Digital Histories for Future Health

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Abstract
In this paper we describe the opportunity for digital behavioral histories to empower individuals to engage in positive health behaviors. The digital trails we leave by using various social, mobile and web services and self-tracking tools can be used to create a compelling digital narrative of past behaviors. The use of these digital narratives should be explored for the purpose of facilitating self-efficacy and positively re-framing health behaviors. We first describe the digital environment that supports our concept of digital histories. We then explore the current methods being employed by health services. Lastly, we explain the theoretical value of digital narratives and give examples of possible implementation strategies that could be used to influence health behaviors.

Keywords
Personal Informatics, Digital Histories, Behavior, Personal Health, Self-Efficacy

ACM Classification Keywords
H5.2 User Interfaces: User-centered Design; Theory and Methods

General Terms
Human Factors, Theory, Design

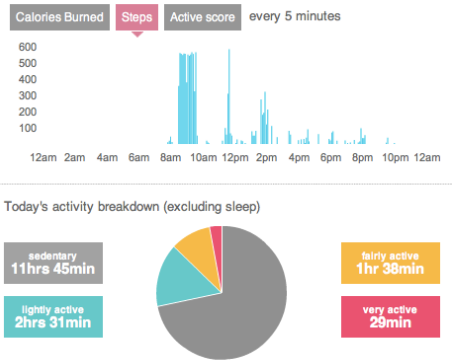

figure 1. Visualization of the daily data recorded by the FitBit physical activity tracker.

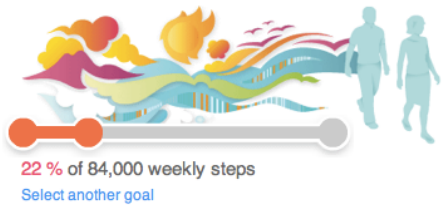

figure 2. Visualization of weekly goal progress for steps measured by the FitBit physical activity tracker.

The Age of the Database

The evolution of technology, and our interactions with it, has brought about a new paradigm in our daily lives. Simply put, our every interaction with an online presence is associated with a database entry. Our everyday experiences with the web, and the entities that use web services/architecture are recorded, saved, and in some cases used to personalize our web experience. For instance, Google allows users to have their browsing history tracked and saved (via cookies) in order to present the user with what Google deems relevant advertisements thought their AdSense network [1]. This operation of personalized advertisements occurs in part because the user has implicitly agreed to the passive tracking of user web-behavior. This passive tracking, while reviled by some has allowed Google, and other services, to create a user-experience that is deeply connected to user behavior.

The passive tracking of user-behavior also has an interesting counterpart in user-initiated active tracking of behaviors. This method of data capture is typified though the use of web and mobile services that offer utility or entertainment. There are numerous examples of these types of services that require an active user for data capture. For example, Foursquare, a mobile location-based service, allows users to "check-in" at locations. The geo-spatial data from the location is also tied to additional data provided by other users in the form of pictures and location-specific tips (e.g. recommended menu items for a restaurant). The user only sees the tips or images if they actively inform Foursquare, in essence updating their database, with their current location. The same active-user database additions can be seen in status updates to Facebook or tweets via Twitter.

Health Data and Tracking

There is a growing trend in the consumer market to develop sensors and services that support the gathering of health and health-related data. Currently consumers can access personal informatics tools and services that analyze and provide reports on a wide range of health aspects and behaviors such as DNA profiles (23&Me, Pathways), daily step counts (FitBit, Striiv), sleep patterns (ZEO, Wakemate), dietary intake (The Eatery, Food by Evernote, DailyBurn), mental health (MoodJam, Moodscope) among others. Often many of the tools, applications and services used to track personal health data focus on helping users live healthier lives. Naturally, helping an individual lead a healthier life inherently creates a future-focus environment in which the user is presented data, analytics and recommendations for positive health behavior change in the future. This is typically accomplished through two methods, current data and goal progress information. First, users are provided data and visualization that describe their current behavior in the context of the most current measurement period (see figure 1). Secondly, as most services attempt to provide users with mechanisms for behavior change, there is typically a focus on short-term (daily) and long-term (weekly, monthly) goals. Progress towards the attainment of a goal at some point in the future is also accomplished through visualization schemas (see figure 2).

While the use of health tracking tools and services can provide users with meaningful mechanisms for behavior change, we argue that there might be additional use cases that take advantage of the large amount of historical data being gathered.

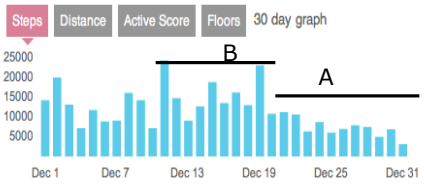

Figure 3. Example of pattern identification in historical behavioral data.

How might we combine these data to support future health?

The advent and increasing popularity of application programming interfaces (APIs) for these types of data gathering systems offer fascinating new opportunities for combining these data in, as of yet, uncharted ways. Through a combination of past behaviors, contextual information such as location and interactions with others (e.g., scraping info from email, Facebook, etc.), and complemented with health actions, there may be unique opportunities for highlighting patterns and accomplishments within past behavior, which could be fed back to users in order to promote successful behavior change or habit maintenance. We explore three possible mechanisms: (a) reminder of success, (b) historical behavior prompting and (c) contextual reminders, that take advantage of the rich digital histories being developed by health tracking users.

Reminders of Success

One of the possible mechanisms for using rich data to influence future health is through using reminders of past success (positive behavior) when "failure" points or lapses in health behaviors are identified. Often times when a user fails to meet a goal it can lead to negative framing and self-doubt about his or her ability to accomplish the behavior of interest [2]. This is manifested in a reduction in self-efficacy (i.e., one's confidence in his/her ability to do a specific action such as be physically active) [3]. Self-efficacy has consistently been shown to be a key predictor of future behavior [4]. We propose that an intelligent data-mining application could be used to identify when behavioral lapses occur and present a user with information about historical behaviors and/or behavioral patterns associated with success. Reminding individuals that they are capable of obtaining goals and/or positive levels of a given behavior may help individuals to reframe their experience with the behavior. In essence, we believe that this reframing may help to reduce the psychological burden related to the failure to meet goals by using past behavior to support self-efficacy for future behavior. For example, in figure 3 we see an interesting pattern of physical activity behavior. One can easily see that period A differs greatly from period B. An intelligent system could easily identify the drop-off in steps during the onset of period A and remind an individual that they very recently were able to obtain a higher, and healthier, level of behavior.

Historical Behavior Prompting

There are many other psychological principles that could be harnessed to capitalize on this type of system. Classic social learning theory [2], the precursor to social cognitive theory, highlighted the importance of modeling for promoting learning. Couple this with the potential power of a past-self avatar providing guidance on strategies, contextual factors, and one could quickly see this as a powerful mechanism for future behavior change. As suggested by the Proteus Effect, a digital presentation of an individual (i.e., avatar) can potentially influence future behaviors by providing implicit cues with regard to how to act [5]. Metaphorically, a person's past could literally come alive, possibly via a past avatar, to prompt continued engagement in health behaviors. The classic studies on this had individuals engage with an avatar in an immersive 3-d environment. Within these environments, individuals were randomized to see their avatars in a variety of contexts and settings. Most interesting for health promotion, one group was

randomized to see their avatars running on a treadmill. During the next few days, these individuals exercised significantly more than other groups. This visual was fictional and made up, but what if past selves could be recreated to help spur on health behaviors. In this way, the past, when a person was successful, even if just briefly, could be utilized as a model for promoting behavior change. This past-self avatar could function as a contextually similar and powerful comparative example for self to help spur new behaviors. It would function much like the descriptive (i.e., how many people do an action) or even injunctive (i.e., how many people believe something about a given act social norm) [6]. A person's past self would be a highly relevant comparison group, which has been shown to be a key factor for utilizing social comparison to create change [7]. Similarly, for those with a competitive spirit, these past digital narratives could be used as a baseline of comparison for which people could work towards competing with themselves.

Contextual Reminders

The addition of multiple data streams can help to provide contextual information that may support users behavior change. For example, data mining could be conducted to explore characteristics of locations, based on a person's digital history, that were linked with improved health behaviors such as increased physical activity. These patterns could then be fed back to an individual as a mechanism for supporting future tasks. Another contextual pathway of interest to explore could focus the use of seasonality and its relationship with different behavioral actions. For example, in temperate zones such as the northeastern part of the United States, certain activities are only possible during certain seasons. In the springtime, a person may enjoy running while in the summer, mountain biking, in the fall, indoor basketball and in the winter skiing. Many health promotion interventions do not adequately take advantage of this seasonal impact on health behaviors. A digital narrative of ones past could also be used to highlight fun healthful activities that a person may have done during previous seasons but may not be engaging in this particular season. In this way, the past self could be used again to help spur on reminders to engage in, re-enjoy and celebrate the healthful activities (or perhaps healthful seasonal foods) during the appropriate season.

Conclusion

In this paper we explored a novel way to use the historical digital data currently stored via numerous tools and services to impact and influence current and future health behaviors. The proliferation of self-tracking mechanisms will have a profound impact on an individual's ability to understand their behavior. Currently, the majority of tools and services focus on future outcomes and goal setting strategies. We argue that the richness of historical data may provide unique methods for interacting with users in ways that can lead to improved self-efficacy, self-based modeling, and contextual cues that can positively impact health behaviors. Moving forward, we suggest that individuals involved in the design of self-tracking systems explore the implementation strategies discussed here that take full advantage of our growing digital histories.

Citations

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