# Jessica Schroeder   Research Statement

Many patients and health providers believe that health technologies, particularly those that incorporate self-tracking, have the potential to provide a more complete, accurate, and longer-term understanding of an individual's habits and overall health. Such an understanding could lead to more personalized care. However, current tools often fail to support the goals people have for health tracking and management, leaving this potential largely unrealized. **My research focuses on supporting people and health providers in expressing and pursuing their multiple, distinct, and evolving goals to help them overcome barriers to personalized management for chronic health conditions**.

My research approach draws on **human-computer interaction** (HCI) theories and techniques to examine supporting patients and providers in specific health contexts, including: 1) **formative work** to identify needs, challenges, and opportunities within that context (e.g., through surveys and interviews); 2) **iterative design and development** of novel methods and tools to support patients and providers (e.g., through prototypes and implementations); and 3) **evaluations** of those methods and tools to understand how patients and providers use and respond to them (e.g., through deployments with pre- and post-interviews and surveys). Throughout this process, I **consult and collaborate with health professionals** to draw on existing medical expertise within those contexts.

Using this approach, I have investigated three health contexts characterized by complex, chronic symptoms that require personalized interventions to address: 1) mental health disorders, in which I investigated support for dialectical behavioral therapy; 2) irritable bowel syndrome, in which I investigated support for personalized trigger identification; and 3) migraine, in which I developed *goal-directed self-tracking*, a novel method to help people and health providers express and pursue their goals. My research in health and self-tracking has been supported by a National Science Foundation Graduate Research Fellowship, received a Best Paper Award (CHI 2017) and two Best Paper Honorable Mentions (CHI 2017, DIS 2018), and directly informed grants from both the National Science Foundation (IIS-1813675) and the National Institutes of Health (R01-LM012810). In the following sections, I review my research in the three health contexts I have examined. I then discuss some future directions in supporting personalized health and wellness.

Supporting Dialectical Behavioral Therapy for Mental Health Management

Approximately 18% of US adults experience a mental health disorder each year [5]. Dialectical behavioral therapy (DBT) is an evidence-based treatment designed to help people develop concrete skills to solve problems, maintain relationships, and navigate negative events and emotions. We investigated how we could foster DBT engagement and mental health management with Pocket Skills, a multimedia mobile web app designed to provide holistic support for DBT, including goal setting, educational components, skill practice, and self-tracking of positive and negative moods and behavior [12]. I joined the Pocket Skills project after initial formative work and development had already taken place, working with a team of HCI researchers, clinical psychologists, and mobile app designers and developers during a summer internship at Microsoft Research to translate the DBT skills training manual and workbooks into app content. We then conducted a 4-week field study with 73 participants to assess the feasibility of Pocket Skills. Throughout the study, participants completed surveys consisting of validated scales that allowed us to assess their progress in terms of depression, anxiety, and positive and negative coping skill use. The surveys also included open-ended questions asking what people liked and disliked about the app and whether and how it helped them. After the
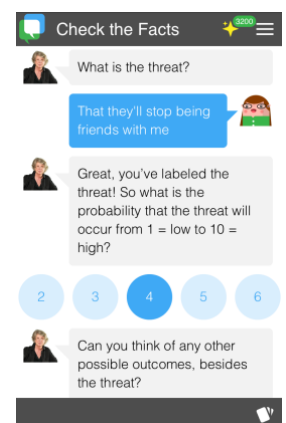
Pocket Skills supports people in learning and practicing skills which they then implement in their daily lives.

study, participants reported improvements that were both statistically and clinically significant (i.e., 50.0% of participants were "recovered" or "improved" in terms of anxiety, 26.4% in terms of depression, and 19.4% in terms of DBT skills use, with details of these scales and definitions in [12]). We also contributed a model of how participants felt Pocket Skills supported DBT, finding that the app helped them *engage* with their DBT and *learn* and *practice* skills that worked for them during times of distress, which enabled them to *implement* those skills in their daily lives, see *concrete results* of using the skills, and *increase their self-efficacy* to manage their mental illness.

Although participants were able to discover skills that worked for them using Pocket Skills, we would ultimately like the app to intelligently *recommend* skills based on the individual and their context. Such a recommendation could help ensure an individual can identify feasible and effective skills during times of distress. Because we collected app usage data throughout the study, we have a unique opportunity to investigate whether specific skills were more or less effective in reducing distress or emotional intensity; such data has not been available in traditional DBT practice and research. We are therefore currently analyzing that data to develop data-driven design implications aimed to inform how evidence-based treatments can be translated into a mobile technology and how technology-based interventions can be personalized to individuals and their context.

Supporting Personalized Trigger Identification for IBS Management

Irritable Bowel Syndrome (IBS) symptoms can often be triggered by certain foods, but different people have different triggers. Providers often recommend patients keep food and symptom journals to attempt to identify their personal symptom triggers [1], but both patients and health providers struggle to interpret resulting data (e.g., describing data as overwhelming, making biased and inconsistent recommendations). I investigated how to support people and providers in identifying personalized IBS triggers using food and symptom journals. Working on a multidisciplinary team of health and HCI researchers, I first developed analyses using food and symptom data to identify correlations between specific food nutrients an individual consumed and their subsequent IBS symptoms [13]. We then designed and developed interactive visualizations to help people explore relationships between the foods they eat, the nutrients those foods contain, and the symptoms that correlate with those nutrients [9]. We evaluated those visualizations in a feasibility study with 10 pairs of patients with IBS and health providers. We found that collaboratively reviewing the visualizations helped patients and providers interpret the data, communicate and apply their knowledge and expertise, and build mutual trust.

We designed our interactive visualizations to support exploration of a patient's food and symptom data, displaying which nutrients were significantly correlated with symptoms and which foods in their diet contained those nutrients. Our feasibility study revealed that such visualizations can enabled patients and providers to individually and collaboratively interpret and reflect on the patient's data.

Our interactive visualization helped people *form hypotheses* about which nutrients may trigger their IBS symptoms. However, as the underlying data was correlational, it was insufficient to establish causal patterns. I therefore collaborated in a project to design, develop, and evaluate a system that supports *hypothesis testing* by guiding people through personalized self-experiments to examine whether a particular nutrient causes symptoms [6]. We also characterized nuanced and personalized goals people often want to pursue *beyond* simply identifying whether a certain food can trigger IBS symptoms (e.g., cost-benefit analyses to determine whether to avoid a potential trigger in a particular context). In a follow-up study investigating personalized health goals [10], we proposed Bayesian methods to analyze self-experimentation data and produce representations that can better support these additional goals. I also adapted my visualizations in a collaboration to design and evaluate a mobile photo-based food and symptom journaling app, finding that photos can support identification of straightforward food-symptom relationships while my analyses and visualizations can support identification of more complex relationships [3].
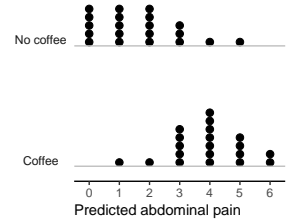
Using Bayesian modeling to generate predictive distributions, we can display predicted symptoms if an individual consumes (bottom) or avoids (top) a nutrient, supporting cost-benefit analyses.

Supporting Goal-Directed Self-Tracking for Migraine Management

My research in mental health and IBS examined supporting common goals patients and providers often have within those contexts and revealed opportunities to support more nuanced and personalized goals. Informed by this prior research, my work in migraine has focused on *goal-directed self-tracking*, a novel method to help people and providers express and pursue their specific goals. Goal-directed self-tracking aims to support people and their providers in: 1) understanding each other's tracking goals; 2) tracking exactly and only what they need to track to achieve those goals; and 3) interpreting resulting data relative to their goals. I am collaborating with the UW Headache Clinic to examine this method in the context of migraine, a condition characterized by debilitating symptoms that can be caused by the accumulation of a variety of personalized contributors [7]. To identify challenges and opportunities in migraine tracking, I first conducted a formative study in which I surveyed 271 people with migraine and conducted follow-up interviews with 13 survey respondents and 6 health providers [8]. Unpacking an overall management goal of reducing symptoms, we found four distinct categories of tracking goals that people often bring to migraine: 1) learning about their migraines; 2) predicting and preventing migraines; 3) monitoring migraines over time; and 4) fostering motivation and social recognition. Each goal category suggests different needs for data, analyses, and visualizations to support migraine-related tracking.
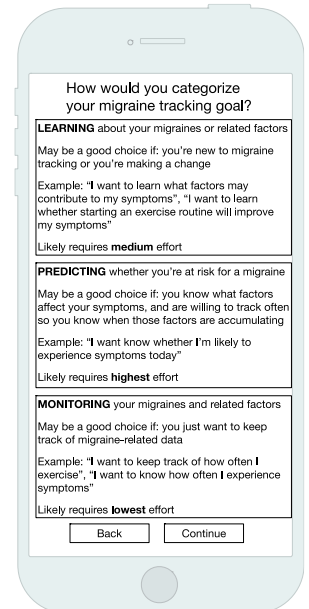
By explicitly asking why a person wants to track migraine-related data, we aim to 1) help them track exactly and only what they need to achieve their goals and 2) present goal-appropriate analyses and visualizations of their resulting data.

Building on this work, I have iteratively designed and developed a goal-directed self-tracking system that supports people in deciding *what*, *when*, and *how* to track toward specific goals, as well as appropriately interpreting the resulting data given those goals [11]. We first reanalyzed the formative study data to identify appropriate guidance for each goal category. Using a paper prototype to present these design ideas, we then conducted interviews with 14 people with migraine and 5 health providers. Our findings indicate potential for such a system to: 1) help people define and develop tracking and management goals; 2) encourage people to consider and prepare for all stages of self-tracking; and 3) contribute additional expertise in patient-provider collaboration. We also found pitfalls people may encounter when relying on a system's expertise or attempting to define and navigate appropriate tracking goals. Based on these findings, I am currently implementing my goal-directed self-tracking system, both to continue to develop and evaluate our ideas and to convey a specific example of how a goal-directed perspective can inform self-tracking tools. Implementing and evaluating this system will allow us to investigate how goal-directed self-tracking can help people collect, interpret, and act on migraine-related data and achieve their migraine-related goals.

Future Research Plans

My research has examined developing novel methods and tools to help patients and health providers better understand and manage chronic health conditions. In the future, I plan to continue to investigate how personal informatics tools can help people understand, manage, and improve their health and wellbeing. I am excited to pursue this research in an industry context, because I believe doing so will provide the best opportunities to have widespread impact in helping people achieve health-related goals. In this section, I discuss two specific challenges I plan to investigate in my future work.

Incorporating and Personalizing Expert Knowledge

My research has often focused on supporting collaborations between a patient and their provider. Although such collaborations are often beneficial, many people lack access to healthcare they need. In the future, I therefore hope to investigate how tools can incorporate expert knowledge to help people more independently understand and manage their health. For example, successful migraine management often requires minimizing acute medication use (i.e., painkillers taken in response to symptoms), as frequent use can contribute to migraines, creating a negative cycle in which people continue to get more migraines and take even more medication to attempt to control them. However, my formative study [8] revealed that many people with migraine, and even some primary care providers, are unaware of this cycle. I would like to investigate when and how tools could incorporate such information to help people gain necessary understanding for their health management.

Although expert advice is often necessary to help people manage chronic conditions, many population-based suggestions may not apply to specific individuals. Population-based knowledge can therefore be insufficient (e.g., by not including edge cases that only apply to a small subset of the population) or excessive (e.g., by recommending significant behavior change where a less burdensome change could have the same results). I would therefore like to investigate how tools could recommend interventions based on a particular individual and their context, incorporating data and machine learning techniques to leverage population-based information to personalize an individual's care. For example, we hope to complete a follow-up study on Pocket Skills [12] to examine whether personalized skill recommendations can help people manage distressing situations.

Examining Goal-Directed Self-Tracking Beyond Chronic Condition Management

My prior work has focused on helping people collect and interpret data related to their chronic conditions. In the future, I hope to examine how goal-directed self-tracking can support health and wellness goals beyond chronic conditions. I have had the opportunity to collaborate on a couple of projects my colleagues led in this area. For example, I contributed to a study investigating how people use Instagram to support healthy eating, finding that people use the social platform both to seek and to provide encouragement in the pursuit of healthy eating goals [2]. I also helped investigate how tools can better support menstrual tracking, finding that tools can be exclusionary when designed with inaccurate assumptions about people's identities, backgrounds, and goals [4]. Supporting the general population in maintaining and improving their health is extremely important, in part because doing so can help prevent future health issues. However, designing for the general population brings additional challenges. For example, people with chronic conditions are often highly motivated when they believe self-tracking will support their condition management, but the general population may be less willing to dedicate time to self-tracking. People with chronic conditions also tend to have well-defined and predictable high-level goals (e.g., reducing or preventing symptoms), but general health and wellness goals may be broad and hard to define. I would like to investigate how goal-directed self-tracking could support these more general health and wellness goals.

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