINTS	bed neck pain	breakfast tinnitus	pain phone	medication hot shower bed	sleep	depression insomnia
OPPORTUNITIES	Tracking sleeping patterns to rule it out as a trigger	Tracking symptoms to recognize migraine sooner	Limiting screen time	Tracking medication effectiveness, limiting screen time		Mental health interventions, support from community members

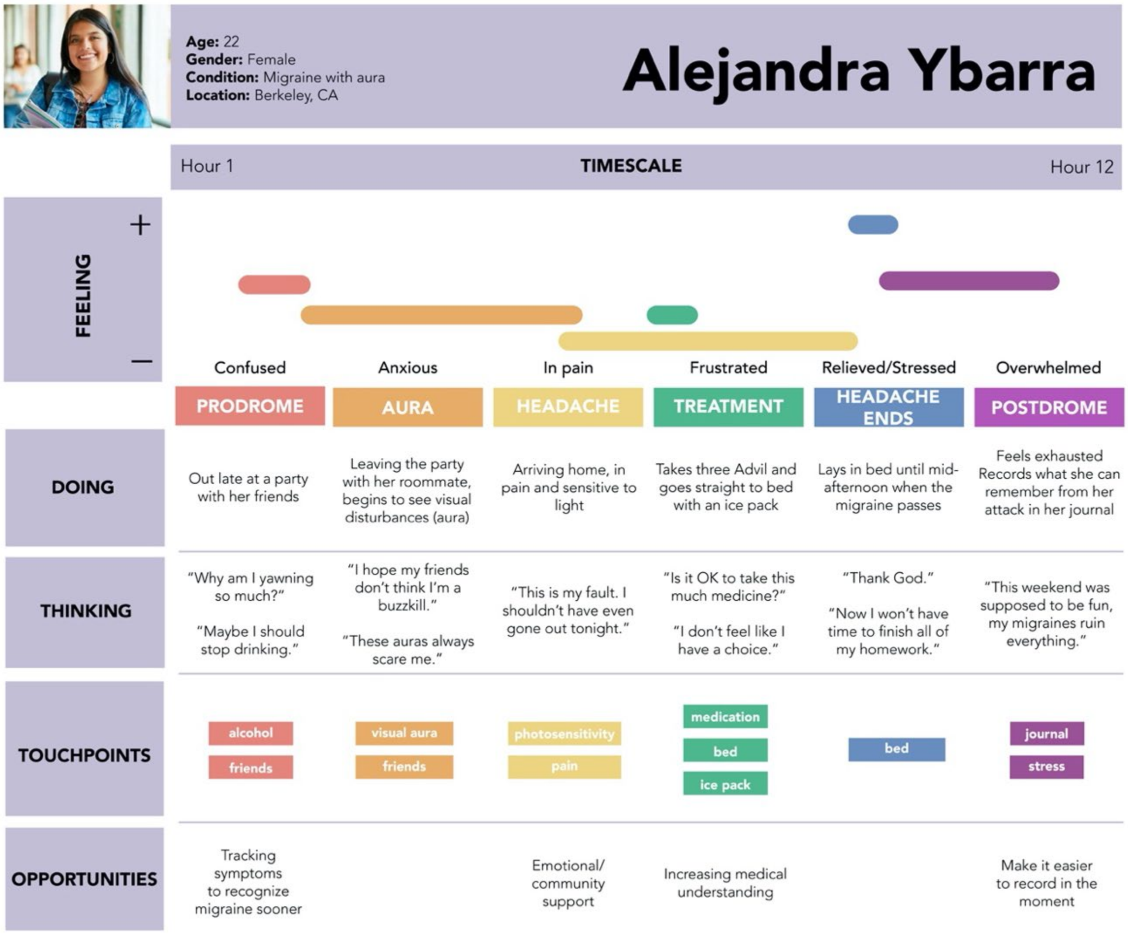


Age: 67
Gender: Female
Condition: Migraine with aura
Location: Cincinnati, OH

Candace Magnuson

hour 1 — **TIMESCALE** — hour 36

	PRODROME	AURA	HEADACHE	TREATMENT	HEADACHE ENDS	POSTDROME
FEELING (+ / —)	Frustrated	Stressed	Isolated	Helpless	Relieved	Euphoric
DOING	In the morning, feeling a tingling in her neck and craving salty foods	Recording her attack on paper, begins to see visual disturbances (aura)	Goes to lie in bed, experiencing very intense pain	Takes Ubrelvy Spends the rest of the day and night in bed, re-doses twice	The migraine ends the following evening after laying in bed all day	Follows up on recording, feeling euphoric and energized
THINKING	"I'm getting a migraine." "But I've been taking my preventative ... "	"My aura is too bad to drive, my husband will need to pick our grandson up from school."	"I wish someone would check on me." "I feel like I've been lying here for ages."	"I hope these meds don't give me a rebound headache." "Do I have any other choice?"	"That's the worst migraine I've had in a while." "What did I do wrong?	"I want to do something, I've had enough of just sitting around!"
TOUCHPOINTS	craving tingling sensation	visual aura migraine calendar	pain bed	medication heating pad	bed	energy migraine calendar
OPPORTUNITIES			Support from community members		Recording method that compiles reports/ summarizes data	



Age: 22
Gender: Female
Condition: Migraine with aura
Location: Berkeley, CA

Alejandra Ybarra

Hour 1 **TIMESCALE** Hour 12

	PRODROME	AURA	HEADACHE	TREATMENT	HEADACHE ENDS	POSTDROME
FEELING	Confused	Anxious	In pain	Frustrated	Relieved/Stressed	Overwhelmed
DOING	Out late at a party with her friends	Leaving the party with her roommate, begins to see visual disturbances (aura)	Arriving home, in pain and sensitive to light	Takes three Advil and goes straight to bed with an ice pack	Lays in bed until mid-afternoon when the migraine passes	Feels exhausted Records what she can remember from her attack in her journal
THINKING	"Why am I yawning so much?" "Maybe I should stop drinking."	"I hope my friends don't think I'm a buzzkill." "These auras always scare me."	"This is my fault. I shouldn't have even gone out tonight."	"Is it OK to take this much medicine?" "I don't feel like I have a choice."	"Thank God." "Now I won't have time to finish all of my homework."	"This weekend was supposed to be fun, my migraines ruin everything."
TOUCHPOINTS	alcohol friends	visual aura friends	photosensitivity pain	medication bed ice pack	bed	journal stress
OPPORTUNITIES	Tracking symptoms to recognize migraine sooner		Emotional/ community support	Increasing medical understanding		Make it easier to record in the moment

Appendix 9: Final Concept Presentation

meet ETO & UMO

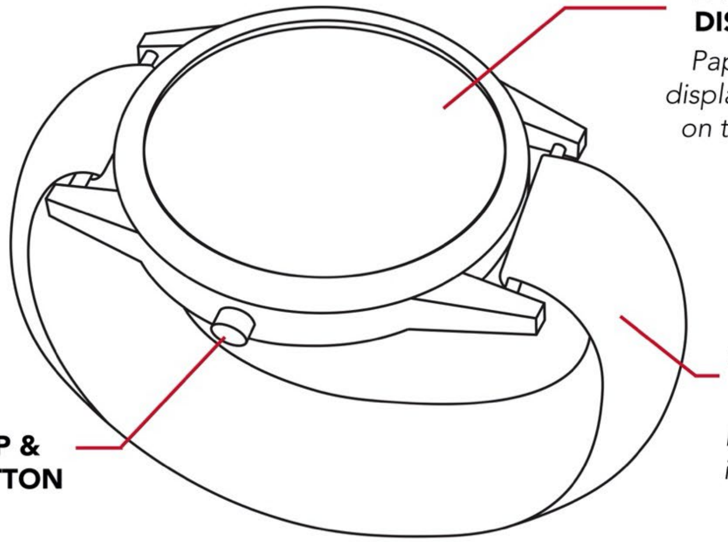
Migraine can be confusing, frustrating, and exhausting. But you don’t have to figure it out alone.

Together, **ETO** and **UMO** make up **PAGNO**, a product pair that helps you track and understand your attacks so you can build healthy, sustained, and impactful habits.

ETO ETO ETO

is a wearable recording device designed to help you track essential and immediate information about your migraines: pain onset, pain intensity, and medication administration. No need to worry about swiping through a dozen pages on a recording app or mustering the energy to find a pen and paper. **ETO** has got this — you focus on feeling better.

anatomy of
ETO



E-PAPER DISPLAY

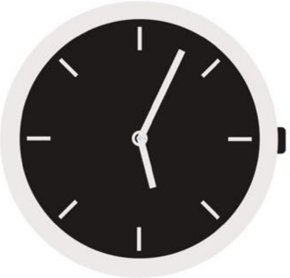
Paper-like display is easy on the eyes

CHANGEABLE WRISTBAND

Personalize with interchangeable wristbands

WAKE UP & SLEEP BUTTON

HOW ETO WORKS



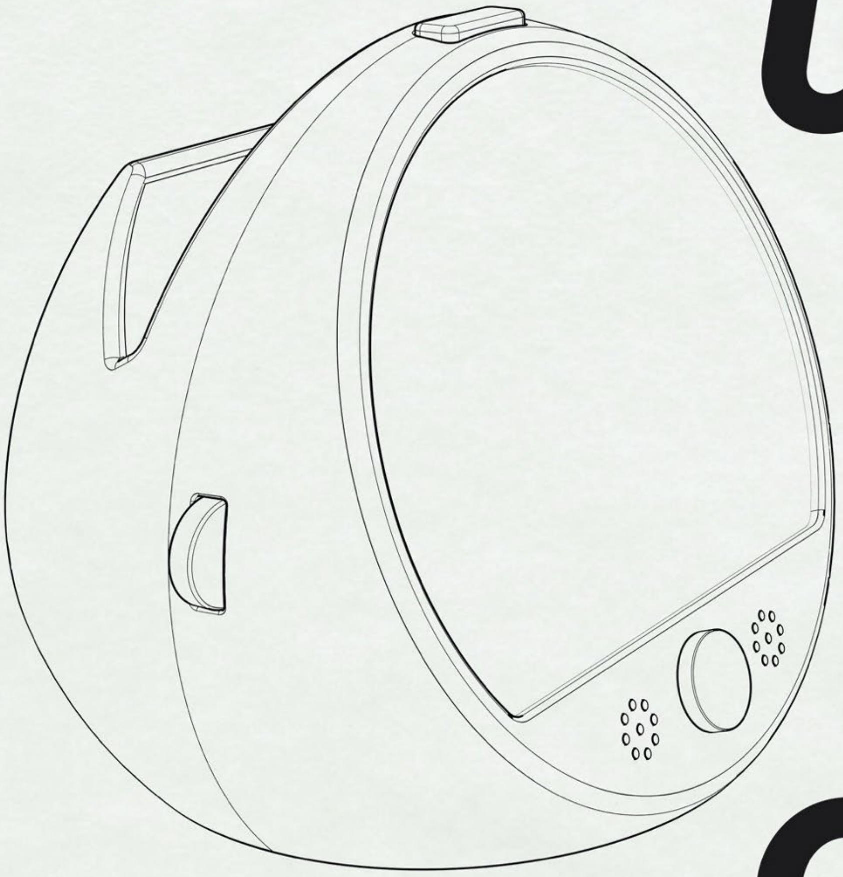
Clock is
displayed in
sleep mode.
Press the side
button to wake
your friend up.

Once your friend
is awake, you
may use the
touchscreen
to select menu
options.

Record only
the essentials,
including
pain level and
medication
administration.

If your pain level
changes, or
your take more
medication,
add to ongoing
recordings.

Once your pain is
gone, celebrate
with ETO



UMO

is your home base for recording migraine information. All the things we use to understand our migraines — sleep patterns, water intake, pressure forecasts — can be tracked and analyzed by UMO to help you figure out what migraine management strategies are right for you. UMO stays by your nightstand and incorporates into your existing routines, allowing you to build habits better.

OWN

UMO

"Decrease pain level to 3"
"I just took Zomig"
"Call mom."
"How long since I took my medication?"
"Set a timer for twenty minutes."

VOICE COMMAND BUTTON

WIRELESS CHARGING PAD

Always have a place for ETO to rest

Make adjustments, even with your eyes closed

BRIGHTNESS DIAL

VOLUME DIAL

WAKE UP & SLEEP BUTTON

SPEAKERS FOR AUDITORY FEEDBACK

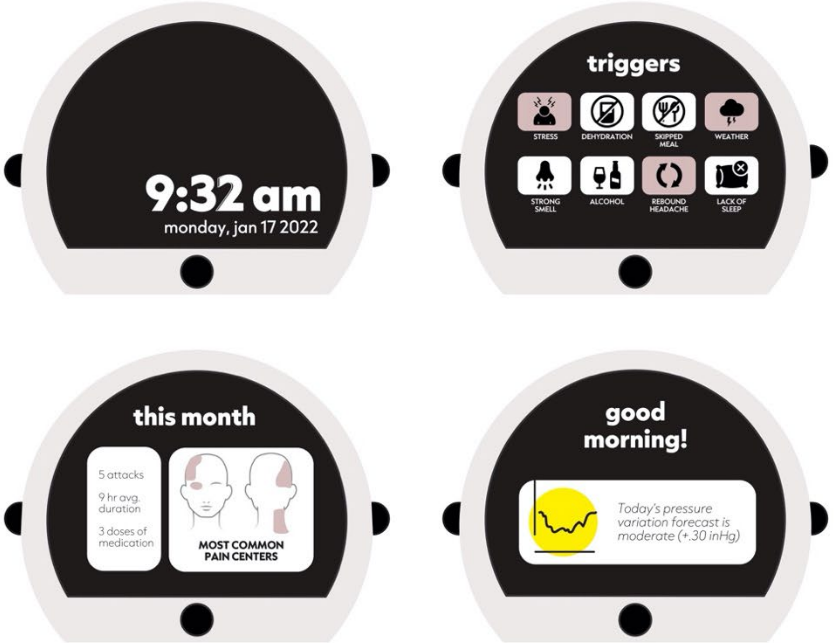
how it works:

UMO

ETO and UMO talk
to each other using a
Bluetooth connection
and sync automatically
as they charge

**With UMO,
You Can ...**

- Record and update migraine attacks
- Record daily habits and personal metrics (water, sleep, stress, etc.)
- Get reports that compile your past recordings
- Get personalized reminders



your care,

YOUR WAY.

Everyone's migraines are different, so everyone's management should look different, too. Customize how ETO and UMO support you using the PAGNO mobile app. By keeping track of the boring stuff on your phone, you free up the mental space to focus on your migraine management.

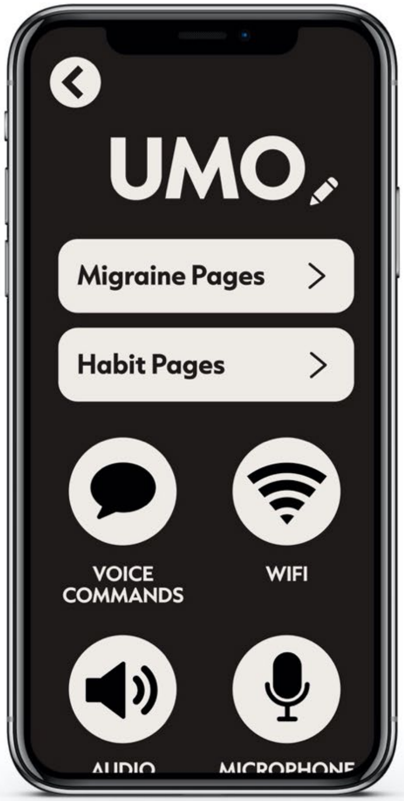
PAGNO MOBILE APP

MY MEDS

- ● ZOMIG 5 mg
- ● IMITREX 6 mg
- ● EXCEDRIN 250 mg
- ○ ZOFRAN 8 mg

REFILLS

script	last fill	remaining
ZOMIG	12/31/21	4
IMITREX	06/27/20	1
• ZOFRAN	01/17/22	0



RECOMMENDED

- ● Pain intensity
- ● Pain location
- ● Prodrome
- ● Symptoms
- ○ Relief methods
- ● Medication
- ○ Menstruation

OTHER

- ○ Attack type
- ● Affected activities
- ● Mood

let's get
TRACKING

ETO and UMO
shown to scale
with iPhone12 Pro

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