Enhancing Personal Health Informatics Through App Integration and End-User Programming of Automated Tasks

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Abstract
Integration platforms (e.g. IFTTT.com) let end-users program simple *personal automations* that integrate different systems to perform useful tasks. This study explores the types of health-related tasks that users choose to automate when given a platform that can integrate different health technologies. Participants created a wide variety of different types of personal automations to send them alerts, consolidate information into email or calendars, and even attempts to "program" their own behavior. The study illustrates that an integration platform that incorporates a visual, end-user programming interface can be a powerful tool for empowering people to design and craft a personal ecosystem of health technologies and adapt these technologies to individual needs.

Keywords
Health Informatics, End-User Programming

Introduction
Integration platforms such as IFTTT, Microsoft Flow, and Zapier have recently emerged to provide simple visual programming interfaces that allow non-technical users to program *personal automations.* Personal automations are small programs or macros that execute simple rules to complete a task using one or more existing systems. For example, using IFTTT, users can write a program to track how much time they

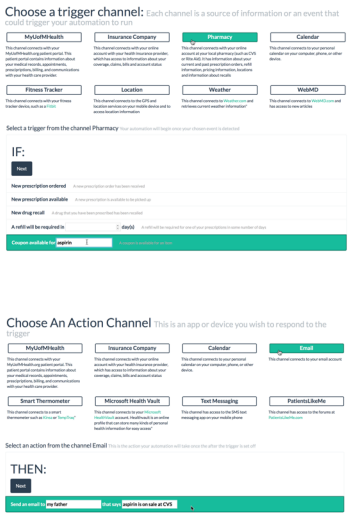

Figure 1. End-user programming interface for creating personal health automations.

spend at work by automatically recording the time their phone enters or leaves their workplace to a cloud-based spreadsheet. In creating a personal automation such as this, and end-user integrates the functionality of two different systems in order to fulfill an otherwise unmet need for the technologies.

Integration platform users have created thousands of creative and innovative personal automations, particularly in the domain of smart homes and the Internet of Things [6]. Current platforms, however, have very little connectivity with health-related systems and devices such as electronic health records, at-home monitoring devices, insurance company web portals, pharmacies, or health-focused online communities.

Previous HCI work [1] has sought to empower users in creating their own health technologies, thereby making these technologies more personalized and effective. Integration platforms and end-user programming similarly can empower users to participate in the design of not only a specific system, but the way that different systems work together to support health. As health technologies are often poorly integrated both with each other and with other technologies that people use in their daily lives to manage information [5], an integration platform has tremendous potential to empower users to integrate systems and personalize health IT to automate important tasks and make the technologies work together for each user.

In this paper, I explore how an integration platform might be used to help users integrate different parts of their health IT ecosystem and automate tasks to help manage their health information. Through a user study in which participants create automations using an end-user programming interface, I demonstrate that there are many important opportunities for automation in personal health informatics, and that an integration platform offers a flexible solution that enables individuals to adapt and integrate health IT to meet their own specific needs.

Methods

I created an end-user programming interface (Figure 1) that would allow users to write personal automations in the management of health information. This interface was modeled after IFTTT.com's interface in which users select *channels* (i.e. apps or devices) that will be used in the automation, then create an "if-this-than-that" rule. For example, using this interface, a user could create an automation with the following structure:

IF: A new test result is added to online patient portal
THEN: Create an event in your calendar that says [new test result is available]

The interface allowed users to create hypothetical automations using 30 different apps or devices, such as an online patient portal, accounts with a pharmacy and insurance company, a personal health record like Microsoft Health Vault, connected medical devices and sensors such as fitness trackers, at-home blood glucose monitors or fertility monitors, and other major online sources of health information such as WebMD or Drugs.com. In addition to these health-specific channels, there were several more general channels such as email and messaging, phone API's, social media sites, calendars and cloud file storage services.

34 participants were recruited from a clinical trials registry at the University of Michigan to participate in

Automation Purposes

- Alert or remind the user to do something
  - IF: prescription is ready for pickup THEN: Send [me] a text message
- Share information with others
  - IF: New article on WebMD about [Depression] THEN: Create a tweet that says [link]
  - IF: New blood glucose measurement greater than [200] THEN: Send message to [my doctor] on patient portal
- Track and Archive Data
  - IF: You record less than 3000 steps THEN: Add a row to spreadsheet containing [dates I did not meet my goal]

Figure 2. Automation purposes with examples. Note that the categories are not exclusive, and most automations fit into multiple categories.

an initial study of this system. 55% of participants were female, ranging from ages 18 to 69 (median age 29). Participants received a $5 gift card for the study.

In this study, participants were asked to create at least five hypothetical automations that they would find useful in their daily use and management of health information. After creating each automation, participants provided a written description of the automation and explained why they would find it useful. Participants created a total of 201 automations for this initial study. As these automations were not functional, participants were asked to provide parameters within each automation that would be helpful to the researchers in analysis of the automation. For example, for automations that sent an email, participants provided a meaningful description of the email recipient such as "myself" or "my father" rather than an email address. This helped provide additional context about the value and purpose of the automations.

Analysis

I performed an inductive qualitative analysis on the automations and their descriptions in order to categorize them and arrive at a set of broad purposes or needs that can be fulfilled through an integration platform for personal health informatics.

In this analysis, I looked at each automation and noted any generalizable function(s) or purpose(s) that might be fulfilled for a user. The descriptions of the automations often made explicit statements suggesting its general purpose, but often this process required some inference into how such an automation might be useful. After looking at all automations and giving each at least one code representing a more general purpose or need, I took several additional passes over the dataset to consider what other codes might apply to a given automation and to begin to refine or consolidate codes into clear themes. After the set of codes had been established, a second coder independently analyzed the data, and we subsequently met to consolidate the codes and discuss disagreement.

Automation Purposes

There was minimal duplication between participants' sets of automations, as the there were 129 unique automations within the set of 201 created by participants (64%). This illustrates that there is a broad set of issues in personal health informatics that users can resolve for themselves using an integration platform and end-user programming interface.

Several themes were abstracted from the automations and their descriptions that illustrate important needs in managing and interacting with health IT that can be fulfilled through personal automations. These themes are listed with examples in Figure 2 along the left side of the subsequent pages.

The most common type of automation was "alerts" or "reminders" to help the user take a specific action at the appropriate time. Other common types of automations were meant to share information with doctors or others, or to assist in "quantified self" [3] practices of tracking and archiving health data from sensors. Participants frequently mentioned a fear of their own forgetfulness or that their healthcare provider would forget or overlook something. Participants wanted to use automation to provide some backup and

Automation Purposes

- Consolidate or integrate interfaces
  - IF: New appointment created in patient portal THEN: Create event in calendar
  - IF: New test result is available in patient portal THEN: Send [me] an email containing [test result]
- Regulate Behavior
  - IF: You enter [a grocery store] THEN: Send [me] a text message that says [Don't forget produce]
  - IF: Less than [8 hours] of sleep is recorded THEN: Delete events from calendar [in the evening]
  - IF: Daily goal for steps is not reached THEN: Post a message to Facebook that says [I didn't reach my goal today]

Figure 2 continued.

prevent errors, or to prevent other mistakes like mistyping something.

Consolidating interfaces

Many automations and/or their descriptions indicated a need or desire to consolidate the users' different interfaces to health information into a single location or into something that the person uses every day for non-health information tasks. The most common example of this were automations that put events or todo items like new appointments or prescription refills into the user's mobile calendar, as many participants noted in their descriptions a strong need to have "everything in one place" or to "avoid logging in." Some participants described this desire as a way to ease the retrieval of information at the moment they anticipate needing it, such as in an appointment or at the pharmacy. Users may find it easier to retrieve information from their email account, calendar, or text messages which are used every day than to retrieve information from a seldom used system like a personal health record or pharmacy online account.

Klasnja et al. [4] describe the issue of "unanchored information activities" that are prevalent in health information management. Interaction with health information can happen at unpredictable times or locations, and access to tools may be limited at the moments they are most needed. For example, users may need to see their calendar's when scheduling appointments but they may not be available at the needed moment. Klasnja et al. find that even users of mobile technologies for health management desire to consolidate their interaction with health information. For example, in their study, users expressed a strong desire to have health-related appointment calendars simply integrate with their regular calendars. The findings from this study of personal automations corroborate those findings, as many automations were used to simply push information from an app or website into a calendar, email, or text messaging app that would be easily accessed on a mobile device.

Regulate Behavior

Many participants described their automations as a way to regulate either their own someone else's behavior. Some people created automations that would establish some type of accountability for their behavior. For example, one automation automatically posted a message to Facebook if a sleep monitor detected that the user had slept in, as *"publicly announcing this would limit me from [sleeping in]"* (P22).

Several automations, however, used the programming platform as a way to "program themselves" by automating good behaviors or using the automation to remove the person from a situation in which they might make a poor health decision. For example, one automation was set up to place an order for vegetables every payday. The participant stated that *"When I get paid, I sometimes decide to go and eat out, at which times I do not make the healthiest choices. If there would be a way to automatically place an order for healthy foods on payday, then it takes the decision to purchase unhealthy foods out of the equation"* (P11).

One participant created an automation to send themselves a text message with the words "Stay home, you're sick today" if their temperature, taken by a smart thermometer, indicated a fever. This participant explained *"A lot of times I need more than myself to tell me I'm sick and that I should take it easy. Getting*

Automation Purposes

- Reduce Burden or Repetition
  - IF: Humidity rises above [80%] THEN: Turn on air conditioning
  - IF: An item named [vitamins] goes on sale at pharmacy THEN: Place an online order for [vitamins]

Figure 2 continued

an objective text would make it easier to rationalize taking care of myself." (P44)

These examples suggest an important direction for future research. This type of platform for automation of health-related tasks has the potential to change the context in which people make many kinds of important health decisions. In writing even a simple automation, users must be introspective and think through their preferences, values, and goals for the future (when the automation will actually run). In this context, people may be more inclined to make decisions that are better for long-term health than for short-term needs, and by automating the execution of those decisions they may be more empowered towards achieving those goals.

At the same time, research on end-user programming has suggested that many people avoid explicit planning and thinking through an entire program from the top down, but rather create then adjust as problems arise [2]. Thus there may be unforeseen consequences for users who write automations. An important step for this research is to investigate the use of these automations over time.

Reducing burden or repetition

Participants frequently described the ways that automations could reduce some burden associated with managing their health. For example, one participant indicated a frustration with constantly monitoring their insurance coverage for changes related to a specific condition, noting that one often only finds out about coverage changes when a claim is rejected and then must go through an appeal, because constantly monitoring coverage information is *"too time consuming"* (P9). Automating this process can save time and energy both in having to monitor coverage and in filing appeals.

Similarly, another participant created an automation to immediately file an insurance claim whenever a new bill arrives, noting that *"Because we have prescription medication coverage under two different health insurance plans, we now have to file a prescription claim ourselves with our secondary insurance when the primary does not cover a prescription or only partially covers it. This would be helpful with both maintenance prescriptions that are ordered thru an online service or with one time prescriptions ordered thru a local pharmacy"* (P42).

As the healthcare system is filled with roadblocks for patients that can require significant time, energy and resources to navigate, an automation platform can give users a powerful tool for finding and sustaining success in this effort.

Furthermore, these examples highlight how an automation platform can leverage the power of a bottom-up participatory design for healthcare infrastructure. As users identify problems, gaps, and other small opportunities to improve efficiency through automation, they are empowered to simply create and implement a solution that works for themselves that can also subsequently be shared to other similar users.

Discussion

The need for integration of health technologies to better fit user needs is well established [5]. This study offers evidence that end-users of these technologies themselves can be effective designers of these integrations if given a powerful and usable platform.

With relatively little effort (the median time to create an automation was just under 1 minute), users crafted solutions to broad set of different problems and challenges for managing and using health information technologies.

There are also important design implications for health IT from these findings. Creators of health IT should design for integration by considering how people might use its information outside of an app itself, such through an email inbox or calendar. As users will seek to integrate the information provided by a health technology with their day to day lives, health information should be accessible to other systems and usable within those contexts.

As personal automations open up opportunities for people to effectively "program their own behavior," future systems and integration platforms need to provide guidance about how to do that effectively. Cao et al. [2] found that end-user programming asks users to simultaneously think like designers, programmers, and users, as well as think through future conditions and contingencies and to make decisions. This is a complex task that users may require guidance to do well. Future work in this area should also explore how these automations are used over time and evaluate their effectiveness in achieving users' goals and in promoting healthy behavior and positive interactions with health IT.

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